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Microbiological sampling of swine carcasses: A comparison of data obtained by swabbing with medical gauze and data collected routinely by excision at Swedish abattoirs

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Abstract

Swab sample data from a 13-month microbiological baseline study of swine carcasses at Swedish abattoirs were combined with excision sample data collected routinely at five abattoirs. The aim was to compare the numbers of total aerobic counts, Enterobacteriaceae, and *Escherichia coli*, recovered by swabbing four carcass sites with gauze (total area 400 cm^2) with those obtained by excision at equivalent sites (total area 20 cm^2). The results are considered in relation to the process hygiene criteria that are stated in Commission Regulation (EC) No 2073/2005. These criteria apply only to destructive sampling of total aerobic counts and Enterobacteriaceae, but alternative sampling schemes, as well as alternative indicator organisms such as *E. coli*, are allowed if equivalent guarantees of food safety can be provided. Swab sampling resulted in higher mean log numbers of total aerobic counts at four of the five abattoirs, compared with excision, and lower or equal standard deviations at all abattoirs. The percentage of swab and excision samples positive for Enterobacteriaceae at the different abattoirs ranged from 68 to 100% and 15 to 24%, respectively. Similarly, the percentages of swab samples that were positive for *E. coli* were higher than the percentages of positive excision samples (range 52 to 84% and 3 to 14%, respectively). Due to the low percentage of positive excision results, the mean log numbers of Enterobacteriaceae and *E. coli* were only compared at two and one abattoirs, respectively, using log probability regression to substitute censored observations. Higher mean log numbers of Enterobacteriaceae were recovered by swabbing compared with excision at one abattoir, whereas the numbers of Enterobacteriaceae and *E. coli* did not differ significantly between sampling methods at one abattoir. This study suggests that the same process hygiene criteria as those stipulated for excision can be used for swabbing with gauze without compromising food safety. For monitoring of low numbers of Enterobacteriaceae and *E. coli*, like those found on swine carcasses at Swedish abattoirs, the results also show that swabbing of a relatively large area is superior to excision of a smaller area.

Keywords: Slaughter swine; Process hygiene; Sampling methods; Total aerobic counts; Enterobacteriaceae; *Escherichia coli*

1. Introduction

The Commission Regulation (EC) No 2073/2005 on microbiological criteria for foodstuffs states that food safety is primarily ensured by preventive approaches, such as implementation of good hygiene practice and application of procedures based on hazard analysis and critical control point (HACCP) principles (Anonymous, 2005). Microbiological criteria are useful for validation and verification of HACCP procedures and other hygiene control measures. Process hygiene criteria for mean log numbers of total aerobic counts and Enterobacteriaceae on carcasses of swine and other animals are given in the Commission Regulation. These criteria apply only to samples taken by a destructive method but the use of other sampling and testing schemes, including the use of alternative indicator organisms such as *Escherichia coli*, is allowed provided that the guarantee of food safety is at least equivalent (Anonymous, 2005).

The relative efficacy of destructive and various non-destructive sampling methods have been compared in several studies. Sampling by excision is commonly considered to be the preferred method for recovery of bacteria from beef and swine carcasses (Bolton, 2003; Capita et al., 2004), based on the

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assumption that higher numbers are recovered and that lower variation is achieved compared with swabbing. This is the case when excision is compared with the wet–dry technique in which swabbing is performed by using cotton-tipped stick swabs (Dorsa et al., 1996; Gill and Jones, 2000; Hutchison et al., 2005), whereas swabbing with more abrasive materials than cotton wool (e.g. polyurethane sponges or medical gauze pads) have been shown to recover bacterial numbers similar to those obtained by excision (Dorsa et al., 1996; Gill and Jones, 2000; Byrne et al., 2005; Pearce and Bolton, 2005). Sampling by swabbing is considered advantageous for the meat industry because it is less laborious than excision sampling and does not compromise meat quality. Swabbing usually covers larger carcass areas than excision and may therefore be more reliable for monitoring of *Salmonella* or other pathogenic microorganisms that occur at low numbers (Bolton, 2003).

In this paper, microbiological swab sample data from a 13-month baseline study of swine carcasses at Swedish abattoirs (Lindblad et al., in press) were combined with excision sample data collected routinely at five abattoirs during the same period. The aim was to compare the estimated numbers of total aerobic counts, Enterobacteriaceae, and *E. coli* obtained by swabbing with gauze with those obtained by excision. The results are considered in relation to the microbiological criteria in Commission Regulation (EC) No 2073/2005.

2. Materials and methods

2.1. Excision samples

Sampling of indicator bacteria on swine carcasses is performed routinely at Swedish abattoirs in accordance with the Commission Regulation (EC) No 2073/2005 (Anonymous, 2005). Sampling is normally performed once a week at alternating weekdays. During each sampling session five carcasses are sampled after dressing but before commencement of chilling. Tissue samples of 5 cm^2 each are excised from four sites: ham, back, belly and neck (total area 20 cm^2). These sampling sites are in accordance with those suggested in the EC Decision of 8 June 2001 (Anonymous, 2001), with the exception that the neck is sampled instead of the jowl. Pooled samples from each carcass are then analyzed for total aerobic counts and Enterobacteriaceae, either by laboratory personnel at the abattoirs or by commercial laboratories. In addition, analyses of *E. coli* are performed at some abattoirs.

2.2. Swab samples

A 13-month microbiological baseline study was performed from September 2004 through September 2005 (Lindblad et al., in press). Swab samples were collected from swine carcasses at the 10 largest abattoirs in Sweden by staff from the National Food Administration. The number of samples per abattoir was proportional to the annual slaughter volume and randomly distributed over the sampling period. During sampling weeks, sampling was performed on Mondays and Tuesdays by swabbing of two to nine carcasses after dressing but before commencement of chilling. As described in detail in Lindblad et al. (in press), one sterile medical gauze pad per carcass was used to swab an undelimited area of approximately 10×10 cm^2 at each of the four sites that are equivalent to those sampled by excision: ham, back, belly and neck (total area 400 cm^2). The samples were sent chilled overnight to the National Food Administration for analysis. In total, 541 swab samples were analyzed for *E. coli* and a selection of pathogenic bacteria (Lindblad et al., in press). About half of the samples were analyzed for total aerobic counts, and half were analyzed for Enterobacteriaceae.

2.3. Microbiological analyses

Excision samples were analyzed for total aerobic counts, Enterobacteriaceae and *E. coli* in accordance with methods described by the Nordic Committee on Food Analysis (NMKL). After homogenization of the samples by stomaching in peptone water, the total aerobic counts were determined by mixing 1 ml of suitable homogenate dilutions with melted plate count agar

Table 1
Occurrence and numbers of total aerobic counts on swine carcasses at different abattoirs as estimated by either excision or swab sampling

Abattoir	No. of sampling weeks	Sampling method	No. of samples	No. (%) of positive samples	Mean[a] (SD[b]) number (log CFU/cm^2)	Log A[c] (log CFU/cm^2)	No. of weeks with a mean number exceeding m[d]
A	20	Excision	105	101 (96)	3.6 (0.8)^A	4.5	5
		Swabbing	83	83 (100)	4.0 (0.4)^B	4.4	8
B	20	Excision	110	110 (100)	3.7 (0.7)^A	4.5	1
		Swabbing	57	57 (100)	3.3 (0.5)^B	3.8	0
C	9	Excision	45	42 (93)	2.7 (0.5)^A	3.4	0
		Swabbing	22	22 (100)	3.4 (0.5)^B	4.0	1
D	10	Excision	51	12 (24)	2.2 (0.9)^A	3.3	0
		Swabbing	28	28 (100)	2.9 (0.6)^B	3.6	0
E	9	Excision	45	45 (100)	3.9 (0.4)^A	4.3	3
		Swabbing	25	25 (100)	4.2 (0.3)^B	4.6	5

[a] Mean of log-transformed bacterial numbers. The results of the two sampling methods were compared for each abattoir. Means with different letters differ significantly (t-test, $P<0.05$). Results below the detection limit were estimated by using log probability regression.
[b] Standard deviation.
[c] Log arithmetic mean.
[d] Limit between satisfactory and acceptable results (4.0 log CFU/cm^2).