4:7

Microbiological Measurements of Hygiene in Danish Abattoirs

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SUMMARY: The level of hygiene in three randomly chosen Danish pig abattoirs has been surveyed. Six sites on th carcasses were studied: three sites on the rind surface and three sites on the meat surface. The same carcasses hav been checked before evisceration, after final slaughtering, and after chilling. The study includes a total of 17 carcasses.

Total counts and Enterobacteriaceae counts varied greatly among the different sites on the carcass. The highes total counts were found on the rind surfaces; among the sites surveyed the hind leg (rind) showed the highest count On the meat surface, the split sternum area showed the highest total count.

In general, there is a drop in total count on the rind surface between "before evisceration" and "after fin slaughtering". However, the Enterobacteriaceae counts indicate that bacteria from the intestine, tools/equipment or operators contaminate the carcass on the clean slaughterline.

INTRODUCTION: Implementation of Hazard Analysis Critical Control Points (HACCP) schemes and/or Microbiologic quality assurance presumes knowledge of the microbial level, i.e. how the level of contamination varies at differe sites on the carcass and where on the slaughterline contamination occurs. In earlier surveys of bacteriologic contamination of carcasses after various processes, (SNIJDERS et al. (1976), GERATS et al. (1982), and NERBRINK a BORCH (1989)) one sample per carcass or samples from several sampling sites per carcass have been pooled to o prior to the examination. The purpose of the present survey is to gather information about the bacteriologic contamination of carcasses after the various processes at Danish pig abattoirs and information about variation counts between high risk sites and low risk sites, where high risk sites are those at risk of being contaminat by removal of plucks, intestines, etc.

MATERIALS AND METHODS: Three randomly chosen abattoirs were surveyed: A, B, and C. The surveys were conduct so that they reflect normal conditions. Samples were taken from 55 pig carcasses in abattoir A and from 60 p carcasses in abattoir B and C, over 4 sampling days per abattoir. Samples at each abattoir were taken over a peri of at least two months.

14 samples were taken from each carcass. Two samples were taken before evisceration, 6 samples after fin slaughtering, and 6 samples after 24 hours' chilling. See table 1 for a list of sampling sites. Samples 1-8 a samples 9-14 were taken alternately from the right and the left side of the carcass. Samples 1 and 3 and sampl 2 and 4 were taken as close to each other as possible. Samples 1 and 2 were taken approx. one hour after start slaughtering. Samples have been taken from approx. every third pig on the line.

Sampling was done using the double swab method. An area of 10 cm^2 is swabbed, first with a wet and then with dry cotton swab. The two cotton swabs from each sampling site were pooled and simultaneously tested for: Total cou on Plate Count Agar (PCA) with 1% salt incubated at 20°C for five days and Enterobacteriaceae count on Red Viol Bile agar (RVB) with glucose incubated at 37°C for 24 hours. The limit of detection is 10 cfu/cm^2. To facilit the calculations, negative results, i.e. <10 cfu/cm^2, were registered as 5 cfu/cm^2.

T-tests for paired observations were used to test whether average counts from the same sampling site ve significantly after different process steps (NIEMELÄ, 1983).

RESULTS AND DISCUSSION: Total counts vary considerably between the different sampling sites, see table 1 and figure 1. The highest total counts have been found on the rind surfaces. The rind surfaces have been surveyed in three positions, and among these the hind leg "before evisceration" showed the highest total count (but not in abattoir B). In abattoir B the highest total count has been found on the rind at the ribs. This could be due to two shower heads installed after the scraping/polishing equipment from which the water hit the hind leg at great pressure.

On the meat surface the highest total count has been found at the split sternum. This is most likely due to the exposure of this area to contamination during removal of intestines, plucks, etc. It is interesting that the total count on the rind surface generally decreases between "before evisceration" and "after final slaughtering".

During the 24 hours' chilling, an increase in total count is only registered at abattoir A. This may be caused by showering of the carcasses prior to the chilling tunnel in abattoir A but not in abattoirs B and C.

After singeing the total count is low on the rind surface. In a previous survey (n=140), 65% of the carcasses had a total count of <10 cfu/cm² on the rind of the hind leg. The bacterial load of the remaining 45% was 1.4 ±0.5 log cfu/cm² (SØRENSEN, 1990). SNIJDERS et al. (1976) found a total count of <1.3 log cfu/cm² after singeing/flaming of 20% of the pigs, the remainder had a total count of 2.3 ±0.6 log cfu/cm². The above indicates that at the abattoirs included in this survey a heavy contamination of the rind surface occurs during scraping/polishing. Some of the contamination can originate from the rectum and the oral cavity. That involves a risk of spreading pathogenic bacteria in the rind treatment equipment. It should be investigated whether contamination also influences keepability.

Enterobacteriaceae are regarded as indicators of the hygiene during slaughtering (GERATS and SNIJDERS, 1982).

If the Enterobacteriaceae counts are calculated as an average/cm², then the level is low relative to the total count, see table 1. The figure showing the per cent positive samples and the distribution of Enterobacteriaceae reveals more information, see figure 2.

Table 1. Microbial count from the sampling sites, average (Av.) and standard deviation (St.d.). The detection limit was 0.7 log cfu/cm². Abattoir A: sampling site 1-8: n=55, 9-14: n=53; Abattoirs B and C: n=60. *: Significant difference ($p<0.05$) between count "before evisceration" and count "after final slaughtering". [a]: Significant difference ($p<0.05$) between count "after final slaughtering" and count "after chilling for 24 hours".

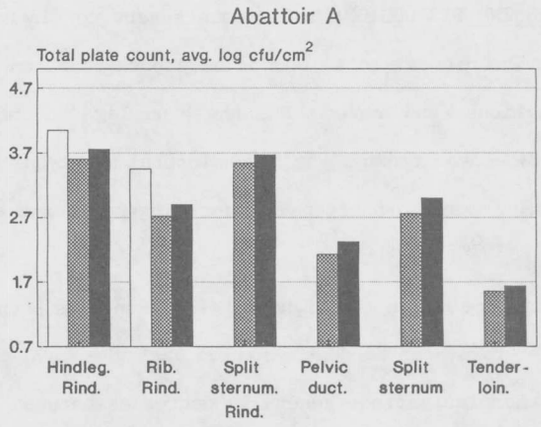
ABATTOIR:	Total plate count. Log cfu/cm²						Enterobacteriaceae. Log cfu/cm²					
	A		B		C		A		B		C	
SAMPLING SITE	Av.	St.d.	Av.	St.d.	Av.	St.d.	Av.	St.d.	Av.	St.d.	Av.	St.d.
Before evisceration												
1. Hind leg, rind.	4.05*	0.35	3.61	0.49	3.77*	0.45	0.94	0.37	0.83*	0.26	0.79*	0.22
2. Rib, rind.	3.45*	0.40	4.23*	0.34	2.97*	0.29	0.77	0.16	1.45*	0.52	0.71*	0.07
After final slaughtering												
3. Hind leg, rind.	3.60*[a]	0.39	3.72	0.61	3.27*[a]	0.47	0.91	0.37	1.02*[a]	0.42	1.03*	0.48
4. Rib, rind.	2.72*	0.45	3.54*	0.82	2.53*[a]	0.59	0.72	0.09	1.01*[a]	0.50	0.96*[a]	0.55
5. Split sternum, rind.	3.54 [a]	0.35	3.78 [a]	0.48	3.05	0.70	0.82	0.30	1.01 [a]	0.41	1.45 [a]	0.73
6. Pelvic duct.	2.13	0.76	2.44	0.87	2.05	0.80	0.79	0.41	1.05	0.56	0.96	0.51
7. Split sternum.	2.76 [a]	0.56	3.06	0.72	2.89 [a]	0.48	0.82	0.25	0.81	0.26	1.08 [a]	0.46
8. Tenderloin.	1.56	0.63	2.03	0.75	2.04	0.87	0.70	0.00	0.71	0.12	0.86 [a]	0.40
After chilling for 24 h.												
9. Hind leg, rind.	3.76 [a]	0.45	3.72	0.71	3.66 [a]	0.61	0.81	0.18	0.89 [a]	0.34	0.99	0.49
10. Rib, rind.	2.90	0.76	3.53	0.71	2.87 [a]	0.60	0.73	0.13	0.79 [a]	0.28	0.80 [a]	0.24
11. Split sternum, rind.	3.67 [a]	0.40	3.55 [a]	0.33	2.99	0.42	0.89	0.37	0.75 [a]	0.13	0.92 [a]	0.41
12. Pelvic duct.	2.32	0.73	2.53	0.88	2.14	0.77	0.80	0.38	0.98	0.61	0.87	0.48
13. Split sternum.	3.01 [a]	0.48	3.15	0.62	3.15 [a]	0.41	0.74	0.12	0.79	0.25	0.89 [a]	0.29
14. Tenderloin.	1.64	0.66	2.02	0.70	1.92	0.71	0.71	0.04	0.74	0.31	0.73 [a]	0.09

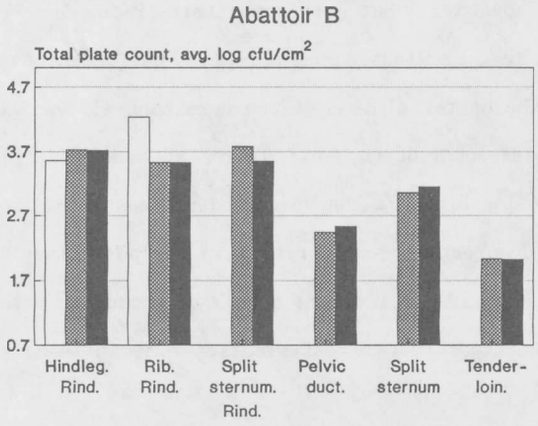
Figure 1. Results from Abattoir A, B and C. Total plate count at sampling sites after different processing stages. Each bar represents the average of 53-60 pigs.

Before evisceration.

After final slaughtering.

After cooling for 24 hours.





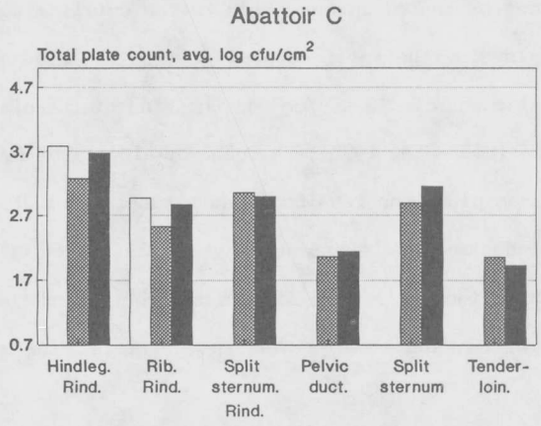


Figure 2. Enterobacteriaceae. Percentage of positive samples from each sample site and distribution of count.

$2 < x$

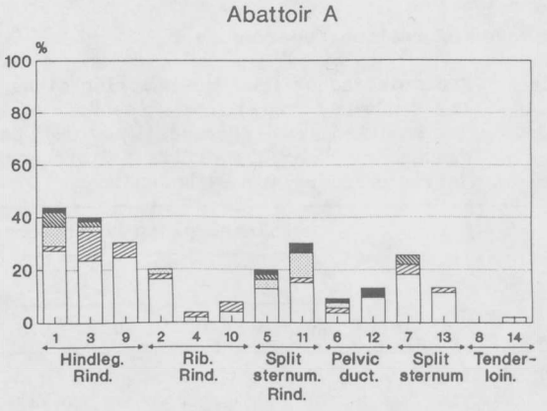
$1{,}7 < x \leq 2$

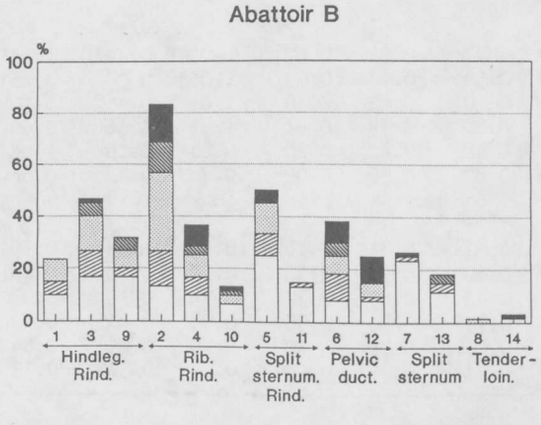
$1{,}3 < x \leq 1{,}7$

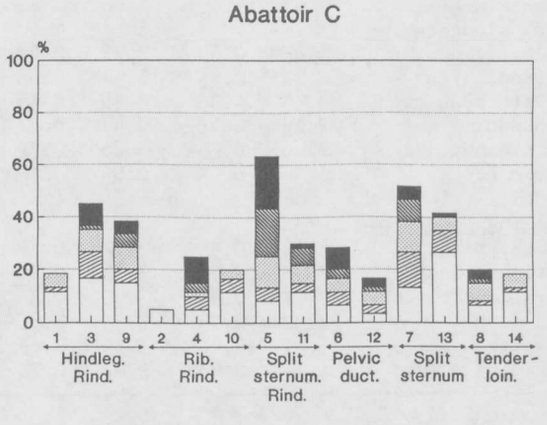
$1 < x \leq 1{,}3$

$0{,}7 < x \leq 1$

x = log cfu/cm^2







Even though the Enterobacteriaceae averages are low, the counts are high for a few carcasses. In two of the abattoirs (B and C) the frequency of Enterobacteriaceae increases on the hind leg (rind) between "before evisceration" and "after final slaughtering", while the total count has either decreased or remained unchanged. This indicates contamination from the intestines, tools/equipment, or operators. The occurence of Enterobacteriaceae in the pelvic duct varies considerably among the three abattoirs. At two of the abattoirs (B and C), the Enterobacteriaceae counts in the pelvic duct after final slaughtering are greater than of the hind leg (rind) before evisceration. This means that the bacteria have not only been transferred from the rind but also from other sources such as tools/equipment or intestinal contents.

The Enterobacteriaceae load of the rind after rind treatment can originate from the rectum or the oral cavity. This can occur through occasional introduction into the rind treatment equipment of bacteria, which are then spread further, or through a more constant low rate "supply". Growth in the equipment is not likely as Enterobacteriaceae then would be found both in greater quantities and also as a more constant "supply" to all carcasses. An earlier survey (SØRENSEN, 1990) supports the theory that Enterobacteriaceae originate from e.g. intestinal contents. During this survey 120 carcasses were run through especially cleaned rind treatment equipment. All the heads of the carcasses had been covered with tightly sealed bags, and the rectum of the first 60 carcasses had been sealed with a tight-fitting plug. 3% of the carcasses with plugs and 22% of the carcasses without plugs were contaminated with Enterobacteriaceae. The samples were taken from the hind leg immediately after the rind treatment.

CONCLUSIONS: Total counts of Enterobacteriaceae vary considerably among different sampling sites of the carcass. The highest total counts were found on the rind surfaces, and among the sites surveyed the highest count was found on the hind leg (rind). The highest total counts on the meat surfaces were found at the split sternum.

The rind becomes heavily contaminated in the scraping/polishing equipment. Any effects on the keepability are not known. This ought to be studied.

In general, the total counts on the rind surface drop between "before evisceration" and "after final slaughtering". However, the Enterobacteriaceae counts show that a contamination of the carcass occurs on the clean slaughter-line with bacteria from the intestine, tools/equipment, or operators. This observation emphasizes that hygiene also can be improved on the clean line. The level of Enterobacteriaceae is generally low. However, a few carcasses have high counts. In contrast to total counts, the occurrence of Enterobacteriaceae varies greatly among the abattoirs in the survey, both with respect to level and distribution on the carcass.

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