S. Afr. J. Anim. Sci. 9, 53-57 (1979)

THE INFLUENCE OF THE DRESSING PROCEDURE ON THE (MESOPHILIC) BACTERIAL POPULATION OF BACONER CARCASS SURFACES

Receipt of MS 22-11-1978

G.L. Nortjé, D. Visser, *W.H. Holzapfel and R.T. Naudé
Animal and Dairy Science Research Institute, Irene, 1675

(Key words: *Dressing procedure, bacteria, bacon carcass)*
(Sleutelwoorde: *Slagproses, bakterieë, spekvarkkarkas)*

OPSOMMING: DIE INVLOED VAN DIE SLAGPROSES OP DIE (MESOFILE) BAKTERIESE BEVOLKING OP DIE OPPERVLAKTE VAN SPEKVARKKARKASSE

In 'n opname by 'n spekfabriek is op verskillende plekke langs die slaglyn agarworsmonsters op 50 verskillende varkkarkasse geneem. Drie plekke op elke karkas is bemonster. Daar is gevind at daar 'n hoë (1×10^4 cm^{-2}) aanvanklike bakteriese lading aanwesig was. Nadat die karkasse deur die skroeier beweeg het is 'n besondere lae bakteriese telling (minder as 100 cm^{-2}) bepaal. Vervolgens het die lading as gevolg van verdere verslagtingsprosesse en hanteringsprosesse weer aansienlik toegeneem. Verkoeling van karkasse aan die einde van die slagproses het egter 'n aanvaarbare bakteriese lading tot gevolg gehad.

SUMMARY:

In a survey at a bacon factory agar sausage samples were taken from three carcass sites of each of 50 pigs at different positions along the dressing line. It was found that despite a very high initial bacterial count, the singeing process reduced this to an acceptable level of less than 100 organisms cm^{-2}. Although intermediate handling and consequent contamination took place along the dressing lines, the final chilling process rendered carcasses with acceptable bacterial levels.

The surface of the carcass is exposed to varying degrees of contamination during slaughtering and dressing. Application of micro-biological guidelines as well as proper sanitary measures can be of great value in controlling contamination. Rapid chilling directly after dressing will, for instance, limit the growth of micro-organisms. Many bacterial genera are encountered on carcasses, but the types of greatest importance to the meat industry are the pathogens and spoilage organisms. The psychrorophs that grow most rapidly during storage and handling at refrigeration temperatures, become the dominant organisms (Eddy & Kitchell, 1960) and of these the most commonly encountered bacterial genera are *Pseudomonas, Acinetobacter, Flavobacterium* and *Achromobacter* (Price & Schweigert, 1971; Holzapfel & Nortje, 1979).

Baltzer (1969) cites researchers of the 1930's who found that as soon as the surface load on chilled carcasses had reached a count of approximately 5×10^7 to 10^8 bacteria cm^{-2} the meat developed off-odours and discolourations and finally the surface became sticky or slimy. This phase, known as the slime limit, is closely correlated to the number of organisms present when storage begins.

**Department of Microbiology and Plant Pathology, University of Pretoria.*

The establishment of guidelines for tolerable bacterial levels on fresh meat is of growing importance in the more advanced countries. When establishing microbiological standards for the meat industry, shelf life is the most important, but not the only aspect to be considered. According to Kotula (1970), microbial criteria need to:

(1) identify and eliminate slaughtering and marketing practices which might be deleterious to consumer health by virture of its microbial content;

(2) increase the level of wholesomeness and shelf life of all meat and meat products;

(3) enhance consumer satisfaction and confidence in meat as a food.

Guidelines for specific needs can only be established once the existing degree of contamination of carcasses and meat, due to slaughtering, dressing, handling, transporting, storing and processing procedures have been surveyed (Roberts, 1976).

The purpose of this study was to determine the total aerobic bacterial count of specific sites on the carcass surfaces in relation to specific carcass dressing procedures at a bacon factory and to determine the influence of these procedures on bacterial counts.

Table 1

The influence of the dressing process on the bacterial population of the surface of the pig carcass – Interaction between three carcass sites and five slaughter line positions

Analysis of Variance

C.V. %	F-values			L.S.D. – Dressing line positions										L.S.D. – carcass sites		
	A[1]	B[2]	AxB	2:3	2:4	2:5	2:6	3:4	3:5	3:6	4:5	4:6	5:6	A:B	A:C	B:C
15,70	22,89**	71,21*	8,65**	**	**	**	–	**	**	**	**	**	**	**	**	**

1) A – Carcass sites
2) B – Dressing line position
3) For dressing line positions and sampling sites see procedure
L.S.D. – Least significant difference
C.V. – Coefficient of variance
*P < 0,05
**P < 0,01

SE of a transformed mean: Dressing line position = 0,0259
Carcass sites = 0,0201

Retransformed means after removal of bias ($\bar{x} + S^2$)

Dressing line position		Mean	Carcass site		Mean
2	After singeing	2,3158	A	hind quarter	2,7951
3	Before evisceration	3,2162	B	brisket	3,2528
4	After inspection	3,8316	C	fore quarter	3,5692
5	After final wash	4,3988			
6	After chilling	2,428			

Procedure

In this survey the agar sausage technique was used (Ten Cate, 1963; Ten Cate 1964; Olgaard, 1966). To determine the relative number of bacteria cm^{-2}, the method of Olgaard (1966) was modified as follows: the diameter of the sausage in the present study was 3,06 cm instead of 3,4 cm, and Olgaard's table for "The mean bacterial count cm^{-2} from the mean point value" was adapted with a factor of 1,23. Samples were incubated at 37°C for 24 to 48 hours on P.C.A. (Difco).

Fifty pig carcasses were examined at six different positions along the dressing line. The carcasses were chosen at random and were sampled in groups of two to five at a time. Each carcass was ear-marked before singeing, and each group was followed along the dressing line up to the chill rooms. Agar sausage sample were taken periodically along the slaughter line at the following six positions:

(1) before singeing;
(2) after singeing;
(3) after scraping of the carcass;
(4) after evisceration and inspection;
(5) after the final washing and the grading of the carcass;
(6) after chilling at 3 to 5°C for 18 to 24 hours.

The following sites on the left sides of the carcasses were examined:

hind quarter (A)
brisket (B); and
fore quarter (C) (Ingram & Roberts, 1976).

The agar sausage slices were incubated at 37°C for 24 hours to determine the mesophilic bacterial count. Point values were transformed to $\sqrt{x + 1}$ before analyses of variance were conducted.

Least significant difference (L.S.D.) tests were performed on all the mean values obtained from the carcass sites and the dressing line positions except in the case of position 1 of the line, where the counts were infinitely high.

Results and Discussion

The agar sausage technique was used because it is less time consuming, there is no damage to carcasses and the results obtained can be expressed as a relative number of organisms present per square cm of surface area.

Analyses of variance were conducted to determine the influence of the dressing procedures on the microbiology of the pig carcass and whether any variation existed between the counts of carcass sites within dressing line positions.

Interaction between the counts of three carcass sites and five dressing line positions

Counts for three carcass sites and five dressing line positions were tested by two-way analysis of variance. All differences on the line were found to be significant at the 1 per cent level except that between the post-singeing (2) and post-chilling (6) positions (Table 1). The results also indicate that an interaction between the sites examined and the line positions occurs as far as counts are concerned (Fig. 1). Because of this interaction no reliable mean value can be estimated for the complete carcass side.

Carcass sites

Analyses of variance for the three separate sampling sites were conducted to determine possible differences between counts at each and every line position. According to Ingram and Roberts (1976) counts vary from site to site and from one carcass or occasion to another. Differences observed on a few occasions, or at a few sites, are thus stated to be unreliable. They are likely to represent no more than chance variation or, if a true difference, one affecting only a limited area on the carcass.

F-values calculated for the results of carcass sites within a line position, were highly significant at three positions (No's 3, 4 and 5, Table 2, Fig. 1). No significant differences were obtained for counts after singeing (2) and after 24 hours chilling (6). The figure represents the retransformed mean aerobic bacterial count at different positions along the line.

L.S.D. tests were carried out on transformed mean point values for each of the three line positions (3 to 5). It was found in the case of the "before evisceration" position (3) that the difference was highly significant between the hind quarter (A) and the fore quarter (C) as well as between the brisket (B) and the fore quarter (C).

Table 2

Analysis of variance for variation within a dressing line position according to the carcass site

No.	Parameter (Position)	C.V. %	F-values	L.S.D. carcass sites 1:2	1:3	2:3
2	Count after singeing	21,4640	2,5388	–	–	–
3	Count before evisceration	13,6245	13,8140**	–	**	**
4	Count after inspection	10,0395	32,5761**	**	**	–
5	Count after final wash	8,8336	68,9797**	**	**	*
6	Count after chilling	22,1969	2,1772	–	–	–

* $P < 0,05$
** $P < 0,01$

S.E. of the transformed means are:

Before evisceration	0,0385
After inspection	0,0309
After final wash	0,0287

Retransformed means after removal of bias ($\bar{x} + S^2$)

No.	Carcass site	Before evisceration	After inspection	After final wash
A	Hind quarter	3,0285	2,9365	3,1622
B	Brisket	2,8167	4,1598	4,7821
C	Fore quarter	3,7593	4,3010	5,1867

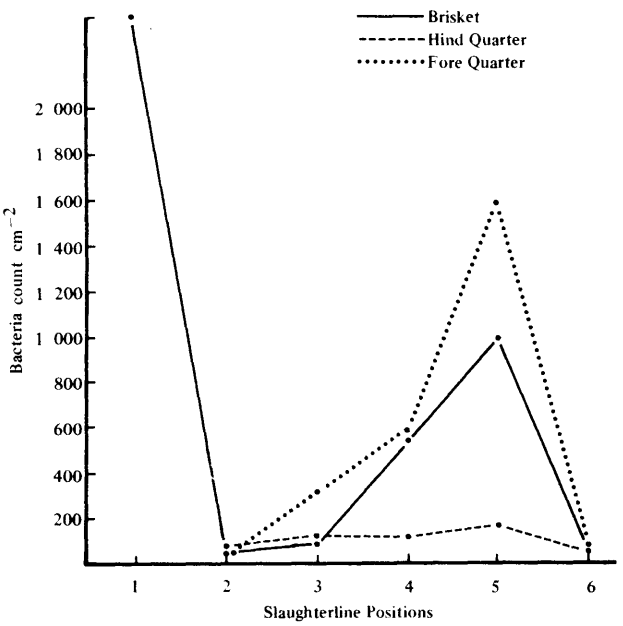

Fig. 1 Retransformed mean aerobic mesophilic bacterial counts at different positions along the production line

For the "after inspection" position (4) the values were highly significant between the hind quarter (A) and the brisket (B) as well as between the hind quarter (A) and the fore quarter (C).

In the case of the "after-final-wash" position (5) the values were highly significant between the hind quarter (A) and the brisket (B) as well as between the hind quarter (A) and for the fore quarter (C). In this case the difference between the brisket (B) and the fore quarter (C) was significant.

These results indicate an increase in contamination during post-slaughter processing. This might be due to handling and dressing procedures from the "before evisceration" (3) position up to the point where carcasses moved into the chill rooms (6). As shown in Fig. 1 singeing reduced the counts from infinite to an acceptable count of less than 100 bacteria cm^{-2}. During the period between singeing and evisceration the count increased to 335 cm^{-2}. As soon as evisceration took place the count on the brisket (B) increased to approximately 500 cm^{-2}, and the count on the fore quarter (C) to 560 cm^{-2}. It is suspected that bacteria on the hind quarter (A) are rinsed off by the washing process (5), thereby probably causing additional contamination of the brisket (B) and fore quarter (C). This, in addition to handling procedures, may have been responsible for the increase in counts to 1 100 and 1600 bacteria cm^{-2} respectively on the brisket (B) and the fore quarter (C). During the chilling process these relatively high counts were reduced to less than 100 cm^{-2}. This underlines the importance of efficient cooling facilities. This reduction in bacterial numbers may be attributed to the combined effects of cooling and drying of the carcass. Unsatisfactory washing procedures may have been the cause of the significant rise in bacterial counts at this stage.

Adequate dislodging of dirt will only be effective if the jet of water is strong enough. If the jet of water is directed incorrectly, it could merely move bacteria from one site on the carcass to another. In addition, water which is not hot enough will not reduce numbers of bacteria sufficiently. Most important of all, if the carcass is not correctly chilled after washing, loss of bloom and reduced keeping quality is inevitable (Hawkins, 1978). As an alternative to washing, bacterial numbers could be reduced before chilling by means of low degree singeing that will kill the bacteria without any adverse effect on the meat quality.

General microbiological guidelines for the slaughterline of bacon factories cannot be based on results obtained in this single and limited survey. Therefore, representative samples from a large number of producers, factories, wholesalers and retailers should be examined.

The results of this survey can be evaluated by comparison with recommended guidelines proposed by various workers (Table 3).

The relatively low counts obtained reflect acceptable hygienic conditions in the bacon factory under discussion. However, an evaluation could best be made if general standards, international or local, were available for meat bacteria. This again stresses the need for internationally accepted microbial guidelines and standardised processing methods for the meat.

Table 3

Acceptable bacterial counts on various meat surfaces

Author	Total aerobic counts cm^{-2}	
Nottingham (1971)	10^4	Initial counts (carcasses)
	10^6	Counts after processing (carcasses) or cuts before freezing
Hobbs (1967)	500	Bacon sides before chilling
Reuter (1972)	10^7	Chilled carcasses
	10^5	Frozen carcasses

Conclusion

The very high initial counts observed in this study were reduced to an acceptable count of less than 100 bacteria cm^{-2} by the singeing process. Although intermediate contamination took place along the slaughterline, the final chilling process yielded carcasses with acceptable microbial levels.

With reference to criteria mentioned by other research workers (Table 3) the final microbial quality of the carcasses produced at this bacon factory is therefore quite acceptable. However, it must be kept in mind that this conclusion is based on aerobic bacterial counts determined by means of the agar sausage technique and at an incubation temperature of 37°C. The quality of the carcasses could possibly be further improved by altering the spray-washing technique as proposed by other workers. The temperature and the force and direction of the spraying water could also be revised.

Low degree singeing instead of spray washing could be used before the chilling process. In this way counts on the carcass may be reduced without damaging the carcass or its appearance.

The influence of various production processes on the microbiology of manufactured meat products will be presented in a following publication.

Acknowledgements

The authors wish to thank the following organisations and individuals for their assistance in the execution of this survey as well as for advice on statistical analysis and helpful comments regarding the interpretation and discussion of the results:

Division of Veterinary Services, Management of Eskort Sausage and Bacon Factory, Dr B. Horton, Mr A. Venter, Prof. P.L. Steyn, Mr J.H. Dreyer and Mr J.F.G. Klingbiel.

References

BALTZER, J., 1969. The relation between bacterial contamination and growth on meats and the quality of meat products. *Proc. 22nd Ann. Rec. Meat Conf. California,* 294.

EDDY, B. & KITCHELL, A.G., 1960. The use and meaning of the term "psychrophilic". *J. Appl. Bacteriol.*, 23, 189.

HAWKINS, M., 1978. Spray washing – an acceptable alternative. *Meat,* Feb. 1978, 47.

HOBBS, W., 1967. Report on a study of various aspects of European meat hygiene and abattoir by-products. *J. S. Afr. vet. med. Ass.*, 38 (3), 266.

HOLZAPFEL, W.H. & NORTJE, G.L., 1978. Bacteria involved in the shelf life of minced meat. (In preparation).

INGRAM, M. & ROBERTS, T.A., 1976. The microbiology of the red meat carcass and the slaughterhouse. *R. Soc. Health J.*, 96, 270.

KOTULA, A.W., 1970. Microbiological criteria for fresh meat. *Proc. 23rd Ann. Rec. Meat Conf. Florida,* 121.

NOTTINGHAM, P.M., 1971. Microbiological quality control in the meat industry. *M.I.R.I.N.Z.* 217, 24.

OLGAARD, K., 1966. Bestemmelse of relative kimtal pa svinekroppe og inventor ved hjaelp af agarpolse metoden. Soertryk af *Medlemsblad for Den danske Dyrlaegeforening* 49, nr. 7, 298.

PRICE, J.F. & SCHWEIGERT, B.S., 1971. The science of meat and meat products. 2nd ed. W.H. Freeman and Company, San Francisco.

REUTER, G., 1972. Vortrangsveranstaltung für Lebensmittelmikrobiologie in Berlin 28.2 – 3.372, Hanzettel f. Teilnehmer.

ROBERTS, T.A., 1976. Establishing microbiological guidelines. *22nd European Meeting of Meat Research workers, Malmö.* 24.

TEN CATE, L., 1963. Eenvoudige en snelle bacteriologische bedrijfscontrolle op vleesverwerkende bedrijven met agar "worsten" in Rilsan-Kunsdarn. *Tydskr. Diergeneesk.*, 88 (14), 883.

TEN CATE, L., 1965. A note on a simple and rapid method of bacteriological sampling by means of agar sausage. *J. Appl. Bacteriol.*, 28, (2) 221.