Bacterial Growth in Exudate of Vacuum Packed Beef

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INTRODUCTION

During the last ten years the production of vacuum packed beef has increased markedly. One of the main advantages of this method is the inhibition of the growth of psychrotolerant spoilage flora (1,6). Thereby the shelf life may be prolonged to 8 weeks or more (3,4,5). However a few weeks after storage on opening vacuum packs a typical odour described as sour/acid can be detected (4,9). This odour is considered to be caused by volatile compounds arising from microbial metabolism (8). In the beginning when this odour develops, the contamination has not reached that level whereby normally off-odour can be detected.

In this survey the growth of bacteria present in the exudate of vacuum packed beef was determined in order to correlate these changes with the development of the typical odour.

MATERIAL AND METHODS

1. Material

In a local processing plant, 3 sirloins were removed from carcasses at 24-h postmortem, and deboned. From each sirloin, 10 steaks of about 5 cm thick were cut off. After microbiological sampling each steak was individually vacuum packed in a polyamide-polyethylene film with the following properties: water vapour transmission rate (WVTR) 15 $g/m^2/24$ h/1 atm. and O_2 transmission rate (OTR) 10 $cm^3/m^2/24$ h/1 atm. at 30°C and 90% RH.

Immediately after arrival at the laboratory the steaks were placed at 0-2°C for storage. Each week, one steak of each sirloin was withdrawn at random for sampling.

2. Sampling

The cutting side of each steak was sampled before packaging by means of the maceration method. Each time, 3 places with a total area of 18.5 cm^2 were outlined with a sterile stainless-steel cork borer. The tissue was removed to a depth of 1-2 mm with a sterile surgical knife and forceps and placed in a tube with 18.5 ml of 0.1% peptone water. The samples were cooled in iced water and transported to the laboratory.

From each stored vacuum pack, immediately after opening the odour was detected and exudate was collected. Thereafter the meat was sampled in the same way as before packaging. After sampling the meat was stored in aerobic conditions at 2°C to determine changes in the odour.

3. Bacteriological determinations

All tissue samples were homogenized for 1 min with a Stomacher 400 (Colworth). On all samples the following bacteriological determinations were performed:
- Total viable counts on P.C.A. (OXOID), 72 h at 25°C
- Lactobacilli spp. on Rogosa-Agar (Inst. Pasteur) 4 d at 28°C
- Pseudomonas spp. on G.S.P.-Agar (Merck) 72 h at 25°C
- Brochothrix thermosphacta on S.T.A.A. according to GARDNER, 48 h at 22°C

RESULTS AND DISCUSSION

The increase of the bacterial flora in vacuum packs during storage is summarised in figure 1. Throughout the whole storage period the number of bacteria in the exudate was significantly higher than that on the meat surface.

After one week of storage the meat juice contained total viable counts of 6.59 log or 2 log units higher than on the meat surface. During the next 2 weeks rapid multiplication occurred whereby the number of bacteria reached 8 log units/ml. With the exception of the 4th week in which a decrease was observed, further storage did not cause an increase in the number. The initial total viable counts on the meat surface was 4.5 log units/cm^2. After a lag phase of one week a large increase in the number took place until the 4th week. After that a phase of less rapid increase occurred. At 10 weeks the meat surface contained 7.27 log units/cm^2.

At one week of storage the number of Pseudomonas spp. and Brochothrix thermosphacta in the meat juice was approximately 6.0 log units/ml. The pattern of changes in the number of these bacteria was similar to that described for the total viable counts. After rapid growth during 2 weeks no further increase was observed for Brochothrix thermosphacta while a small decrease for Pseudomonas spp. occurred. After 10 weeks of storage a major decrease in both species of bacteria was observed. Initially the total of Lactobacilli spp. was relatively low. At 5 weeks of storage Lactobacilli spp. reached a number which was

equal to that of Brochothrix thermosphacta . From this time the exudate contained a very constant number of Lactobacilli spp., ie. 7 log units/ml.

In comparison with the exudate another flora developed on the meat surface. Initially rapid growth of the different bacteria species occurred. The growth of Pseudomonas spp. and Brochothrix thermosphacta , however, ceased after 2 and 3 weeks respectively, while Lactobacilli spp. continued to grow. The result was that Lactobacilli spp. became the most common organisms on the meat surface. Such a pattern of growth on vacuum packed beef has also been reported by other investigators (2,5,7).

On opening the vacuum packs stored for 3 weeks, for the first time a slight acid odour was detected. As the storage time increased the acid odour became distinctly. With the exception of the pieces of meat stored throughout the 10 weeks, the odour dissipated within a few hours after the meat was placed in aerobic conditions at 2°C.

Sutherland (8) has stated that exudate contained volatile compounds, which were responsible for the sour/acid odour. The compounds were arisen from microbiol metabolism. The number of bacteria on meat surface of the steaks stored up to 8 weeks, was relatively low ie. 7.0 log units, while exudate contained already more than 8.0 log units at 3 weeks. From these data it could be concluded that the source of this odour was probably due to biochemical changes caused by the high number of bacteria in the exudate.

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Figure 1 : Bacterial numbers on vacuum packed beef during storage at 0-2°C. Exudate $\log_{10}N/ml$, meat surface $\log_{10}N/cm^2$.