THE EFFECT OF VARIOUS GASEOUS ATMOSPHERES ON THE SHELF-LIFE OF FRESH MEAT

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The aim of our research program was an objective evaluation of the shelf-life of fresh meat in packages with 20 % CO_2 + 80 % O_2 and 100 % CO_2 respectively. For this purpose we tested the inhibitory effect of those gaseous atmospheres on the total aerobic germs, Enterobacteriaceae, Pseudomonads and Lactobacilli. The storage temperature was as a rule +1 ± 1 °C. In several other experiments we tested the influence of a higher temperature of 4, 5 and 8 °C respectively. Of special interest was the behaviour of germs which had already adapted themselves some days before the meat was exposed to the various gaseous atmospheres. For this purpose meat was, for several experiments, deboned 5 days before packaging.

Material and methods

Beef, veal and pork was cut into small cubes or minced. From each kind of meat we prepared 400 packages. For the determination of the development of germs during the storage time we required a homogeneously contaminated mass of meat. We therefore kneaded the whole amount of meat in a large sterile plastic bag during 15-20 minutes so intensively that the contamination became evenly distributet. After this we packaged portions of 100 g in plastic film bags[1]. The germ count was determined daily as a geometric mean of 4 packages. Before the bacteriological examination, the whole content of each 100 g package was passed twice through a sterile mincer and kneaded once more in a plastic bag.

Results

The packaging in CO_2/O_2-atmosphere with subsequent storage at +1 ± 1 °C resulted, in comparison with meat in normal atmosphere, in a substantial inhibition of the growth of total aerobic germs, especially Pseudomonads. After a storage time of 10 days at +1 ± 1 °C in CO_2/O_2 we found that the multiplication of the total aerobic germs was inhibited by the factor of about 500, the growth of the Pseudomonads by the factor of about 1'000 and the development of the Enterobacteriaceae and Lactobacilli by the factor of about 50 (fig. 1 and 2). These comparative figures are geometric means of 36 samples each. The inhibitory effect of the modified gaseous atmosphere depends on the storage temperature. In packages stored at +5 °C, the bacterial growth was substantially faster and comparable to the one in normal atmosphere at +1 °C (fig. 3 and 4). After the transfer of the packages from the original storage temperature of +1 ± 1 °C to 5 or 8 °C, the multiplication of germs was considerably faster (fig. 5). If the contamination flora was allowed to adapt itself for a period of 4 days between deboning and packaging, the germ count increased even at +1 ± 1 °C already at the beginning of the storage period in CO_2/O_2-atmosphere (fig. 5). In minced meat, which was packaged and stored under the same conditions, the inhibitory effect in CO_2/O_2-atmosphere was less significant than in cubed meat.

In pure CO_2-atmosphere[2] the growth of Pseudomonads and Enterobacteriaceae was completely stopped for 8 weeks, whereas under vacuum, even in gastight plastic-coated aluminium bags, their development started after 1 week (fig. 6). In an atmosphere of 100 % CO_2 we had a combined inhibitory effect of CO_2 and complete anaerobiosis. In pure CO_2-atmosphere the growth of aerobic germs was totally inhibited for a period of 14 days, provided that the meat was deboned 1-2 days after slaughtering and packaged without any delay. The fresh colour of beef, as expected, didn't last as long as in the CO_2/O_2-mixture, because Oximyoglobine was not built up. In plastic bags, being more or less permeable to oxygen, we observed after a storage time of 2 weeks a certain amount of Metmyoglobine. In completely tight combined aluminium-plastic bags we never detected Metmyoglobine even after a storage time of 8 weeks.

Conclusions

Conditio sine qua non for a significant better shelf-life of meat was a low germ count at the start, packaging immediately after deboning and carving and storage near 0 °C. The inhibitory effect of gaseous atmospheres must commence, whatever happens, before the spoilage flora of the deboned meat can adapt itself.

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[1] Transoform 70 K, AB Akerlund & Rausing, Lund/Sweden

[2] Polyethylene/Polyamide bags, Polyfilm AG, Rorschach/Switzerland

Fig.1. Total aerobic germs and Enterobacteriaceae in CO_2/O_2 and in normal atmosphere.
Storage temperature +1°C

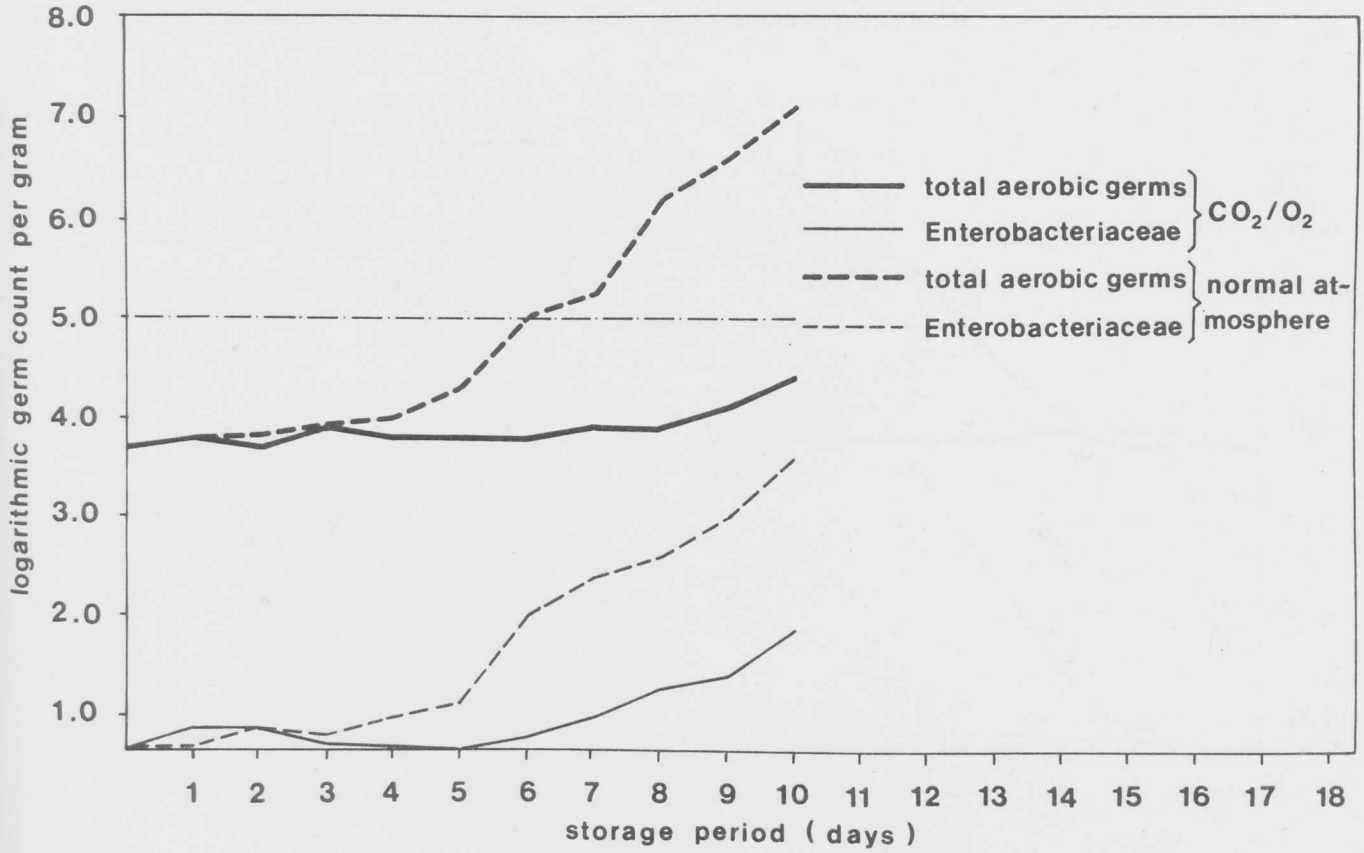

Fig.2. Lactobacilli and Pseudomonads in CO_2 / O_2 and in normal atmosphere
Storage temperature +1°C

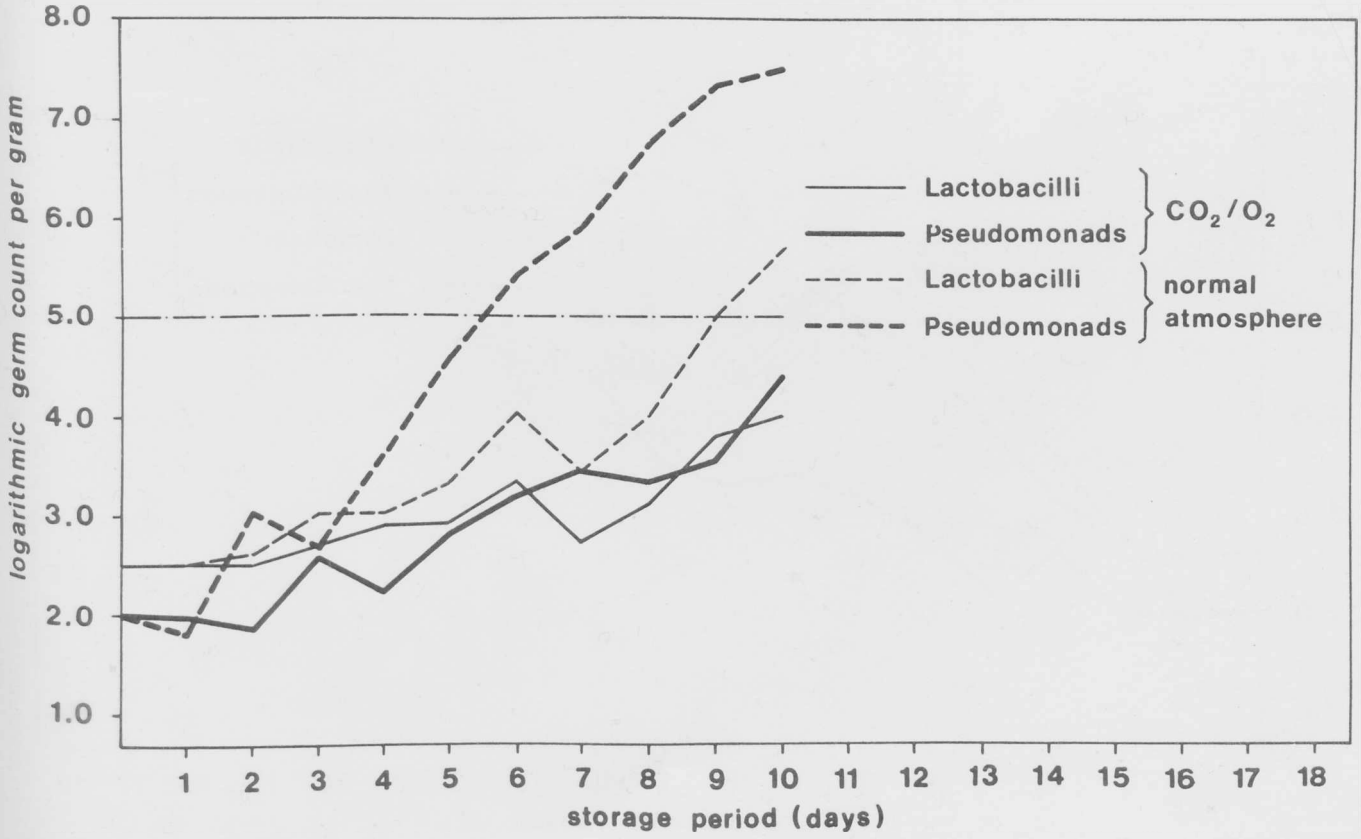

Fig. 3. Total aerobic germs and Enterobacteriaceae in CO_2 / O_2
Storage temperature +1°C and +5°C

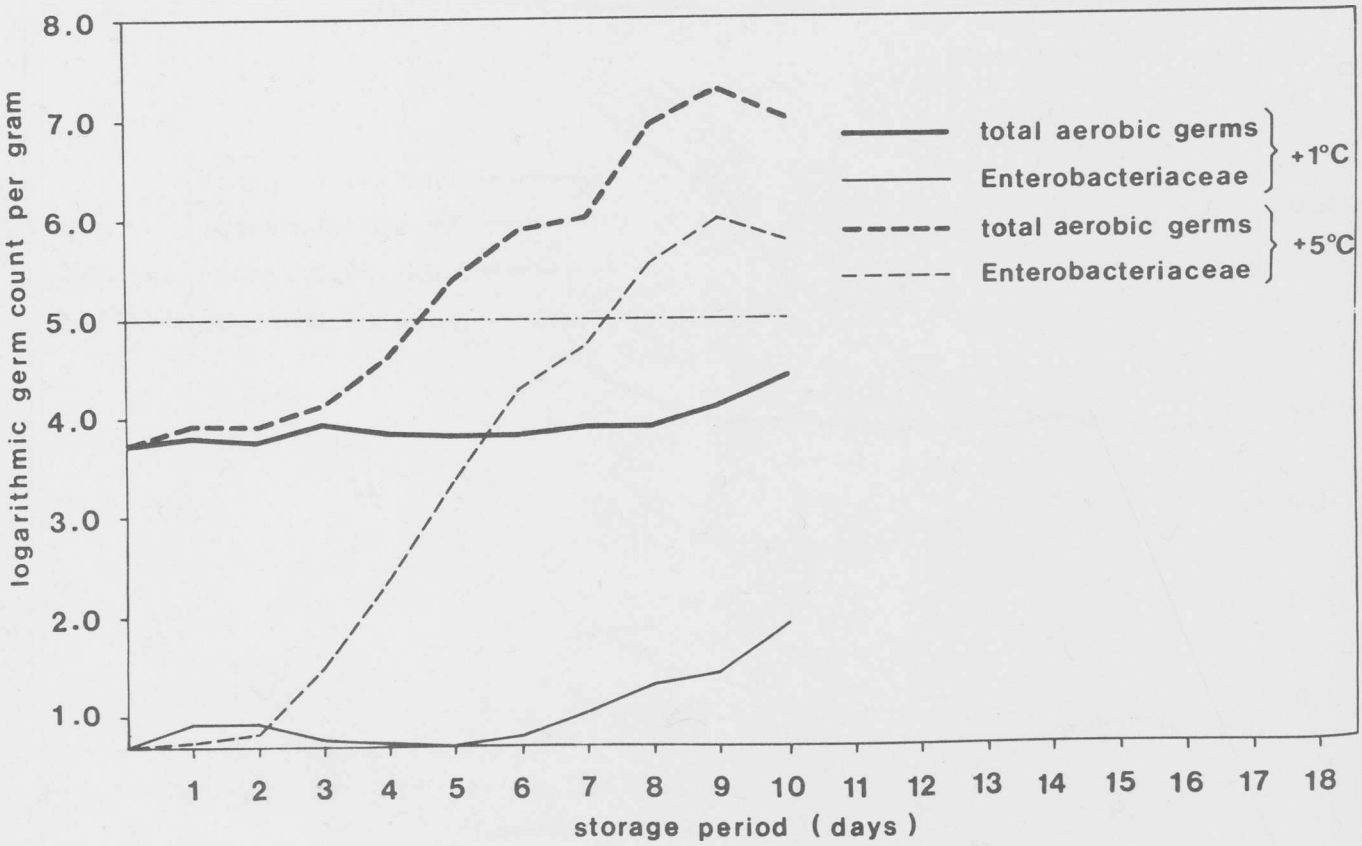

Fig. 4. Lactobacilli and Pseudomonads in CO_2 / O_2
Storage temperature +1°C and +5°C

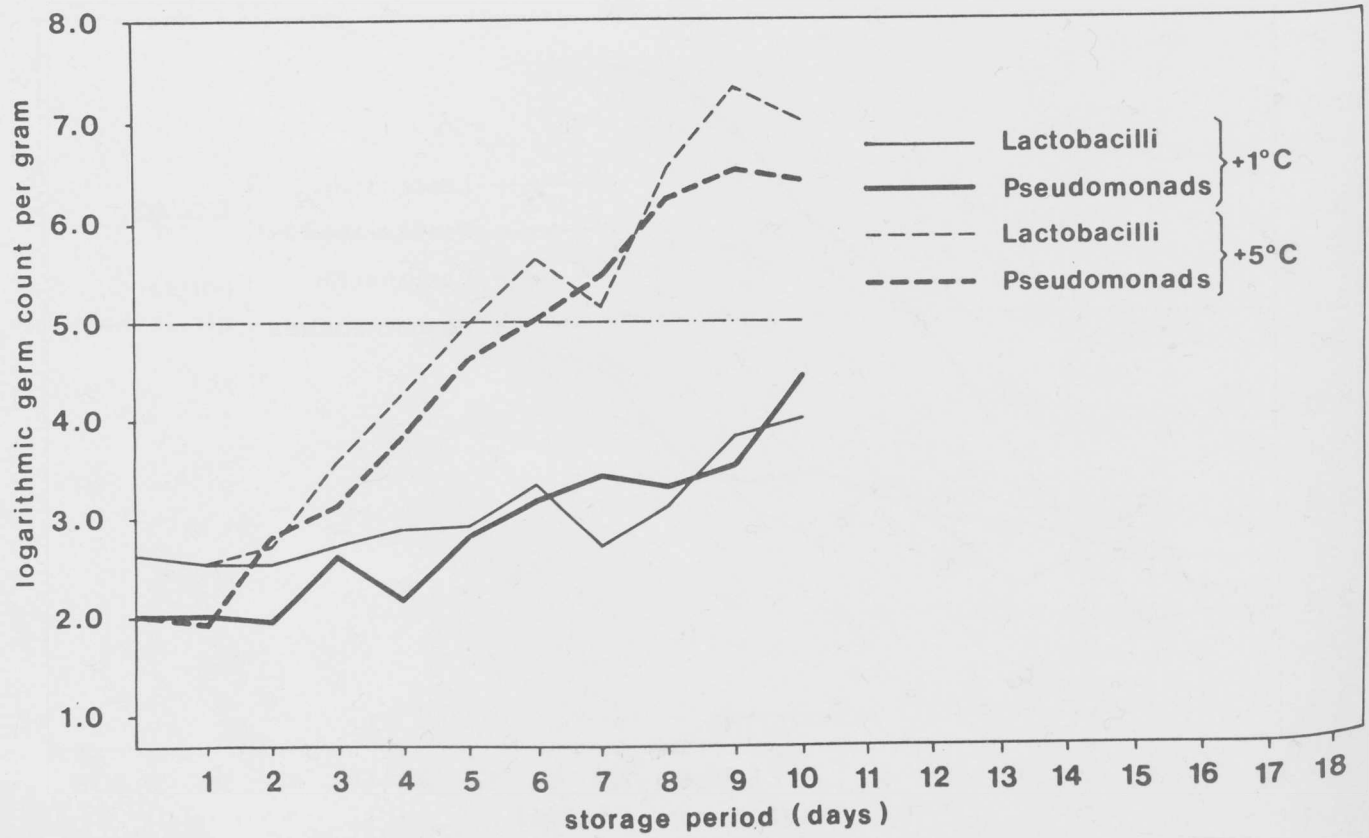

Fig. 5. Total aerobic germs and Enterobacteriaceae in CO_2 / O_2
Meat deboned 4 days before packaging.
Storage temperature +1° C, changed to +5 and +8° C after 6 days

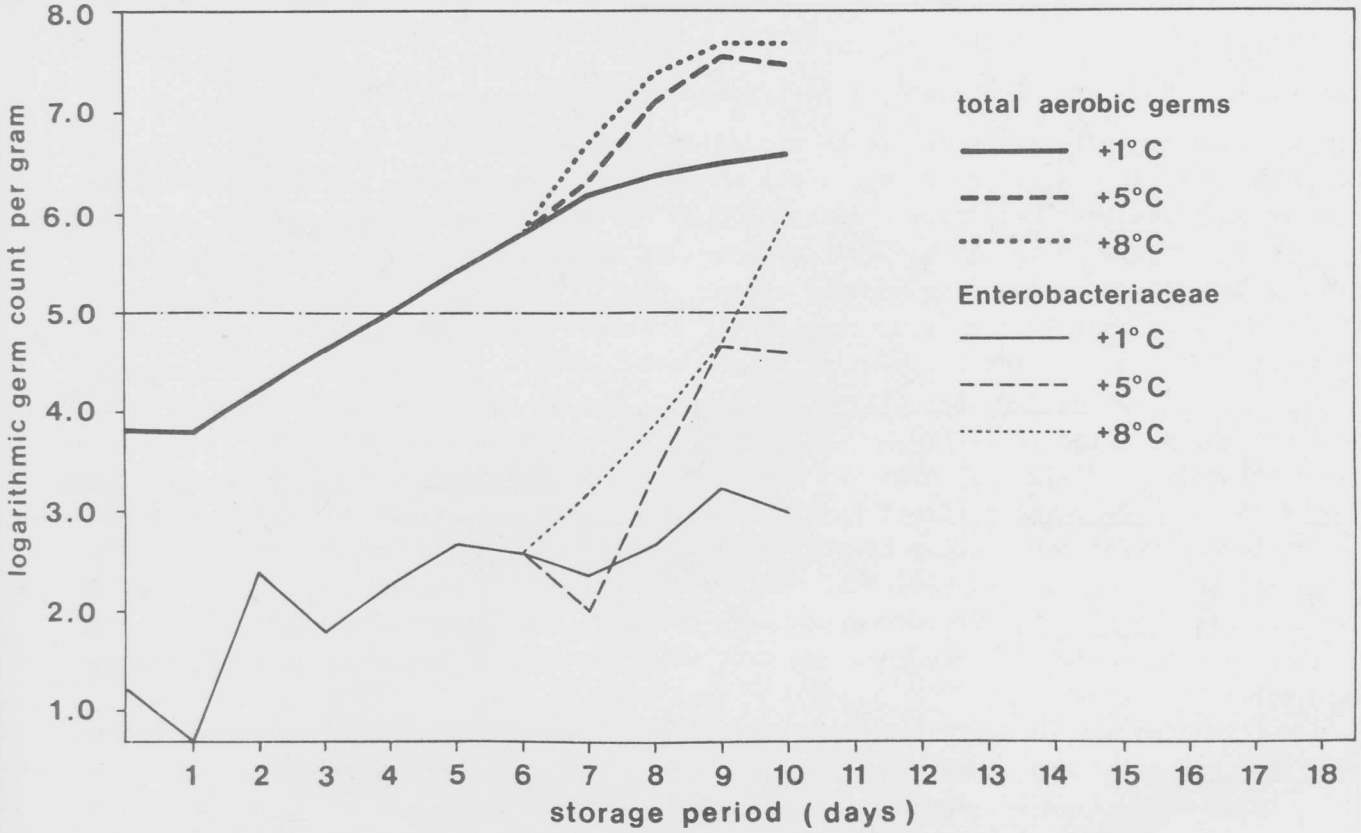

Fig. 6. Enterobacteriaceae in plastic film bags (Polyethylene / Polyamide) with pure CO_2 and in evacuated (20 mbar) plastic-coated aluminium bags.