THE SHELF-LIFE OF VACUUM-PACKAGED FRESH MEAT

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In view of the centralisation of the production and marketing of meat, the prolongation of the shelf-life of freshly carved meat becomes more and more urgent. To assess the shelf-life objectively, we examined among others the influence of high vacuum on the development of total aerobic germs, Enterobacteriaceae, Pseudomonads, Clostridia and Lactobacilli in freshly carved and packaged beef, pork and veal. The storage temperature was in each case +1 ± 1 °C, as a control we used the same meat, but in traditional packages without any vacuum.

When we started the experiments, we needed packages with nearly the same germ count for the determination of bacterial growth during the storage time. For this purpose, the carved meat was kneaded in sterile plastic bags for 20 minutes, so that an even distribution of bacteria in the meat was obtained. The germ count was determined daily by means of the geometric mean of 6 or 12 packages.

The culture media, the incubation time and temperature, we used for the germ count, are listed in table 1.

As a first experiment, we packaged 120 portions of freshly cubed meat in plastic bags with a vacuum of 10 - 20 mbar. As packaging material, we used a combined polyamide-surlyne-foil and cardboard, coated with aluminium and surlyne. The same number of portions were packaged traditionally in normal atmosphere. All packages were stored for 10 days at +1 ± 1 °C. Every day we examined 12 packages with vacuum and 12 packages without vacuum.

In the vacuum-packaged meat, the development of total aerobic germs and Enterobacteriaceae was drastically reduced, compared to the traditional packages (table 2). At the end of the 10 day storage, the multiplication-factor in the vacuum-packages was 6 and 16 respectively, compared to 3400 and 1500 in normal atmosphere. A striking difference could be noticed in the case of Pseudomonads, they multiplied in vacuum only by the factor 3, whereas their number increased 1:500 000 in air. The Lactobacilli grew a little less in vacuum than in air, but the difference was minimal. Clostridia could not be found during the whole storage time.

In a second experiment, we packaged fresh meat with a vacuum of 5 mbar. With this we confirmed the inhibitory effect of high vacuum on the growth of bacteria.

To ascertain, whether the degree of vacuum in the range between 1 and 20 mbar has any influence on the development of bacteria, we packaged 840 portions of freshly carved meat with a vacuum of 1, 10 and 20 mbar respectively in totally oxygen-tight, plastic-coated aluminium bags. The packages were stored for 50 days at +1 ± 1 °C.

In figure 1 and 2 it is proved, that neither the total aerobic germs nor the Enterobacteriaceae or the Lactobacilli showed any significant difference between the development at the different degrees of vacuum. The growth of Pseudomonads was completely stopped in the packages with 1 or 10 mbar during these 50 days. In the packages with a vacuum of 20 mbar, they were able to develop after a lag phase of 10 days to a maximum of 10^4 per gram. This limit was never exceeded during the whole experiment.

In a further experiment we found out, that the oxygen-permeability of a foil has a more important influence on the shelf-life of packaged fresh meat than the degree of vacuum at the time of packaging. Therefore we tested different plastic films, whose composition, thickness and oxygen-permeability is listed in table 3.

In each film we packaged 280 portions of freshly cubed beef. The vacuum in each package was 1 mbar. After packaging, all the portions were stored at +1 $\pm$ 1 ^{o}C for 50 days and we periodically examined the growth-rate of bacteria. We found out, that the number of total aerobic germs, Enterobacteriaceae and Lactobacilli was almost completely unaffected by the quality of the films tested. The lag phase continued in the oxygen-tight packages a little bit longer, but the differences were not considerable. On the other hand, the increase in the number of Pseudomonads is a reliable measure of the oxygen-permeability of a plastic film. While the oxygen-tight films restrained the growth of Pseudomonads completely, the inhibitory effect of the oxygen-permeable films was quite poor (figure 3).

Based on our findings we hold, that the shelf-life of vacuum-packaged, freshly carved meat depends first of all on the oxygen-tightness of the packaging material used and not so much on the degree of vacuum applied at packaging, provided the range of vacuum is between 1 and 20 mbar.

Table 1: Methods of bacteriological examination, culture-media, incubation-temperature and -time

Microorganisms	Culture - media	Method	Incubation	
			Temperature	Time
Total aerobic germs	Standard-Method-Agar (BBL 11 643)	Drop-Plate-Method, aerobic incubation	30 ^{o}C	48 hrs
Enterobacteriaceae	Violet-Red-Bile-Agar + 1% glucose (BBL 11 807)	Drop-Plate-Method, anaerobic incubation	30 ^{o}C	48 hrs
Pseudomonads	GSP - Agar (Merck 10 230)	Surface-Plate-Method, oxidase-positive colonies	22 ^{o}C	72 hrs
Clostridia	SPS - Agar (Merck 10235)	Pour-Plate-Method, anaerobic incubation	37 ^{o}C	48 hrs
Lactobacilli	MRS - Agar (Oxoid CM 361)	Pour-Plate-Method, incubation in 2% O_2, 5% CO_2, 10% H_2, 83% N_2	30 ^{o}C	72 hrs

Table 2: Development of bacteria in vacuum-packaged fresh meat (10 - 20 mbar) during a storage period of 10 days at +1 ± 1 °C

Microorganisms	Germ count at packaging * (per gram)	Germ count after a 10-day storage * (per gram)	
		vacuum - packaged	packaged without vacuum
Total aerobic germs	6 700	38 000	22 900 000
Enterobacteriaceae	< 50	800	74 000
Pseudomonads	120	360	61 500 000
Clostridia	< 10	< 10	< 10
Lactobacilli	800	15 500	407 000

* Geometric mean of 12 packages

Table 3: Packaging materials tested

Producer	Trade name	Composition *	Thickness /um	Oxygen - permeability $cm^3/m^2/24$ h/l bar/20 °C
Kalle, Wiesbaden	Hostaphan-Alu-Hostaphan-PE KA	PETP/AL/PETP/PE	106	0.1
N.W. Grace, New York	Cryovac BB 1	PE/PVC-PVDC/PE	61	6
Kureha, Tokyo	Krehalon	PE/PVC-PVDC/PE	60	5
Nielsen, Copenhagen	HI-VAC 20	PE/PVDC/PA	85	10
Nielsen, Copenhagen	RIL - O - TEN	PE/PA	90	78
Polyfilm AG, Rorschach	NPE 2070	PE/PA	90	30 - 40

* Abbreviations: AL = Aluminium
PA = Polyamide
PE = Polyethylene
PETP = Polyethylene-glycol-terephthalate
PVC = Polyvinyl chloride
PVDC = Polyvinylidene cholride

Fig.1 and 2 Development of total aerobic germs, Enterobacteriaceae, Pseudomonads and Lactobacilli in meat, packaged in plastic-coated aluminium bags with different degrees of vacuum

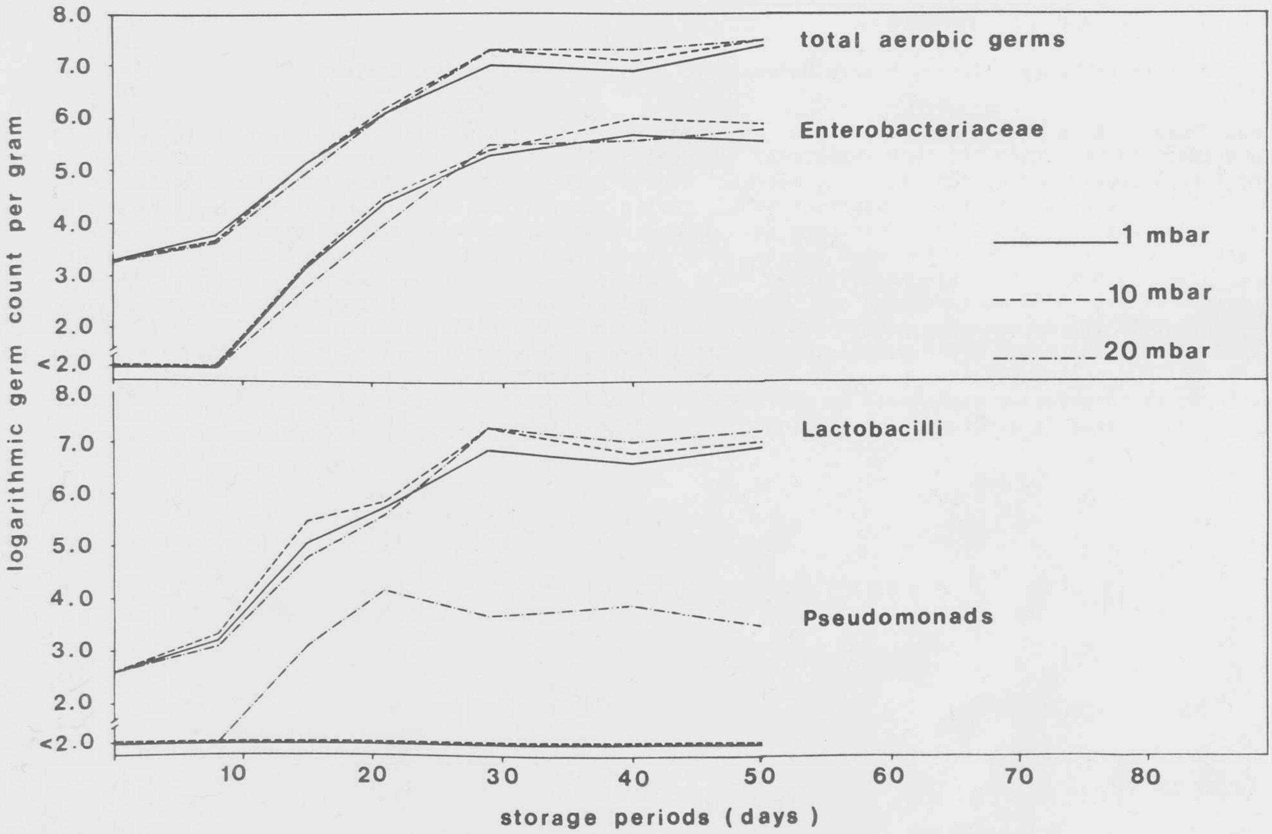
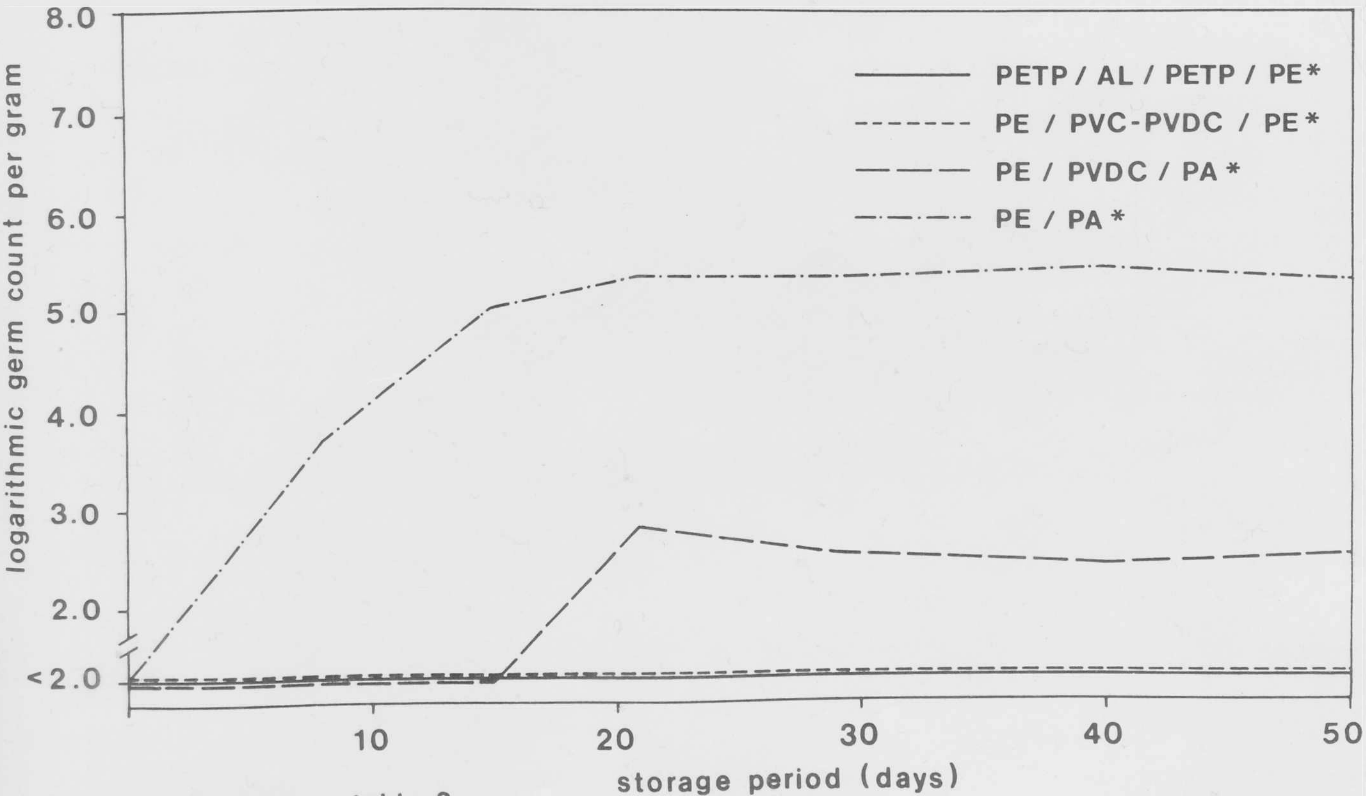


Fig. 3. Development of Pseudomonads in meat, packaged in bags of different plastic-films with a vacuum of 1mbar



* Abbreviation see table 3