SHELF LIFE OF VACUUM PACKED BOLOGNA TYPE SAUSAGE AS AFFECTED BY OXYGEN PERMEABILITY, INITIAL COUNT AND STORAGE TEMPERATURE

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INTRODUCTION

Cured, cooked and sliced meat products are often vacuum packed for retail sale. Vacuum packs are usually produced from laminates in reel form on deep drawing packaging machines. In Denmark the top web is usually a laminate with a barrier layer and the bottom web a PA/PE laminate.

Oxygen permeability of packaging films has been shown to influence shelf life (Nielsen, 1983; Lin and Sebranek, 1979; Møller, 1984). The normally used films have an oxygen permeability which can be characterized as having moderate barrier properties. Typical shelf lives for cured sliced products, packed in these films, are 3 - 6 weeks at 5°C.

Recent developments in film technology have produced high barrier films for deep drawing. These films have very low oxygen permeabilities (< 5 cm^3/m^2 x 24h x atm; 25°C, 75% rh).

Two experiments were carried out to find whether high barrier films give significantly longer shelf lives than medium barrier films. The product used was "kødpølse" which is a Bologna type sausage. Different permeability levels were tested as well as different levels of initial counts and storage temperatures. The experiments showed no significant effect of permeability levels and initial counts on shelf life. Storage temperature had an effect giving longer shelf life at 4°C than at 10°C.

MATERIALS AND METHODS

Experiment A

40 kg of Bologna type sausage were sliced in portions of 100 g at a factory. Vacuum packaging took place the next day after storage at 2°C. Before packaging half of the sliced product was contaminated with a culture of bacteria originating from fresh packs of same product type from the same factory. Packaging was carried out on a Multivac R7000 with a pack size of 200 mm x 115 mm x 5 mm (l x w x d). 4 different types of packs were made:

A: PA/EVOH/PA/PE 25/60 + PA/EVOH/PA/PE 25/60
B: PETP/PVdC/PE 12/60 + PA/EVOH/PA/PE 25/60
C: PETP/PVdC/PE 12/60 + PA/PE 40/70
D: PA/PE 40/70 + PE/PE 20/60

The calculated oxygen permeabilities, with 100 g product i each pack, were at standard conditions (25°C, 75% rh):

A: $2.3 \times 10^{-3} cm^3/g \times 24h \times atm$
B: 6.4×10^{-3} "
C: 17.7×10^{-3} "
D: 35.2×10^{-3} "

After packaging the packs were stored at 4°C and 10°C (+/-1°C). Shelf life of stored packs were determined by organoleptical evaluation of appearance, smell and taste. The microbiological development was followed for total viable count (PCA with 1% NaCl), Lactic acid bacteria (MRS), Brochothrix thermosphacta (STAA), Leuconostoc (NA with 10% saccharose) and yeasts (MA). Chemical analyses included nitrite, NaCl and water content of the product on the day of packaging and nitrite content when shelf life ended.

Experiment B

20 kg of bologna type sausage were left in a storage room at 5°C for a week before slicing. At the day of packaging 20 kg fresh produced sausage was also sliced and packed. Slicing and packaging took place at a factory. A Tiromat deep drawing machine was used for packaging with a pack size of 180 mm x 130 mm. The depth of packs differed to obtain different permeabilities. 4 different types of packs were made:

A: PETP/PVdC/PE 12/75 + PETP/PVdC/PE 12/75
B: PA/PE 20/70 + PA/PE 50/70
C: PA/PE 20/70 + PA/PE 20/70
D: PA/PE 20/70 + PA/PE 20/70

Depths of packs were: A, B and C = 10 mm, and D = 30 mm.

The calculated oxygen permeabilities at standard conditions (25°C, 75% rh), with 100 g of product per pack, were:

A: 9.1×10^{-3} $cm^3/g \times 24h \times atm$
B: 30.0×10^{-3} "
C: 47.5×10^{-3} "
D: 77.1×10^{-3} "

After packaging storage took place at 4°C +/-1°C and 6.5°C +/-0.5°C. Shelf life, microbiological development and chemical analyses were carried out as in experiment A.

RESULTS

<u>Experiment A</u>

Shelf life (days):

temp.	contam.	pack A	B	C	D
4°C	-	27	28	29	29
	+	24	27	30	28
10°C	-	12	13	12	13
	+	10	11	12	12

Analysis of variance showed no effect of permeability and of contamination before packaging. Effect of storage temperature was tested by t-test, which showed *** significance for effect (longest shelf life at 4°C).

Microbiological examinations from day of packaging showed viable total counts (PCA) of app. 3.5×10^3/g for untreated samples and app. 2×10^7/g for contaminated samples. In both cases app. 25% of the initial flora was lactic acid bacteria.

The microbiological development during storage showed that the contaminated samples reached the maximum level faster than the untreated samples. There was also a tendency to a higher growth rate at 10°C. There was no marked effect of permeability on the microbiological development. Total counts stabilised at 10^8 - 10^9/g for all samples. Lactic acid bacteria and Leuconostoc stabilised at the same level. B. thermosphacta stabilised at app. 10^7/g for untreated samples and at app. 10^5/g for contaminated samples. Samples at 10°C showed a decrease in B. thermosphacta at the end of storage. Yeasts were rather constant through the storage periode at 10^2 - 10^4/g. At the end of shelf life microbiological counts were similar in all samples.

Chemical analyses showed an initial nitrite content of app. 37 ppm, 2.5% NaCl and 52.5% water (4.8% salt i water). At the end of shelf life all samples had a nitrite content of 1-2 ppm.

<u>Experiment B</u>

Shelf life (days):

temp.	stored	pack A	B	C	D
4°C	-	21	26	22	19
	+	28	26	26	24
6.5°C	-	13	23	16	12
	+	14	25	27	22

Statistical analysis of obtained shelf lives showed no effect of permeability levels and of storage before slicing in analysis of variance. A t-test for effect of storage temperature showed no effect, but was nearly significante at the 95% level which could indicate a sligth effect on shelf life (longer shelf life at 4°C).

Microbiological examinations on day of packaging showed initial total counts for stored samples of app. 3×10^6/g and of app. 6×10^3/g for fresh samples. For both types half the flora consisted of lactic acid bacteria .

The microbiological examinations showed similar developments in all samples. The stored samples reached the maximum level faster than the fresh samples but they stabilised at the same levels. Total counts stabilised at 10^8 - 10^9/g after one week for stored and after two weeks for fresh samples. Lactic acid bacteria had an identical development. B. thermosphacta stabilised at 10^6 - 10^7/g for fresh and 10^7 - 10^8/g for stored samples. Leuconostoc stabilised at 10^7 - 10^8/g after 2-3 weeks of storage.

Yeast was rather constant at 10 - 10^3/g throughout the storage periode.

Chemical analyses on the day of packaging showed an initial nitrite content in fresh samples of app. 37 ppm, 2.3% NaCl, 48.2% water (4.7% salt in water) and pH = 6.1 . For stored samples the nitrite content was app. 46 ppm, 2.9% NaCl, 60.6% water (4.8% salt in water) and pH = 6.2 . At the end of the shelf life the nitrite content was 1-2 ppm in all samples. pH dropped in all samles during storage, stabilising at app. pH = 5. The decrease in pH was fastest in samples stored before slicing.

CONCLUSION

Shelf life, determined by sensory assessment, was mainly affected by the storage temperature while no significant efffect could be shown neither from levels of permeability nor from initial counts in the two experiments. The longest shelf life was obtained at the lowest storage temperature. The obtained shelf lives are similar to other findings for same type of product (Nielsen, 1983; Møller, 1984).

It must be noted that influence of light exposure was not examined (samples were stored in darkness). This factor may cause discolouration of nitrite cured meat products (Bøgh-Sørensen et al, 1987).

Microbiological examinations showed that samples with high initial counts reached maximum levels sooner than untreated samples. There was also a sligthly faster growth rate at the higher storage temperatures. A more intensive metabolic activity due to these factors has probably caused the shorter shelf life in samples stored at higher temperatures. Microbiological development was not evenly affected by the permeability levels. The relative differences between the different levels of permeability were probably to small. The difference in initial counts did not influence shelf life. An explanation could be the high proportion of lactic acid bacteria from the start which caused a similar microbiological development during the storage period.

The chemical analyses showed some variation in product composition in experiment 2 but the salt-water ratio was similar in both experiments. The nitrite content fell to wery low levels during the storage period.

The experiments indicate that a significantly longer shelf life is not achieved by using high barrier materials for the vacuum packaging of this type of product compaired to using traditional laminates. It must be noted, however, that the effect of exposure to light was not examined in this investigation.

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