EXTENSION OF THE SHELF-LIFE OF VACUUM-PACKAGED HIGH PH PORK BY STORAGE AT -1°C

SHAY B.J., MILLER D. and EGAN A.F.

CSIRO Division of Food Science and Technology, Meat Research Laboratory, Cannon Hil, Australia

S-IIA.06

SUMMARY

Storage of vacuum-packaged pork loins of high pH (6.2-6.6) at -1°C increased shelf-life by about two weeks as compared to storage at 0°C.
Spoilage appeared to result from the growth of psychrotropic Gram-negative bacteria, which was more rapid at 0°C. Provided vacuum-packaged storage does not exceed 5-6 weeks at -1°C, consumer portions derived from high pH pork should maintain quality for sufficient time to permit distribution and retail sale.

Introduction

The storage life of fresh meats at temperatures of 0-5°C may be extended by vacuum-packaging. This process is widely used with beef and vacuum-packaged primal cuts have a storage life of 10-12 weeks at 0°C provided the meat is of normal pH (5.4-5.8). This is the basis for international trade in this commodity because it allows for transport by sea-freight. When meat of pH 6.0 or higher is vacuum-packaged, storage life is much shorter because a wider range of psychrotrophic bacteria is able to grow and Gram-negative bacteria may attain populations of 10^6-10^7/cm^2 and cause putrefactive spoilage (Egan and Shay, 1988).
Vacuum-packaged pork has a shorter storage life than beef and one reason for this is the greater incidence of meat of high pH. Boneless pork loins have a storage life at 0°C of six weeks if the meat pH is 5.4 - 5.8, but only 4-5 weeks if the pH is higher (6.2-6.5).
There are several techniques that can be used to increase the storage life of vacuum-packaged pork. These include decontamination, preferably using dilute solutions of lactic and acetic acids (Smulders et al., 1986; Eustace, 1984) and irradiation (Egan et al., 1988). However a simpler and less expensive procedure is to reduce storage temperature from 0 to +1°C, which has been commonly used, to -1°C. This is technically feasible because modern shipping containers are now able to maintain this temperature.
In the present study we have determined the effect of storage at -1°C on the shelf-life of vacuum-packaged pork loins of pH 6.2-6.6.

Materials and Methods

Pork loins were obtained from local processors. They were taken from carcasses 1-2 days post mortem and selected on the basis of pH immediately after boning and skin removal. The range of pH values of the meat chosen was 6.2-6.6.
Striploins were cut into four pieces, sampled for microbiological analysis and vacuum-packaged in plastic bags with an oxygen permeability of 25-30 ml/m^2/24 h/atm measured at 25°C and 98% RH (W gauge Barrier Bag, W.R. Grace and Co.). Packs were not heat shrunk and were stored in the dark at 90% RH. One piece of meat from each loin was stored 0°C, two at -1°C and the remaining piece at -20°C (frozen control sample).
In the taste panel assessments, meat compared in a session was all taken from the same muscle. Each session consisted of two treatments presented as a three way test - two pieces of meat stored at -1°C were compared to the control sample stored at -20°C. Steaks, 19 mm thick, cut from the loins were placed on a wire rack in an open tray and cooked in a convection oven at 230°C for 20 minutes. After cooking the meat was cut into cubes and presented to a 15-person trained taste panel for assessment. All other details of taste panel assessment have been previously described (Egan and Shay, 1982).
Meat stored at 0°C was not taste tested, but was used for microbiological analysis. Microbiological methods have been described before (Egan and Shay, 1984).

Results and Discussion

Two storage trials were done. The growth of the psychrotrophic bacterial flora on vacuum-packaged pork is shown in Fig. 1. The total population reached $10^8/cm^2$ after about six weeks storage. Lactic acid bacteria were dominant and comprised more than 90% of the population (data not shown). Gram-negative bacteria reached a population of $10^6/cm^2$ after five weeks storage at 0 °C but grew more slowly at -1 °C. The major component comprised Enterobacteriaceae with *Aeromonas hydrophila* and *Alteromonas* sp. also present.

Spoilage of meat stored at 0 °C first occurred after 5-6 weeks storage and was characterised by atypical odours detected on opening the packs. At -1 °C atypical odour was first noted after eight weeks storage. These odours were described as putrid or dairy/putrid and are characteristic of spoilage by Gram-negative bacteria growing under these conditions.

In the first storage trial, taste panel evaluation of the cooked meat showed that no significant aroma or flavour defects developed during eight weeks storage at -1 °C. Results of the second trial are shown in Fig. 2. Atypical aroma first became significant after nine weeks storage at -1 °C and flavour after eight weeks. Acceptability was significantly downgraded after eight weeks also.

Taste panel downgrading of meat stored at -1 °C occurred at the same time that putrid odours were first detected on opening the packs. Similar odours were noted earlier for meat stored at 0 °C. The times at which putrid odours were detected approximate the times when the population of Gram-negative bacteria reached spoilage levels and this suggests that spoilage was caused by the growth of the Gram-negative flora.

These results show that storage at -1 °C extends the shelf-life by about two weeks compared to 0 °C. Provided the duration of vacuum-packaged storage does not exceed 5-6 weeks at -1 °C, consumer portions derived from the vacuum-packaged meat should maintain quality for a sufficient time to permit distribution and retail sale.

Conclusion

When vacuum-packaged pork loins of high pH (6.2-6.6) are stored at -1 °C, shelf-life is increased to about eight weeks as compared to 5-6 weeks for meat stored at 0 °C. Spoilage results from the growth of psychrotrophic Gram-negative bacteria which occurs more slowly at -1 °C.

Acknowledgement

The authors are grateful for support provided by the Australian Pig Research and Development Corporation.

References

Egan, A.F. and Shay, B.J., (1982). Significance of Lactobacills and film permeability in the spoilage of vacuum-packaged beef. J. Food Sci., 47:1119-1122 & 1126.

Egan, A.F. and Shay, B.J., (1984). The microbiology of vacuum-packaged pork. Proc. 30th European Meeting of Meat Research Workers, 215-216.

Egan, A.F. and Shay, B.J., (1988). Long-term storage of chilled fresh meats. Proc. 34th Int. Congress of Meat Science and Technology, 476-481.

Egan, A.F., Miller, D., Shay, B.J. and Wills, P.A., (1988). Preservation of vacuum-packaged pork using irradiation. In: Food Science and Technology in Industrial Development, (Proc. of the Food Conference '88, Bangkok, Thailand) 2:515-518.

Eustace, I.J., (1984). Prolongation of the storage-life of vacuum-packaged lamb. CSIRO Food Res. Quarterly, 44:60-67.

Smulders, F.J., Barendsen, P., van Logjestijn, J.G., Mossel, D.A. and van der Marel, G.M., (1986). Review: lactic acid considerations in favour of its acceptance as a meat decontaminant. J. Food Technol., 21:419-436.