CONTROLLED ATMOSPHERE VS. VACUUM PACKAGING OF PORK PRIMALS, HOT BONED FROM SKINNED PIG CARCASSES

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SUMMARY

The effects were investigated of gas- (100%) vs vacuum packaging (as conducted by the Corr-vac® packaging system) on temperature decline in ham muscles, on the microbiological quality of the shoulder, and on the sensory quality of the loin, hot boned from skinned pig carcasses. Neither rate of temperature decline nor sensory quality were affected by packaging technique. This was probably due to the system of vacuum packaging which aims at evacuating until a residual air pressure of 300 mbar, and thus leaving a considerable amount of air in the pack. The microbiological condition of CO_2-packaging of pork primals from skinned pig carcasses appears to be a good alternative for vacuum packaging when the Corr-vac® system is used. Further research is needed to establish optimal (gas) packaging conditions.

INTRODUCTION

The two packaging methods currently available to processors to maximise storage life of fresh pork are vacuum packaging and storage in modified atmospheres. In fact, vacuum packaging is a form of modified atmosphere storage, albeit one in which the gas atmosphere is neither known nor controlled. Apart from this drawback vacuum-packaging has several other disadvantages (Seideman et al., 1980) e.g. high leaker rates associated with vacuum packaged primals that may still contain bone fragments, cut distortion and increased amounts of purge (Seideman et al., 1979).

Controlled atmosphere packaging could reduce leaker rates, purge losses and distortion. Furthermore, in controlled atmosphere packaging, bacterial growth is hampered immediately, whereas in vacuum this may take some time.

Reports on controlled atmosphere systems for hot boned meat are scarce (Erichson, 1984). In speculative terms there are bound to be problems to overcome. Firstly the chilling of the product might pose a problem. Although not well-documented, the rate of temperature decline is probably rather slow. This may affect the microbiological condition. Moreover, as the positive effects of hot boning on sensory meat quality (e.g. improved waterholding capacity and better colour) are ascribed to a faster pre-rigor temperature decline (Taylor et al., 1980-1981; Reagan, 1983; Smulders and Van Laack, 1988), gas packaging may be expected to also affect sensory quality.

In the present study the effects were evaluated of controlled vs vacuum packaging on the microbiological and sensory quality of hot boned, skinned pork primals.

MATERIALS AND METHODS

Our study consisted of 3 experiments. Experiment A was concerned with the effects of gas- vs vacuum packaging on the rate of temperature decline in boneless ham. In experiment B the effects of packaging method on the microbiological condition of the shoulder were investigated; finally, experiment C monitored the effects of packaging method on sensory quality characteristics of the longissimus muscle.

In all experiments Large White/Dutch Landrace cross-bred pigs were slaughtered, skinned with a vertical drum skinner and boned immediately after slaughter. At the end of the slaughterline (i.e. ca. 30 min post mortem) carcasses were selected on the basis of their loin-pH ($6.3<pH<6.8$). Boned primals were packaged with a Corr-vac® machine (Seffelaar en Looyen, Oldenzaal, The Netherlands). For vacuum packaging the gassing factors were 0.0001-0.100, respectively (gassing factor x weight of the primal determines the gassing time). The O_2-permeability of the packaging film was 4.5 ml/m^2/24 h at 4°C and E_{rh} 75%.

Experiment A: temperature decline.
Fifty-two hot boned hams were vacuum-packaged and 52 hot boned hams were gas-packaged and chilled at 0-2°C immediately after packaging. After 0, 2, 4, 8, 19.5 and 24 h of chilling 10 (0 and 2 h) or 8 (4, 8, 19.5 and 24 h) hams were unpacked and temperature was measured on the surface, in the centre of the M. semitendinosus and in the centre of the M. semimembranosus.

Experiment B: microbiological condition.
Twenty-four hot boned shoulders were vacuum-packaged, another 24 hot boned shoulders were gas-packaged and chilled immediately at 0-2°C. After 1, 7 and 14 days of storage at 0-2°C, eight vacuum-packaged and 8 gas-packaged shoulders (M. triceps brachii) were sampled for microbiological examination by a destructive method (Snijders et al., 1984). Aerobic colony counts and numbers of Enterobacteriaceae were assessed as described by Van Laack and Smulders (1989).

Experiment C: sensory quality.
Twenty hot boned loins (M. longissimus dorsi) were vacuum packaged another 20 hot boned loins were gas-packaged. After 1 and 9 days of storage at 1±1°C, 10 loins of each treatment group were unpacked and sampled to assess waterholding capacity (Honikel, 1987; Kauffman et al., 1986), colour (with Minolta® reflectometer), transmission value (Hart, 1962) and pH.

Data were analysed for statistical significance with the Student-t-test ($p<0.05$).

RESULTS AND DISCUSSION
For reasons mentioned earlier we expected the temperature decline of hot boned gas-packaged meat to be slower than that of hot boned vacuum-packaged meat. However, as can be seen in Figure 1, this was not the case in experiment A, where the rate of temperature fall was hardly affected by the packaging method. This may seem surprising as air is known to have an

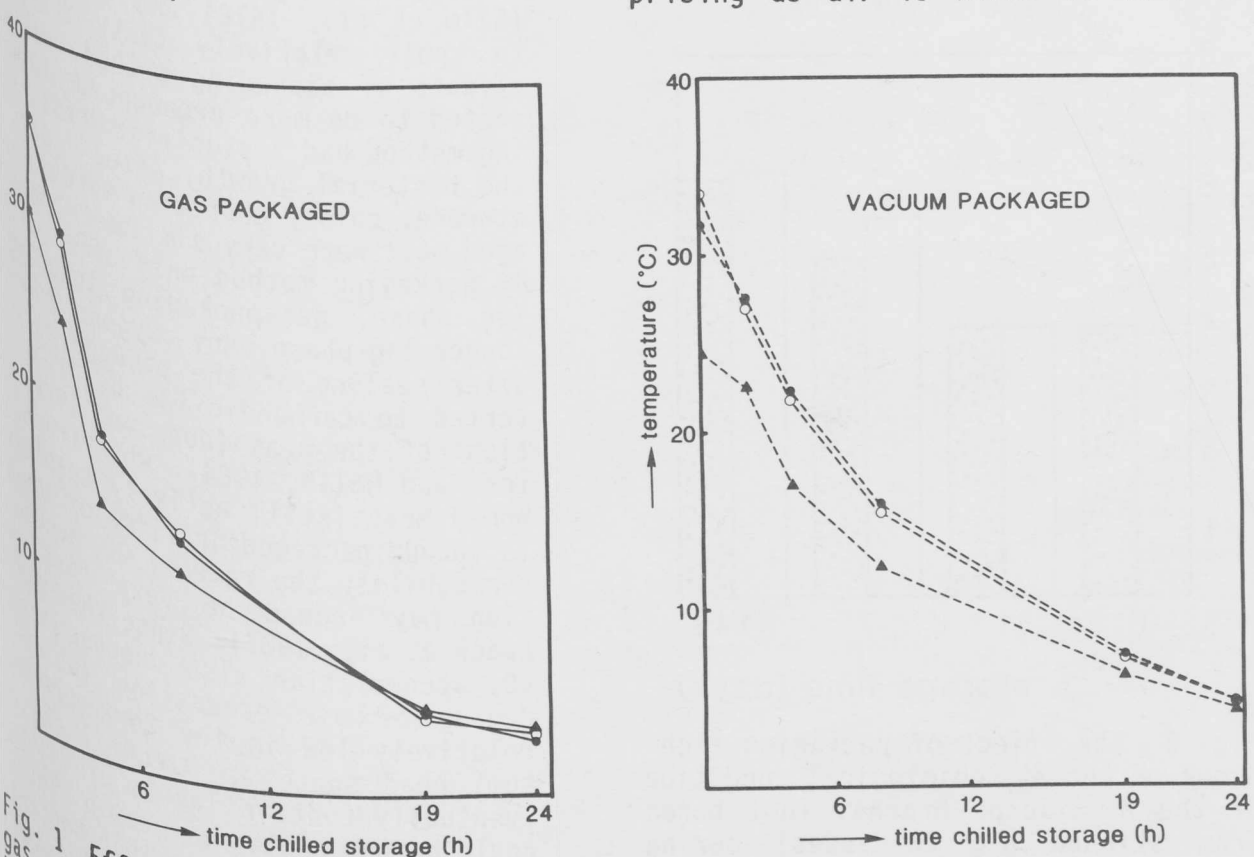
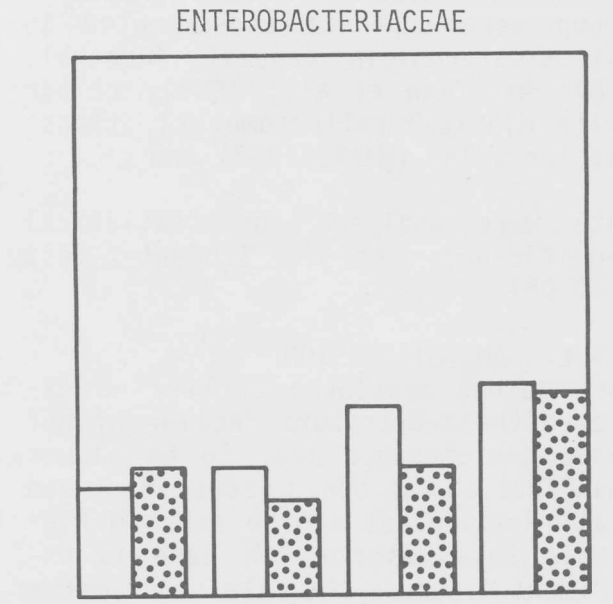


Fig. 1 Effect of packaging, vacuum vs gas, on temperature decline in and on hot boned ham muscles from skinned pig carcasses during 24 h chilling at 0-2°C (o semitendinosus, • semimembranosus, Δ surface)

insulating effect. A possible explanation for these results is the vacuum technique applied. The conventional method of vacuum packaging aims at minimal quantities of packaged head space. This is achieved by lowering the air pressure to 2 mbar. The Corr-vac® system evacuates until air pressures of 300 mbar are obtained. Consequently the amount of residual air in the pack is considerable. This means that both in "vacuum"- and gas-packaging a substantial amount of residual air was left in the pack. Apparently the difference in air content (being lower with vacuum-packaging) was too small to affect the temperature decline appreciably.

Although the effects on the rate of temperature decline were negligible the effects on the microbiological and sensory quality were not anticipated to be necessarily similar for "vacuum"- and gas-packaged meat. Figure 2 includes the results of the bacteriological examination of the shoulder during a storage period of 2 weeks. The reason we examined the shoulder muscle was that in practice this primal is known to be contaminated with rather high numbers of bacteria (Salm et al., 1978) and consequently to spoil relatively fast. Therefore effects of packaging method were expected to be more pronounced. Packaging method had a significant effect on the bacterial growth. After 7 days of storage, colony counts on vacuum packaged meat were very similar. Apparently packaging method only affected the lag phase, gas-packaging inducing a longer lag phase. Any oxygen remaining after sealing of the package is converted to carbondioxide by "respiration" of the meat (Johnson, 1974; Efors and Molin, 1984). When fresh hot boned meat (still actively respiring) is vacuum packaged in films of low gas permeability the rate of CO_2 accumulation may indeed be very fast (Vo Laack et al., 1987). Since the rate of CO_2 accumulation also depends on the degree of air evacuation (which is relatively low in the Corr-vac® system) head space in vacuum packs may eventually contain levels of CO_2 that could hamper bacterial growth. Yet, it is more important to inhibit bacterial growth on the meat surface before it has reached a considerable rate (Boeth et al., 1976). From the present results it may be concluded that CO_2 formation of Corr-vac® vacuum-packages



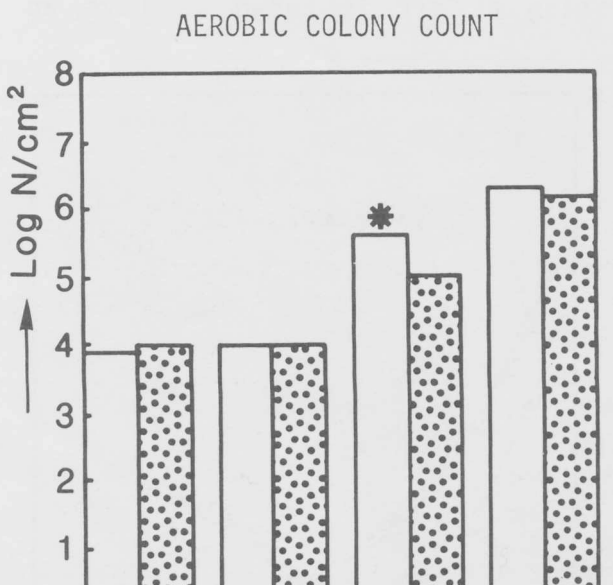


Fig. 2 The effect of packaging technique on the microbiological condition of the M. triceps brachii (hot boned from skinned pig carcasses) during 14 days of storage at 0-2°C: gas-packaging ([ ]) vs vacuum-packaging ([ ])
* statistically significant difference ($p<0.05$)

primals was too slow to adequately inhibit microbial growth.

It is not clear why differences in colony counts that existed at day 7 were no longer present after an additional week of storage (day 14). Possibly a high gas-to-meat ratio, as suggested by Gill and Penny (1988), might have had a more prolonged positive effect of CO_2 on the keepability. Some investigators (Egan and Shay, 1988; Seideman et al., 1980) suggest that CO_2-packaging per se directly affects sensory quality of meat irrespective of the "indirect" effect of gas-packaging. The direct effects would include negative effects on colour, and positive effects on the waterholding capacity. The packaging system applied in our study was not designed to evacuate packs to extremely low residual air pressures. The philosophy behind the Corr-vac® system is to reduce drip formation drastically at the expense of having to package at higher residual air pressures (Corr-vac® advertising). Vacuum- and gas-packaging were not expected to affect meat quality to a different degree. Indeed we found negligible differences in sensory quality traits of vacuum- vs gas-packaged loins (Table 1). Vacuum-packaged meat tended to have a lower waterholding capacity than CO_2 packaged meat, 4.2% vs 3.2%, respectively ($p<0.10$). More extensive research is necessary to establish the importance and reproducibility of this observation.

Our results are largely in agreement with those of Erichson et al. (1984).

CONCLUSION

In the present study CO_2 packaging of pork primals from skinned pig carcasses was a good alternative for vacuum-packaging when the Corr-vac® packaging system was used: sensory quality was hardly affected and the microbiological condition was slightly better. Further research is necessary to establish the optimal CO_2-to-meat ratio and whether CO_2 packaging is to be preferred over the conventional vacuum-packaging.

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Table 1a Sensory quality characteristics assessed at 1 and 9 days post mortem of hot boned pork loins as influenced by vacuum vs gas packaging (n=10)

		Day 1	
		Vacuum	Gas
Muscle pH		5.71	5.67
Drip % (Honikel, 1987)		2.6	2.5
Filter paper method (mg) (Kauffman et al., 1986)		24	17
Colour	L	53.4	53.8
	a	13.6	14.3
	b	7.4	7.9
Transmission value		29	30

Table 1b Sensory quality characteristics assessed at 1 and 9 days post mortem of hot boned pork loins as influenced by vacuum vs gas packaging (n=10)

		Day 9	
		Vacuum	Gas
Muscle pH		5.87	5.82
Drip % (Honikel, 1987)		4.2	3.2
Filter paper method (mg) (Kauffman et al., 1986)		37	35
Colour	L	55.8	55.7
	a	15.6	15.0
	b	9.6	9.5
Transmission value		26	26

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