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Display life of frozen lamb chops. Effect of breed, sex, packaging film and temperature at packaging

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ABSTRACT

Display life of frozen lamb chops was unaffected by breed or sex. Chops shrink-wrapped in oxygen permeable film had a longer display life than those vacuum packaged in a film of low oxygen permeability. Chops cut from frozen loins, then packaged had a significantly longer display life than chops cut from chilled loins, packaged, and then frozen. Ram lamb chops had significantly higher pH values than those from wethers and ewes. Chops from Romney-cross lambs had lower pH values than those from Coopworth-cross and Perendale-cross lambs. Meat pH decreased slightly but significantly during storage.

Keywords Display life; frozen lamb; packaging film; lamb breed; ram lambs; ewe lambs; wether lambs.

INTRODUCTION

The display life of frozen meat is primarily determined by its appearance, because at usual display temperatures microbial growth does not occur and any flavour changes occur extremely slowly. Although many studies have investigated the factors affecting the appearance of frozen beef (see review by Kropf (1982)), lamb has received little attention.

Hunt *et al.* (1975) tested the effects of freezing temperatures, packaging film, display temperature and the type of lighting on the colour stability of frozen lamb chops. Chops were bloomed and then packaged in oxygen-permeable or oxygen-impermeable film, frozen at -40°C or -26°C then displayed at -21°C or -29°C for 42 days under incandescent or fluorescent light. Chops wrapped in oxygen-permeable film were a brighter red than those wrapped in impermeable film; freezing at -40°C gave a more attractive product than the slower freezing at -26°C , and display at -21°C was favoured over that at -29°C .

The appearance of frozen meat may also be influenced by sex of the animal. Chilled chops from ram lambs discoloured more rapidly during display than did chops from wether lambs (Riley *et al.*, 1981). This latter finding, although on chilled product, may be important since there is a trend in the New Zealand industry to the slaughter of entire male lambs which are larger and leaner than ewe and wether lambs of the same age.

This paper examines the display life of frozen chops from ram, ewe and wether lambs from 3 breeds of sheep under 2 packaging conditions and 2 types of packaging film.

EXPERIMENTAL

Double loins from 27 lambs were used. There were 9 each of ewes, wethers, and rams, composed of 3 each of Perendale, Coopworth, and Romney breeds (maternal) crossed with Southdown (paternal). All were from the same mob and had been treated similarly during their growing period. The animals were slaughtered and dressed by usual slaughterhouse methods and carcasses were held at 8°C overnight.

The double loins were removed from the carcasses and brought to the laboratory where they were halved through the vertebrae. The loin from 1 side of each cut was vacuum packaged in film of low oxygen permeability and frozen at -20°C until cut into chops (1 week). The loin from the other side was vacuum packaged in film of low oxygen permeability and held at 5°C until cut into chops (within 3 days).

Loins from both sides were cut into 20 mm chops. Five chops were removed from each side beginning at the posterior end. The first 2 were shrink-wrapped in a hot air tunnel with an oxygen permeable film (d-film, W.R. Grace, Wellington, oxygen permeability $>2000\text{ ml/m}^2/24\text{ hr at }25^{\circ}\text{C}$), and the second 2 were vacuum packaged in film of low oxygen permeability (Tuflex, Trigon Plastics,

Hamilton, oxygen permeability 100 ml/m²/24 hr at 25°C). The fifth chop was used immediately for pH measurement. Nine sides/day were packaged, representing 1 each of all the combinations of breed and sex. Chilled chops were cut and packaged first, after which they were placed in an open box in a -20°C freezer and frozen overnight at -20°C. Although some blooming undoubtedly took place before the chops were frozen, they were not held for blooming. The chops, now frozen, were placed in the display case the morning after packaging which was called day 0. Panel assessments began at this stage. After the chilled chops had been packaged, the frozen loins were cut into 20 mm chops and treated in a similar manner.

A General Electric open display case was used. This case operated at -20°C, and was sited in a small room painted white, with no outside illumination. Fluorescent lighting (32° Deluxe, Philips, Holland) was placed 2 m above chops. The samples were placed on a wire shelf at half depth. Lighting was continuous.

For pH measurements a core of the longissimus muscle 10 mm in diameter and 20 mm in length was homogenised in 0.005M iodoacetate. Measurements were made on 1 chop from each side at the time of packaging and on the chops as they were removed from the display case at the end of their display life.

A panel of 7 Meat Industry Research Institute staff evaluated the colour of the chops. These panelists had been selected for their ability to discriminate small changes in colour, but as there was no extensive training, the panel was effectively a 'consumer' panel. Scoring was on a 1 to 50 scale as follows:

0-9	Unacceptable meat colour.
10-19	Barely acceptable meat colour.
20-29	Acceptable meat colour.
30-39	Good meat colour.
40-50	Excellent meat colour.

Chops were removed from the display case when they attained an average score of less than 20, which was taken as the end of retail life. The experiment ended at 63 days when all the vacuum packaged samples had been rejected.

TABLE 1 Effect of breed and sex of lamb on display life (d) of lamb chops.

	Ewe	Wether	Ram
Romney x	48	44	51
Coopworth x	51	51	48
Perendale x	46	43	49
SED, significance			
Breed	2.28 NS		
Sex	2.26 NS		
S x B	3.90 NS		

Data were analysed with the Genstat V Program (Lawes Agricultural Trust, Rothamsted Experiment Station (C) 1980). The parameter used was the number of days each chop remained acceptable on display, rather than the panel scores. The pH values were also analysed. Because the seals on a number of vacuum-packaged chops failed, all data pertaining to these chops were discarded and the data were analysed by a least squares analysis of variance (Harvey, 1975). The results obtained with and without failed packages were the same, so the data reported here were analysed by the Genstat analysis of variance, using the data from the failed packs as a covariate.

Display life was not affected by breed or sex of lamb (Table 1) but was shortened when the chops were cut and packaged from the chilled state (Table 2). Those packaged frozen lasted on average 9 days longer than those packaged chilled and then frozen (Table 2). Packaging in oxygen permeable film increased display life by 12 days on average. Film by condition at packaging interaction was significant ($P < 0.05$) which suggests that chops cut frozen had a greater advantage over those cut from the chilled state when film of low oxygen permeability was used.

Chop pH at the time of packaging and discarding from the display case was affected by sex and breed and there was a significant breed x sex interaction ($P < 0.05$) (Table 3). Ram lambs had a higher pH than either ewes or wethers. Perendale-

TABLE 2 Effect of condition at packaging and packaging film on display life (d) of lamb chops.

	Shrinkwrap O ₂ -permeable	Vacuum low O ₂ -permeable
Chilled	51	36
Frozen	56	48
SED, significance		
Condition	1.84***	
Film	3.54***	
C x F	3.62*	

TABLE 3 Effect of breed and sex of lamb on pH of lamb chops.

	Ewe	Wether	Ram
Romney x	5.57	5.58	5.70
Coopworth x	5.57	5.63	5.80
Perendale x	5.57	5.58	6.02
SED, (mean) 0.082			
Significance			
Breed	*		
Sex	***		
S x B	*		

cross ewes and rams had a greater difference in pH (0.45) than Coopworth-cross (0.33) or Romney-cross (0.13) ewes and rams. The Perendale-cross rams appear to contribute more to the sex effect than the other 2 breeds. There was no difference in pH between a chilled chop and the corresponding frozen chop, but a significant drop of 0.04 during display ($P < 0.01$) was noted (Table 4).

TABLE 4 Effect of condition at packaging and packaging film on pH of lamb chops before and after storage.

	Chilled	Frozen
Before storage	5.70	5.69
After storage		
0,-permeable film	5.67	5.65
Low 0,-permeable film	5.66	5.64
SED, significance		
Storage 0.012 **		
Condition 0.014 NS		
Film 0.012 NS		

DISCUSSION

Although chilled ram lamb chops discoloured more quickly during refrigerated display than chops from wethers (Riley *et al.*, 1981), sex had no effect on the display life of frozen chops in the present study. Breed also had no effect on frozen display life.

Chops packaged in oxygen permeable film had a display life 23% longer than those vacuum-packaged in film of low oxygen permeability, and chops cut from the frozen state had a 17% longer display life than those cut from the chilled state. This may partly be explained by the fact that many chilled, vacuum-packaged chops had an unattractive yellow colour, caused by blood staining the fat as the vacuum was drawn. The yellowness persisted after freezing. Those cut from the frozen state did not suffer from this problem. Alternatively, oxygen permeable film had a 29% advantage over film of low oxygen permeability when chops were cut from the chilled state, whereas there was only a 14% advantage when loins were frozen before cutting. Metmyoglobin formation due to oxygen diffusion through the film does not appear to be a problem at or below -20°C , but failure of vacuum seals is a problem since loss of vacuum can cause icing of the chops and an unattractive appearance.

Although the decrease in pH during display was significant, the practical consequences of a pH drop of 0.04 are minimal, since pH and frozen display life were not significantly correlated ($r = 0.18$). The decrease could be a natural one due to frozen storage and not the display itself.

There was no dark, firm, dry meat among these

carcasses although some of the pH values were above 5.8. For beef, Tarrant (1981) considers pH 5.8 as the upper limit for "normal" while MacDougall and Rhodes (1972) consider any beef above pH 5.65 as suspect. For lamb, Petersen (1984) considers that pH 5.8 is the upper limit for normal meat. The pH values in this study ranged from a mean of 5.57 for ewes to 6.02 for Perendale rams. The higher pH values of chops from rams did not shorten their frozen display life. However, chilled high pH lamb chops could have a shortened display life owing to early microbial spoilage of high pH meat.

Petersen (1984) found a significant effect of breed on the pH of meat from Perendale v Romney or mixed breed lambs of the order of 0.20 pH units. Overall breed differences in this study were only 0.10 unit. Overall sex differences were greater (0.27), with differences ranging from only 0.13 for the Romney ewe-ram difference to 0.45 for the Perendale ewe-ram difference, with wether pH values intermediate. These significant differences reflect real difference between groups, as all animals had been treated similarly as regards farm and slaughterhouse handling.

In summary, to prolong frozen display life, it is preferable to cut chops from the frozen carcass rather than the chilled, whatever the wrap. For frozen display oxygen permeable shrink wrap is preferable to vacuum packaging in low oxygen permeable film. Although a sex and breed difference in pH was noted, it was not related to the display life.

ACKNOWLEDGEMENTS

The authors wish to thank Dr R. Moore, Whatawhata Research Station, Hamilton, for supplying the animals used in this trial, MIRINZ staff who served on the colour panels, and T. Ireland for help with data collection.

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