Consumer panel evaluation of bulk pre-packaged pork retail cuts stored under O_2 and CO_2

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INTRODUCTION

To facilitate the acceptance of a bulk pre-packaging system by the South African meat industry, consumer reaction to the pork retail cuts, bulk packaged in various gas mixtures, had to be tested. Bulk packaging of retail ready product under oxygen-depleted atmospheres offers a means of preserving chilled pork during its distribution from central cutting facilities (Scholtz *et al.* 1992; Buys *et al.* 1994). However, the commercial storage life of 100% CO_2 bulk stored chops was found to be limited since no "bloom" was apparent after storage in CO_2, although an extended odour and microbiological shelf life was achieved (Buys *et al.* 1994). Very low oxygen concentration in the packaging may be responsible for the lack of bloom. Therefore, during this study colour retention of bulk packed samples (including an oxygen scavenger) was evaluated by a consumer panel.

MATERIALS AND METHODS

Meat

Twelve pig carcasses were selected according to a *c.* 30 minute post mortem pH (> 6, in the *M. longissimus thoracis,* in the area of the last three ribs) and a carcass mass of *c.* 65 kg. The 12 carcasses represented three repetitions of the experimental design. Only the loin cuts were used.

Packaging Treatments

One loin of each carcass was cut into a total of 18 chops, which included 2 duplicates. Each chop was placed in a shallow styrofoam tray and overwrapped with PVC (OTR - *c.* 5 000 ml/m^2/24h/ 1 atm at 22 °C 75% RH). These chops were then randomly allocated to a specific bulk pack treatment (*c.* 20% CO_2: 80% O_2, *c.* 100% CO_2 + oxygen scavenger (ageless, Mitshibushi; *c.* 25% CO_2:25% O_2:50% N_2).
Bulk Packaging: All the PVC-overwrapped chops were bulk packed, six per bulk pack (BB4L Cryovac barrier bag, OTR - 39 ml/m^2/24h/atm at 23 °C 75% RH). Twelve bulk packs, representing three repetitions, were filled with *c.* 20% CO_2: 80% O_2, 12 with *c.* 100% CO_2 + oxygen scavenger and the remaining 12 with *c.* 25% CO_2 : 25% O_2 : 50% N_2. All the bulks were subsequently gas packed with the specified gas mixtures (MultiVac).

Storage and Shelf life study

Bulk Packaging: Three bulk packs from each treatment (*c.* 100% CO_2 + oxygen asorber (ageless), *c.* 25% CO_2 : 25% O_2 : 50% N_2, *c.* 20% CO_2: 80% O_2) were opened after *c.* one hour of saturation (day 0). One set (2) of PVC-overwrapped samples from each bulk pack was assessed (2) 1-2h after opening to allow for "bloom" and the remaining samples (4) were displayed for 2 or 4 days, in an open deck retail display cabinet (*c.* 4°C). The remainder of the bulk packs (27) were stored at 0 °C for either 7, 14 or 21 days. After each relevant storage period (7, 14 or 21 days), 3 bulk packs from each treatment were opened and assessed as noted above.

Quality Attributes

After 0, 7, 14 and 21 days bulk pack storage, the PVC-overwrapped samples were displayed for the specified period (0, 2 or 4 days), withdrawn and the lean area of the *M. longissimus thoracis et lumborum* assessed by a consumer panel.

Acceptability: A consumer panel consisting of a total of 150 people was used to evaluate the packaging treatments. Since it was imperative that the consumer panel evaluated all the meat samples (days 0, 7, 14 & 21) simultaneously, the day 21 samples were packed 4 weeks before display, the day 14 samples 3 weeks, the day 7 samples 1 week and the day 0 samples packaged on the days of display. Fifty people per display period were used i.e. 50 on day 0 of display, 50 on day 2 and 50 on day 4. Three display cabinets were used during the assessment. Each gas mixture was randomly allocated to a display cabinet on each display period (i.e. *c* 100% CO^2 + oxygen absorber- cabinet A, *c.* 20% CO_2: 80% O_2 - cabinet B and *c.* 25% CO_2 : 25% O_2 : 50% N_2 - cabinet C). The samples from each storage period (days 0, 7, 14 & 21) were randomly placed in the display cabinets. The three replicate samples from each storage period were evaluated by the panel simultaneously and they were instructed to judge the acceptability af all three replicate samples as one . The acceptability of each PVC-overwrapped sample was done according to a scale ranging from 9= 'Like extremly'; 8= 'Like very much'; 7= 'Like moderately'; 6= 'Like slightly'; 5= 'Neither like nor dislike'; 4= 'Dislike slightly'; 3= 'Dislike moderately'; 2= 'Dislike very much' to 1= 'Dislike extremely'.

Statistical analysis

The data was analysed by analysis of variance to determine which factors (bulk packaging, storage period, display period) and interaction between factors contributed signficantly to the different parameters determined. Levels of <05 were taken to be significant.

RESULTS

Acceptability panel

The statistical analysis of the acceptability scores indicated that all the main effects (gas mixtures, bulk storage period, retail display period) and interactions of the main effects were all highly significant (P=0, 0001) (Table 1). According to the consumer panel the *c.* 100% CO_2 samples became less acceptable as the bulk storage periods progressed (day 0=like moderately, day7=like slightly, day 14=neither like nor dislike, day

21=dislike slightly), while the samples from the other two gas mixtures (*c.* 25% CO_2 : 25% O_2 : 50% N_2, *c.* 20% CO_2: 80% O_2) were found to be more acceptable after 7 and 14 days bulk storage (like moderately) than after 0 and 21 days bulk storage (i.e. like slightly and neither like nor dislike) (gas mixture X bulk storage interaction, P=0,0001).

The acceptability scores also indicated that there was a significant gas mixture X retail display period interaction (P=0,0001), since the *c.* 100% CO_2 samples became singificantly more acceptable after 4 days of retail display, while the samples from the two other gas mixtures became less acceptable during retail display (Table 1). After 0 days storage all the samples were liked slightly(6) to moderately(7) initially, but after 2 and 4 days display the samples stored in *c.* 100% CO_2 were liked very much(8), while the samples stored in the O_2 containing gas mixtures were judged to be liked slightly(6) to neither liked or disliked (Table 1). After 7 days storage the samples from the *c.* 100% CO_2 bulk packs were also judged to be more acceptable during the display period (7 vs. 6). However, after 14 days storage the samples stored in the O_2 containing gas mixtures were found to be more acceptable by the panel. After 21 days storage the samples stored in *c.* 100% CO_2 were less acceptable, than all the other samples initially (4 vs. 5-7), but were also judged to be disliked slightly(4) to moderately(3) after 2 and 4 days display.

DISCUSSION

The consumer panel found the samples bulk packed in a *c.* 100% CO_2 + oxygen scavenger (ageless) to be more acceptable after 0 and 7 days bulk storage and subsequent retail display (2 and 4 days) than the samples stored in either *c.* 25% CO_2 : 50% N_2 : 25% O_2 or *c.* 80% O_2 : 20% CO_2. However, after 14 days bulk storage the samples stored at in the high O_2 concentrations were more acceptable. After 21 days storage all the samples were disliked slightly.

During a previous study done by Buys *et al.* (1994) samples stored in a 100% CO_2, not containing an oxygen scavenger, were found to be less acceptable than bulk packed samples stored in *c.* 25% CO_2 : 50% N_2 : 25% O_2 and *c.* 80% O_2 : 20% CO_2, i.e. 'greyish pale' vs. 'redish pale'. According to Rousset and Renerre (1990) very low O_2 concentrations in gas-packaging have been found to be responsible for fresh meat discoloration. However, when packaging beef under *c.* 100% CO_2 + an O_2 scavenger (ageless) the residual O_2 concentration was reduced rapidly to less than 0,1% and remained at this level, extending colour stability. It has also been reported by various other researchers that although the *c.* 100% CO_2 packaging treatment was the most successful, regarding storage and subsequent shelf life extension of fresh pork at *c.* 0<198>C, the colour-life (9 days) of these pork samples was shorter than the microbial shelf life (21 days) (Gill and Harrison 1989; Scideman and Durland 1984; Scholtz *et al.* 1992; Buys *et al.* 1994). However, this study clearly indicates that the inclusion of an oxygen scavenger will ensure that pork retail samples bulk packed in *c.* 100% CO_2 are still slightly to moderately acceptable to a consumer panel after 14 days storage and a subsequent 4 days shelf life. Furthermore, these samples were found to be as acceptable as the samples in oxygen enriched atmospheres. Similar findings were also reported by Gill and Jones (1996) regarding the appearance of pork chops after bulk packaging.

From the results of this study it is apparent that the consumers find pork retail packs, bulk pre-packaged in oxygen depleted atmospheres, as acceptable as pork chops stored in oxygen enriched atmospheres.

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TABLE 1. ACCEPTABILITY SCORES OBTAINED FOR CENTRALISED BULK PACKAGED (STORED 0 °C) AND A SUBSEQUENT RETAIL SHELF LIFE STUDY (4 °C) OF PORK RETAIL CUTS.

Storage	Display	100 % CO^2	Stnd. error	20% CO_2: 80% O_2	Stnd. error	25% CO_2: 25% O_2: 50% N_2	Stnd. error
0 DAYS	Day 0	4.3	0.2	4.2	0.2	3.5	0.2
	Day 2	2.3	0.2	4.4	0.3	4.0	0.2
	Day 4	2.4	0.1	5.9	0.3	5.5	0.3
7 DAYS	Day 0	5.8	0.2	2.7	0.1	4.1	0.2
	Day 2	3.5	0.2	3.0	0.2	4.8	0.2
	Day 4	3.7	0.2	4.7	0.3	4.9	0.2
14 DAYS	Day 0	6.0	0.2	3.5	0.2	2.7	0.1
	Day 2	4.1	0.3	3.1	0.3	2.8	0.2
	Day 4	4.9	0.3	2.9	0.2	5.5	0.3
21 DAYS	Day 0	6.1	0.2	3.4	0.2	5.8	0.2
	Day 2	5.9	0.3	7.2	0.3	7.1	0.2
	Day 4	6.7	0.3	6.0	0.3	6.7	0.2