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## INFLUENCE OF AGEING TREATMENT ON THE BACTERIAL QUALITY OF SOUTH AFRICAN SPRINGBOK (*Antidorcas marsupialis*).

**E.M. Buys, J. Kruger & G.L. Nortjé**
**Meat Industry Centre, Animal Nutrition and Animal Production Institute, Private Bag X2, Irene 1675, Republic of South Africa**

### Background

Although vacuum packaging of meat causes a shift in the microflora from a predominance of aerobic spoilage organisms to lactic acid bacteria, some researchers have suggested that vacuum packaging does not have an advantage over the conventional method of ageing (Smith *et al.*, 1974; Newsome *et al.*, 1984). Nortje and Shaw (1989) concluded that ageing treatment can have considerable effects on the initial microbial population of the packaged retail meat cuts. The present study was undertaken to determine the most effective way to age springbok meat in order to produce quality products to be marketed in South Africa and internationally. The aim of the study was to determine the influence of different ageing treatments on the microbiological characteristics of springbok carcass sides and cuts.

### Materials and Methods

#### Meat

Springbok rams (*Antidorcas marsupialis*) obtained from the same geographical area (De Aar district, Northern-Cape Province, South Africa) were harvested by a professional culling team during three consecutive nights (*ca* -2 to +2 °C). The carcasses were bled *ca* 2-8 minutes after being shot and eviscerated in the veld *ca* 10-30 minutes after bleeding. The carcasses were hung outside overnight (skin on, *ca* -2 to +2 °C) and transported (*ca* 700 km) to the Meat Industry Centre (MIC) the following day (*ca* 10 °C). On arrival the carcasses were placed in a chiller (*ca* 0 °C) overnight and the following morning (32-36 h post mortem, pH range 5.4-6.9) the carcasses were skinned, halved and packaged.

#### Treatments

Forty carcasses were used during this trial. Twenty carcasses were aged hung in air and the other twenty carcasses vacuum packaged. The left sides of twenty springbok carcasses were aged with the skin on (treatment 1), while the right sides were aged without the skin (treatment 2). The skin was removed from the right side of the carcass before it was sawn in half and the resulting skin then draped around the left sides. The twenty remaining (vacuum pack aged) carcasses were skinned, halved and cut into wholesale cuts, namely: loin and leg. The cuts from the left sides were vacuum packed with the bone in (treatment 4), while the cuts from the right sides were deboned before vacuum packaging (treatment 3) (45ml/m2/24h atm at 23 °C and 75 % RH, Kholer packaging limited, South Africa) with a Multivac. All the carcass sides and vacuum packed cuts were placed in a chiller (*ca* 0 °C) for ageig.

#### Ageing

The 20 carcass sides (36h *post mortem*) and vacuum packed cuts (36h post mortem) were aged for either 2, 5, 12 and 19 days respectively (*ca* 0 °). After each respective ageing period 5 skin-on aged carcasses were skinned. These 5 carcass sides as well as 5 skin-off aged carcass sides were cut into wholesale cuts (loin and leg) and bacteriologically sampled. Five vacuum packed cuts from each ageing treatment (bone-in and without-bone) were also bacteriologically monitored after each respective ageing period.

#### Bacteriological Analysis

The springbok carcass sides and vacuum packed cuts were bacteriologically monitored, after each ageing period (2, 5, 12 or 19 days) using the excision technique. A measured area of 12 $cm^2$ was removed aseptically to a depth of *ca* 5 mm from the upper surface of the sample. This was homogenised with a Colworth Stomacher 400 in a 100 ml of 1/4-strength Ringer diluent. Counts were obtained as follows: Total aerobic counts on Standard 1 nutrient agar (Std 1; Merck), incubated for 3 days at 25 °C and MRS agar (De Man *et al.*, 1960) was used for determination of lactic acid bacteria (5 days at 30 °C). *Pseudomonas* spp. were monitored on cetrimide fusidin ceporin agar (CFC) (Mead & Adams, 1977) incubated for 3 days at 25 °C and DHL agar (Sakazaki *et al.*, 1960) was used to determine Enterobacteriaceae (2 days, 37 °C).

#### Statistical Analysis

The loin and leg data were analysed by analyses of variance to determine which factors: ageing treatment (skin-on = 1, skin-off = 2, vacuum packed bone-out = 3, vacuum packed bone-in = 4) or ageing period (2, 5, 12 or 19 days) and interaction between factors differed significantly regarding the initial microbial quality. Levels of $P < 0,05$ were taken to be significant.

### Results

The statistical analysis of all the examined groups of bacteria on the springbok leg samples indicated that the different ageing treatments (1-4) did not differ significantly ($P < 0.05$) from each other, although the counts recorded at the different ageing periods did (days 2, 5, 12 & 19) ($P = 0.0001$). Although, the initial total counts (day 2) recorded for treatments 1 and 2 were lower (log 4 cm-2) than those recorded for treatments 3 and 4 (log 6 $cm^{-2}$), these counts increased to reach significantly higher levels of log 7 $cm^{-2}$ after an ageing period of 19 days (Table 1). In contrast, the counts of treatments 3 and 4 decreased initially, but reached similar levels (log 6 $cm^{-2}$), to the initial count, on day 19. The pseudomonad counts recorded followed a similar trend to that of the total counts. The lactic acid bacteria counts of all 4 treatments increased during the ageing period to reach significantly higher levels of

log 5 $cm^{-2}$ on day 19, although, the day 19 lactic acid bacteria counts for treatments 1 and 2 were 2 log units lower than the pseudomonad counts, while the respective counts for treatments 3 and 4 were similar (log 5 $cm^{-2}$). Although the Enterobacteriaceae counts recorded (treatments 1-4) followed a similar trend to that of the total counts, treatments 1 and 2 recorded unacceptably high counts after 19 days ageing (log 5 $cm^{-2}$).

The statistical analysis of the lactic acid bacteria group on the springbok loin samples was similar to that of the leg samples. All the other bacteria groups examined were significantly influenced by an ageing treatment by ageing period interaction ($P < 0.05$). This significant interaction was caused by the contrasting reaction of treatments 1 and 2 in relation to treatments 3 and 4. Regarding the total counts, Table 2 clearly shows that while the initial counts of treatments 3 and 4 decreased to reach lower levels (log 7-5 $cm^{-2}$ and log 7-6 $cm^{-2}$ respectively) on day 19, the counts of treatments 1 and 2 steadily increased to reach higher levels at the end of the ageing period (log 2-7 $cm^{-2}$ and log 0.5-6 $cm^{-2}$ respectively). The pseudomonad and Enterobacteriaceae counts reacted similarly to the total counts. Similarly to the leg wholesale cut the Enterobacteriaceae counts of treatments 1 and 2 also reached unacceptably high numbers at the end of the ageing period (log 5 $cm^{-2}$).

## Discussion

Although the four ageing treatments (skin-on = 1, skin-off = 2, vacuum packed bone-out = 3, vacuum packed bone-in = 4) did not differ significantly over the whole ageing period (days 2 - 19), they did at the respective ageing periods. Indicating that as the ageing period progressed the vacuum packaging treatments became more effective. The lactic acid bacteria and pseudomonad counts clearly demonstrate this, in that after 19 days vacuum ageing these counts are similar, whereas the pseudomonad counts of the carcass sides hung in air are *ca* 2 log units higher than the respective lactic acid bacteria counts at day 19. This is to be expected since the aerobic spoilage bacteria are inhibited and the lactic acid bacteria proliferate over a period of time in vacuum (Sutherland *et al.* 1975; Christopher *et al.* 1979; Asensio, 1988). Regarding all the examined groups of bacteria the results indicate that, for an ageing period of 12 days or less, vacuum packaging does not have an advantage over the hung in air method. Nortje & Shaw (1989) reported that beef carcasses aged for *ca* 1 week either as hung carcasses or primal joints in vacuum packs gave a similar product. This trend was also described by Silliker *et al.* (1977) and Buys *et al* (1993), who reported that at 7 days storage the differences between pork stored in air as compared with pork stored in modified atmospheres were trivial.

However, when considering an extended ageing period (12 days) vacuum packaging ensures that spoilage bacteria are inhibited and that the Enterobacteriaceae group of bacteria do not increase (*ca* 0 °C), while the results clearly show that this is not the case with the hung in air ageing treatments (1 & 2). The total and pseudomonad counts of the hung in air treatments (1 & 2), after 19 days ageing, also indicate that these samples were already not microbiologically acceptable, because according to Dainty *et al.* (1983), lean meat off-odours become evident during aerobic storage of lean meat when microbial numbers reach *ca* log 7 $cm^{-2}$.

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TABLE 1. MEAN BACTERIOLOGICAL COUNTS ($LOG/CM^2$) OBTAINED FROM LEG WHOLESALE CUTS FROM SPRINGBOK CARCASSES (32 - 36 h *post mortem*) AGED FOR 2, 5 12 OR 19 DAYS (0 °C).

| Ageing Treatment | Ageing Period (days) | Total Count ($log\ cm^{-2}$) | Stnd. error | Pseudomonads ($log\ cm^{-2}$) | Stnd. error | Lactic acid bacteria ($log\ cm^{-2}$) | Stnd. error | Enterobacteriaceae ($log\ cm^{-2}$) | Stnd. error |
|---|---|---|---|---|---|---|---|---|---|
| LEG WHOLESALE CUT | | | | | | | | | |
| Skin-on | Day 2 | 3.11 | 0.98 | 1.31 | 0.82 | 1.21 | 0.74 | 0.53 | 0.53 |
| (n=5) | Day 5 | 4.05 | 0.67 | 2.59 | 1.21 | 1.71 | 0.70 | 1.82 | 1.25 |
| | Day 12 | 4.77 | 0.34 | 4.14 | 0.21 | 3.30 | 0.85 | 3.07 | 0.86 |
| | Day 19 | 7.20 | 0.29 | 7.04 | 0.33 | 4.92 | 0.49 | 5.61 | 0.23 |
| Skin-off | Day 2 | 4.16 | 0.39 | 2.99 | 1.27 | 1.15 | 0.70 | 1.60 | 0.98 |
| (n=5) | Day 5 | 6.23 | 1.80 | 4.04 | 2.00 | 1.57 | 0.97 | 3.43 | 2.00 |
| | Day 12 | 2.44 | 0.62 | 1.97 | 0.81 | 0.78 | 0.78 | 2.60 | 0.66 |
| | Day 19 | 7.94 | 1.29 | 7.60 | 1.11 | 5.63 | 0.62 | 6.59 | 0.93 |
| Vacuum packed | Day 2 | 6.36 | 1.31 | 6.22 | 0.99 | 2.41 | 0.62 | 3.32 | 1.86 |
| bone-out | Day 5 | 5.35 | 1.87 | 3.36 | 2.00 | 1.87 | 0.77 | 2.13 | 1.46 |
| (n=5) | Day 12 | 4.89 | 0.75 | 1.58 | 1.32 | 4.72 | 0.67 | 2.55 | 1.18 |
| | Day 19 | 6.12 | 0.51 | 5.53 | 0.79 | 5.57 | 0.35 | 3.90 | 0.64 |
| Vacuum packed | Day 2 | 6.89 | 1.56 | 5.46 | 1.67 | 1.79 | 0.73 | 2.48 | 0.62 |
| bone-in | Day 5 | 5.26 | 2.00 | 1.84 | 2.00 | 0.00 | 0.00 | 1.45 | 0.88 |
| (n=5) | Day 12 | 4.91 | 0.84 | 2.89 | 1.35 | 3.88 | 0.33 | 3.02 | 0.89 |
| | Day 19 | 6.53 | 1.06 | 5.31 | 0.58 | 5.13 | 1.33 | 3.34 | 1.04 |

TABLE 2. MEAN BACTERIOLOGICAL COUNTS ($LOG/CM^2$) OBTAINED FROM LOIN WHOLESALE CUTS FROM SPRINGBOK CARCASSES (32 - 36 h *post mortem*) AGED FOR 2, 5 12 OR 19 DAYS (0 °C).

| Ageing Treatment | Ageing Period (days) | Total Count ($log\ cm^{-2}$) | Stnd. error | Pseudomonads ($log\ cm^{-2}$) | Stnd. error | Lactic acid bacteria ($log\ cm^{-2}$) | Stnd. error | Enterobacteriaceae ($log\ cm^{-2}$) | Stnd. error |
|---|---|---|---|---|---|---|---|---|---|
| LOIN WHOLESALE CUT | | | | | | | | | |
| Skin-on | Day 2 | 2.53 | 0.66 | 0.70 | 0.70 | 0.54 | 0.54 | 0.64 | 0.64 |
| (n=5) | Day 5 | 4.46 | 0.63 | 3.89 | 0.68 | 1.99 | 0.84 | 2.95 | 1.02 |
| | Day 12 | 4.43 | 0.48 | 5.70 | 0.52 | 4.02 | 0.45 | 3.60 | 0.90 |
| | Day 19 | 7.52 | 0.26 | 7.20 | 0.32 | 5.98 | 0.36 | 5.97 | 0.23 |
| Skin-off | Day 2 | 0.00 | 0.00 | 1.58 | 1.06 | 1.62 | 0.66 | 0.81 | 0.81 |
| (n=5) | Day 5 | 5.17 | 1.73 | 6.18 | 2.00 | 1.06 | 0.65 | 0.78 | 0.78 |
| | Day 12 | 5.77 | 0.57 | 4.94 | 0.79 | 4.86 | 0.53 | 3.03 | 1.00 |
| | Day 19 | 6.46 | 0.49 | 6.24 | 0.12 | 4.75 | 0.22 | 5.13 | 0.38 |
| Vacuum packed | Day 2 | 7.19 | 1.68 | 5.74 | 0.68 | 1.91 | 0.79 | 5.26 | 1.67 |
| bone-out | Day 5 | 4.29 | 1.31 | 1.51 | 1.51 | 1.10 | 1.10 | 1.51 | 1.51 |
| (n=5) | Day 12 | 5.00 | 1.02 | 3.95 | 0.41 | 4.03 | 0.58 | 3.17 | 1.02 |
| | Day 19 | 5.90 | 0.24 | 4.69 | 1.18 | 6.15 | 0.30 | 2.40 | 0.75 |
| Vacuum packed | Day 2 | 7.37 | 1.53 | 5.81 | 1.80 | 1.42 | 0.87 | 2.60 | 1.94 |
| bone-in | Day 5 | 5.30 | 0.95 | 5.05 | 1.57 | 2.02 | 0.84 | 3.42 | 1.59 |
| (n=5) | Day 12 | 3.97 | 0.17 | 2.22 | 0.63 | 3.79 | 0.15 | 0.25 | 0.25 |
| | Day 19 | 6.48 | 0.53 | 4.51 | 1.34 | 5.49 | 0.42 | 3.80 | 1.31 |