STORAGE LIFE OF CHILLED LAMB CARCASSES EITHER PRODUCED IN SAUDI ARABIA OR IMPORTED BY AIR FROM NEW ZEALAND

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SUMMARY

In this study visual appearance determined the commercial storage life of carcasses. However, the meat was still organoleptically acceptable when carcass appearance became unacceptable. packaging to prevent desiccation did not extend the storage life, but instead accelerated the onset of microbial spoilage. Nose of the Chemical parameters measured: pH, total volatile bases, free fatty acids or Kreis value, reliably indicated incipient spoilage. Results for carcasses from Saudi and New Zealand sources were similar. Within the Saudi cold chain a storage life, at 0C, of no more than 21 days can be expected for locally produced carcasses. The storage life of air freighted carcasses after landing is reduced, because of the time spent in transit, to less than 14 days.

INTRODUCTION

The Saudi consumer prefers to purchase sheepmeats as fresh, whole carcasses. This consumer demand is met either by local slaughter or through importation of chilled carcasses. Carcass storage life is influenced both by the microbiological status of the carcasses at the time they enter storage and by the storage conditions.

The microbiological status, i.e. the size and Composition of the meat microflora, is itself a function ot hygiene practiced at the point of production and the conditions experienced during transportation. AS part of a comprehensive investigation of chilled moats within the Kingdom of Saudi Arabia, undertaken jointly by the Saudi Arabian Standards Organisation (SASO) and the Meat Industry Research Institute of New Zealand (MIRINZ), a study has been conducted to monitor the cold chain, and to compare the chill storage life of locally slaughtered lamb carcasses with that ot chilled lamb carcasses imported by air freight from New Zealand.

EXPERIMENTAL METHODS

Six 32-lamb carcass consignments, three obtained from a Riyadh slaughter house and three air freighted from New Zealand, were used in storage trials.

a) *Cold chain*. Coded computer-activated miniature temperature monitors (Delphi Electronics, Auckland, N.Z.) were placed in the body cavities of ten carcasses in each consignment when the carcasses were on the cooling floor of the facilities at which the animals hare slaughtered. These monitors remained in place until the end of the storage trials, and recorded the temperature every 15 minutes with an accuracy of ± 0.25°C. When received at the cool store, the carcasses of local origin were marked, but those air freighted from New Zealand were wrapped in double stockinet. The carcasses from both sources were divided into three groups and stored naked, or wrapped in stockinet or in polyethylene bags.

b) *Microbiological examination*. Five carcasses were sampled for microbiological quality on the cooling floor. Thereafter, groups of three carcasses were sampled upon removal from chill storage. A composite sample was obtained for each carcass by swabbing 5 cm^2 sites on the brisket, flap and leg. Each site was swabbed first with a wet and then with a dry swab. Appropriate dilutions of these composite samples were prepared in 0.1% peptone, spread onto Plate Count Agar and after incubation at 25°C for 72 hr, a differential count based on colonial appearance was made. From a single plate, one for each carcass examined, ten representative colonies were selected in numerical proportion to their relative abundance in the spoilage microflora. These colonies were subcultured and identified to genus level using a 7-test identification procedure (Newton et al. 1978). Samples taken on the cooling floor and at the end of the storage trials were also examined for the presence of faecal coliforms, coagulase positive *Staphylococcus aureus* and *Salmonella*.

c) *Chemical Analysis*. After completion of microbiological sampling, samples were taken for chemical analysis. Seven carcasses were sampled on arrival at the coolstore, and thereafter samples were taken from groups of five carcasses. The following analyses were performed on samples of lean meat or superficial fat: i) pH: was determined directly on minced lean muscle tissue using a glass electrode; ii) total volatile bases (TVB) in muscle tissue: was determined by a steam distillation procedure (SASO 1977b); iii) Free fatty acids (FFA) in fat tissue: was determined by titrating fat extracted in cold 40/60 petroleum ether against sodium hydroxide (SASO 1977a); and iv) Kreis value of superficial fat: was determined colorimetrically following

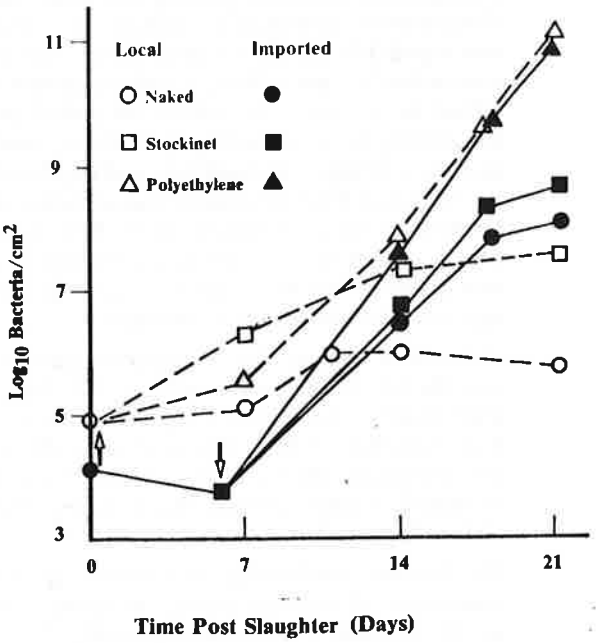

Figure 1. Aerobic microflora development on lamb carcasses during storage at 0°C. Arrows indicate time carcasses entered chill storage in Riyadh.

the addition of phloroglucinol to fat extracted in cold chloroform (Egan et al. 1981).

d) *Sensory evaluation and visual appearance assessment.* The loins and right legs of the carcasses from each consignment that were sampled on consignment arrival at the cool store were removed, wrapped in a cling wrap and frozen to serve as controls. At each sampling time, the loins from two stored carcasses and a thawed control were each placed into a Tuflex bag (Trigon, Hamilton, N.Z.) and cooked to an internal temperature of at least 70°C by immersion in boiling water for 80 minutes. Aroma, texture, flavour and overall acceptability were assessed on a 7-point hedonic scale by a 40 member 'in-house' panel of SASO staff. This panel then rated the visual appearance of a thawed control leg and legs from two stored carcasses on a 5-point hedonic scale.

RESULTS

a) *Cold Chain.* The mean temperature of imported carcasses during the 20 days from loadout in New Zealand to removal from cold storage in Riyadh was 1.4°C + 0.22°C. However, during the 48-hour air journey the temperature gradually increased from 0°C to between 4 and 8°C and rose a further 2 to 7°C during official inspection in Riyadh. By reaching the cool store the mean temperatures of local and imported carcasses were respectively 25°C and 9°C. Both local and imported carcasses equilibrated to the operating temperature (-0.5°C to 2°C) within 12 hours of loading into the cool store. The operating temperature of the cool store fluctuated little during individual trials. However, the temperature rose by 2 to 6°C for 3 to 6 hours when the cool store doors were open during normal loading and unloading operations.

b) *Microbiological examination.* Wrapping carcasses in polyethylene gave carcass surface conditions that were conducive for microbial growth, so that a Gram-negative *Pseudomonas*-dominated spoilage microflora rapidly developed (Fig.1). The Gram-positive cocci of the initial contaminating microflora remained dominant on the naked local carcasses, where microbial growth was curtailed by desiccation (Fig.1). Both local and imported carcasses wrapped in stockinet, and imported carcasses stored unwrapped, developed *Pseudomonas*-dominated microfloras that contained up to 10% Gram-positive cocci. Regardless of carcass packaging, no growth of mesophilic Enterobacteriaceae, S. aureus or Salmonella spp. occurred during chilled storage.

c) *Chemical analysis.* Freshly slaughtered local carcasses gave the following mean values (n = 24): pH 6.16 ± 0.34, TVB 20.19 ± 2.25 mg N/100 g, FFA 0.41 ± 0.21% and Kreis value 4.27 ± 0.92. During storage of both local and imported carcasses, all parameters except pH increased. Figure 2 shows this trend for TVB and FFA in imported carcasses.

d) *Sensory evaluation and visual appearance assessment.* A two-way analysis of variance showed in all six trials that organoleptically, the chilled samples were not significantly different from the frozen controls, and that none of the cooked meat attributes were significantly affected by packaging or tune, except for those carcasses wrapped in polyethylene. Carcasses in polyethylene bags became moist, slimy and malodorous after only 7 days storage, at which time they were withdrawn from further sensory evaluation. The visual appearance of the carcasses during storage was, however, significantly ($P < 0.01$) affected by both tune and packaging. Desiccation and discoloration here more severe for naked carcasses than those in stockinet (Table 1).

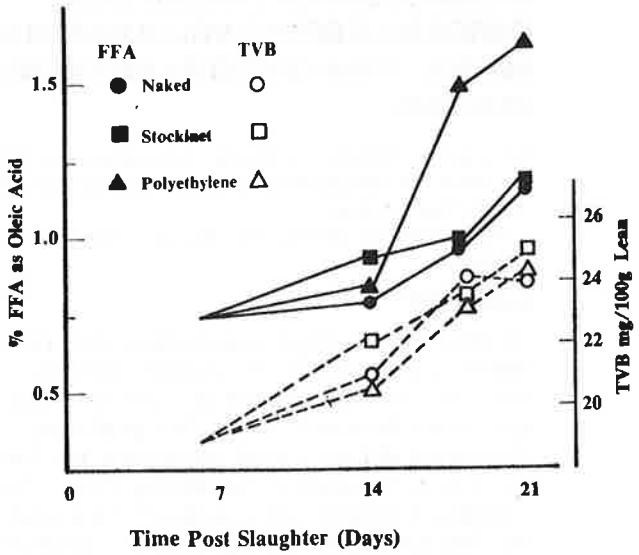

Figure 2. Changes in free fatty acids and total volatile bases during storage of lamb carcasses at 0°C. (Mean results from 2 air freight shipments).

DISCUSSION

The results obtained in the present trials confirm the commercial perception that the effective storage life of chilled lamb carcasses is determined by their visual appearance. Deterioration in carcass appearance was manifested as severe desiccation and discoloration. Attempts to extend storage life by preventing desiccation were variously frustrated because the treatments accelerated the onset of microbial spoilage. The presence or absence or carcass wrappings by influencing the rate of carcass desiccation, determined whether development of a spoilage microflora was prevented, restricted, or progressed to produce overt spoilage. Notwithstanding the inadequacies of temperature control during air transport and inspection, the microbiological status of imported carcasses at the time they entered chilled storage was apparently superior to that of local carcasses. However, this advantage was short lived because the spoilage microflora developed more rapidly. This probably reflects a higher incidence

Table 1. Influence of packaging on the visual appearance of legs of Naaimi sheep slaughtered in Riyadh during storage at 0°C (Scores greater than 3 indicate acceptability on the 1 to 5 hedonic scale)

Time after Slaughter (Days)	Frozen control	Chilled		
		Naked	Stockinet	Polyethylene
7	4.15	3.55	3.68	2.80
14	4.55	2.15	3.13	2.88
21	4.48	2.40	3.38	*

* Not determined because of advanced microbiological spoilage

on imported carcasses of psychrotrophs that can proliferate on marked carcasses at chill temperatures until growth is terminated by desiccation after 12 days' storage (i.e. 18 days post slaughter; cf 11 days post slaughter for local carcasses - see Fig.1). Furthermore, in the winter, the ambient air entering the chiller during open door events would be of lower temperature and higher relative humidity than during the summer, causing less severe desiccation and hence allowing more microbial growth to occur on imported carcasses (winter stored) than on local carcasses (summer stored).

Changes in the chemical parameters, essentially measures of proteolytic and lipolytic activity, bore little direct relationship to microbial growth. The final accumulated levels of TVB, FFA and oxidized fats (Kreis value) for naked and stockinet wrapped carcasses were not associated with detectable off flavours or odours and were not significantly different from those associated with the highly offensive carcasses in polyethylene bags 14 days after slaughter (Fig.2). Therefore, none of these parameters can be regarded as being a reliable indicator of the imminent onset of spoilage.

Measured from the slaughter date local and imported New zealand carcasses have a similar storage life; i.e. the time in transit is virtually equivalent to time in chilled storage. Consequently, once landed in Saudi Arabia, imported carcasses must have a shorter remaining storage life than that of freshly slaughtered local carcasses.

To maximize chilled storage life the use of water impermeable coverings should be avoided. Locally produced carcasses stored in stockinet or left naked can be expected to have an effective storage life of 21 and 14 days, respectively, if visual appearance is the limiting criterion. However, if the criterion is that the microflora shall not exceed 10^7 organisms/cm^2 the storage-life in stockinet is reduced to 14 days and that for desiccated naked carcasses becomes indeterminate. Some practical extension of effective storage life may be obtained through better hygiene, temperature and humidity control during production, transportation, inspection and storage.

CONCLUSION

The effective storage life of chilled lamb carcasses in Saudi Arabia is determined by their visual acceptability to the consumer. A storage life at 0°C of 14 and 21 days can be reasonably expected for naked and stockinet wrapped carcasses of local origin while that of similarly wrapped carcasses imported by air from New Zealand is reduced by the time spent in transit to approximately 7 and 14 days, respectively.

ACKNOWLEDGEMENT

The authors wish to acknowledge the financial support received from SASO and MIRINZ; the co-operation of Saudi Arabian and New Zealand meat interests and the technical support of the Food Section at the SASO laboratories and the Microbiology Section at MIRINZ.

REFERENCES

Egan, H., Kirk, R.S. and Sawyer, R. (1981). Chemical Analysis of Foods. 8th Ed. Churchill Livingstone, Edinburgh.

Newton, K.G., Harrison, J.C.L. and Wauters, A.M. (1978). *Journal of Applied Bacteriology* **45**: 75.

Saudi Arabian Standards Organisation. (1977a). SSA: 30.

Saudi Arabian Standards Organisation. (1977b). SSA: 45.