THE RELATIONSHIP BETWEEN MICROBIAL GROWTH AND SOME BIOCHEMICAL PARAMETERS IN VENISON AND BEEF DURING AEROBIC STORAGE AT 4 ^{O}C.

Mohd Hafiz Jamaludin[1], Alaa El Din Ahmed Bekhit[1*], Grant Cochrane[2], Phil Bremer[1]
[1]*Department of Food Science, University of Otago, Dunedin, New Zealand*
[2]*Totara Hills, Glenomaru Valley Road, Balclutha, New Zealand*
[*]Corresponding author (e-mail: aladin.bekhit@otago.ac.nz)

Abstract- **Venison has previously shown to have a much longer microbial shelf life. A study was conducted to observe the relationship between microbial growth and some biochemical parameters in minced venison and beef during aerobic chill storage. Venison showed a much superior microbial shelf life compared to beef despite having higher initial glucose and glycogen concentration. The increased lipid oxidation and non-haem concentration in venison compared to beef suggests a role for the oxidative processes in inhibiting the growth of microorganisms in venison.**

Index terms: **beef, microbial spoilage, venison.**

Introduction

Microbial cell growth and proliferation is one of the major factors limiting the shelf-life of chilled meat due to the formation of off-odours, off-flavours and decrease in the visual appeal of meat. Traditionally meat microbiology has focused on the detection or prevention of microbial spoilage with the goal of enhancing chilled shelf-life. We have previously reported that venison has a longer microbiological shelf life than beef (Jamaludin, Bekhit & Bremer, 2009). Understanding the mechanism responsible for the delay in microbial growth in venison may help in the development of strategies to prevent microbial spoilage of other red meats.

Materials and Methods

Strip loins from venison (n=9) and beef (n=3) were either processed immediately (fresh) or vacuum packed, frozen at -20 ^{o}C for 7 days then thawed over night prior to processing (frozen). The loins were individually minced, formed into patties and stored on Styrofoam trays wrapped with oxygen permeable plastic film at 4 ^{o}C. Triplicate loins from each product and treatment were analyzed at 3 days interval until bacterial numbers exceeded 10^6 CFU g^{-1}. Total aerobic bacterial cell numbers were determined on Plate Count Agar. The pH was determined using a meat:water (1:9) slurry. Glucose and glycogen concentrations were determined using a commercial kit (D-Glucose Kit, Roche) according to the manufacturer guidelines. Lipid oxidation was estimated by the Thiobarbituric Acid Reactive Substances (TBARS) assay (Benjakul & Bauer, 2001). Haem iron and non-haem iron contents were determined as described by Benjakul and Bauer (2001).

Results and Discussion

Bacterial numbers on both fresh and previously frozen beef reached 10^6 CFU g^{-1} in less than 6 days (Fig. 1). In comparison, it took approximately 9 days and 14 days for this number to be reached in previously frozen and fresh venison held at 4 ^{o}C, respectively (Fig 1). Intact venison cuts would be expected to have a longer shelf-life than the minced product.

The glucose and glycogen concentration in venison was higher than in beef (Fig. 2). The glucose and glycogen concentrations were depleted over the storage period in all samples, with glucose exhaustion occurring sooner in previously frozen compared to fresh venison (Fig. 2).

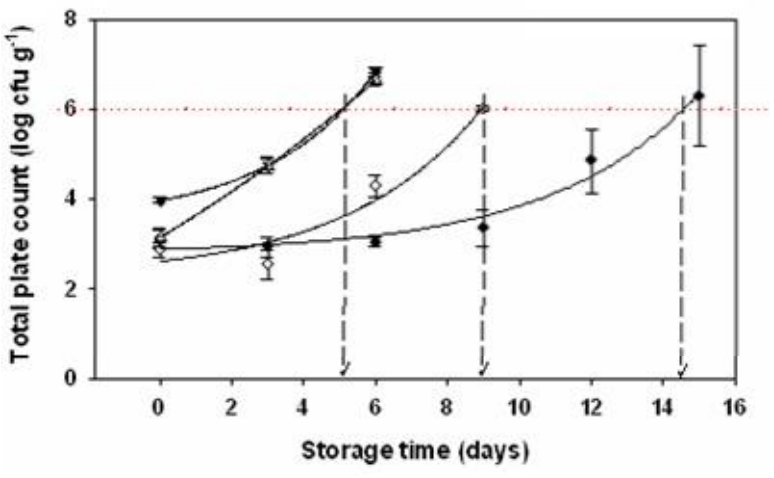

Figure 1. Microbial total plate count of mince meat of fresh venison (—●—), frozen venison (—○—), fresh beef (—▼—), and frozen beef (—△—) kept aerobically at 4 ^{o}C over the storage period

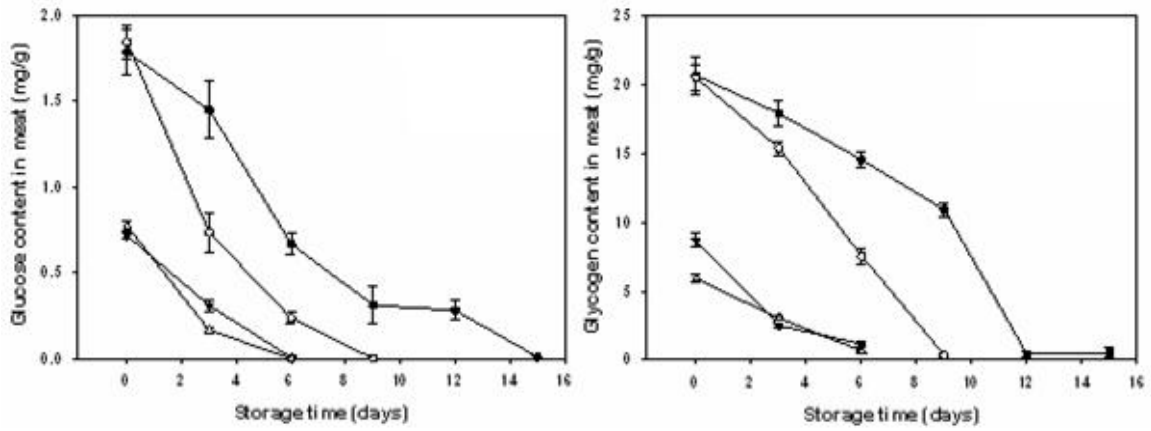

Figure 2. Glucose content and glycogen content value of fresh venison (●), frozen venison (○), fresh beef (▼) and frozen beef (△) stored aerobically at 4 °C over the storage period

Glucose is a good indicator of spoilage, as it can be used to identify metabolic by-produce associated with particular spoilage microbe groups (Nychas, Dillon & Board, 1988). It has previously been reported for beef that while glucose did not change microbial growth numbers, it did delay protein decomposition by spoilage microbes resulting in a delay in off-odour formation (Lombropulou, Drosinos & Nychas, 1996). The glycogen content of meat prior to slaughter will impact upon its subsequent shelf-life as meat with a low glycogen concentration will have a higher ultimate pH (>5.8 for beef), than meat (pH of 5.5-5.8) with a normal glycogen concentration and a shorter microbiological shelf life.

Lipid oxidation TBARS value increased with storage time (Fig. 3) and the rate of lipid oxidation was higher in pre-frozen samples. This may be due to increased cell disruption caused by freezing and thawing resulting in more direct interactions between the enzymatic systems responsible for lipid hydrolysis and their substrates. In addition, the higher concentration of phospholipids in the muscle of venison compared to beef may result in the higher TBARS values in venison (Okabe et al., 2002).

Haem iron concentration in frozen venison, fresh beef and frozen beef decreased slightly during storage, probably due to drip loss (Purchas et al., 2003). An increase in haem iron for fresh venison between days 9 and 12 was observed (Fig. 4) and is probably due to moisture loss as a result of evaporation. Non-haem iron in beef samples was lower than in venison samples, and no changes in non-haem iron concentration were observed during the trial.

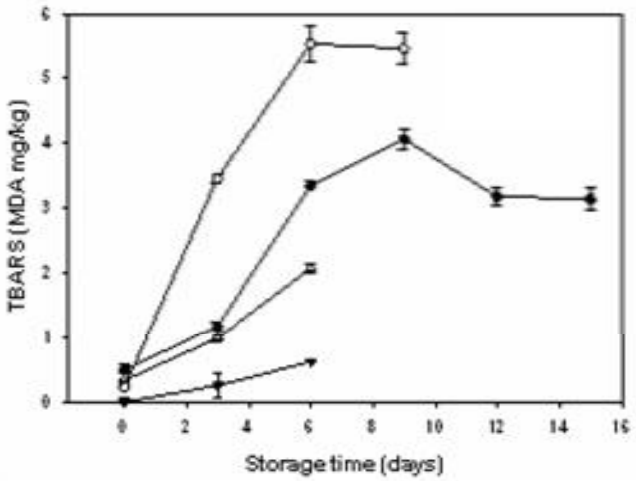

Figure 3. TBARS value of fresh venison (●), frozen venison (○), fresh beef (▼) and frozen beef (△) stored aerobically at 4 °C over the storage period

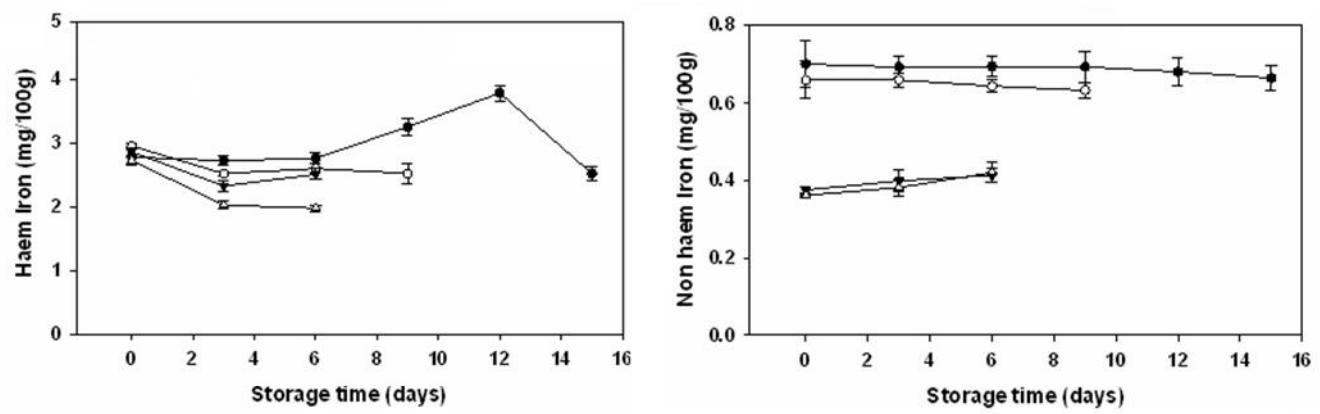

Figure 4. Haem and non haem iron from fresh venison (●), frozen venison (○), fresh beef (▼) or frozen beef (△) stored aerobically at 4 °C over the storage period

Conclusions

Venison had a superior microbiological shelf life compared to beef despite having higher initial glucose and glycogen concentrations. The increased lipid oxidation (TBARS values) and non-haem concentration in venison compared to beef suggests a role for the oxidative processes in inhibiting the growth of microorganisms in venison. A detailed experiment investigating this hypothesis is underway to identify the relationship between lipid and myoglobin oxidation and the microbiological status of fresh venison.

Acknowledgement

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