Thermal transition behavior of osmotically processed beef meat by differential scanning calorimetry

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Introduction

The cellular structure of muscle tissue and meat, such as the semi-permeable cell membranes, play the most crucial role in mass transfer phenomena during meat processing, e.g. salting, dehydration (Rastogi et al., 2002). Several parameters affect mass transfer during osmotic processing, with temperature being one of the most important (Dimakopoulou-Papazoglou and Katsanidis, 2020). Thus, an in-depth understanding of the effect of low temperatures on meat structure is important for improving mass transfer kinetics. Although there are several studies on osmotic processing of meat, the effect of low temperature on meat structure during processing, as attested by the phase transition behavior of constituents present in the meat tissue, has not been investigated.

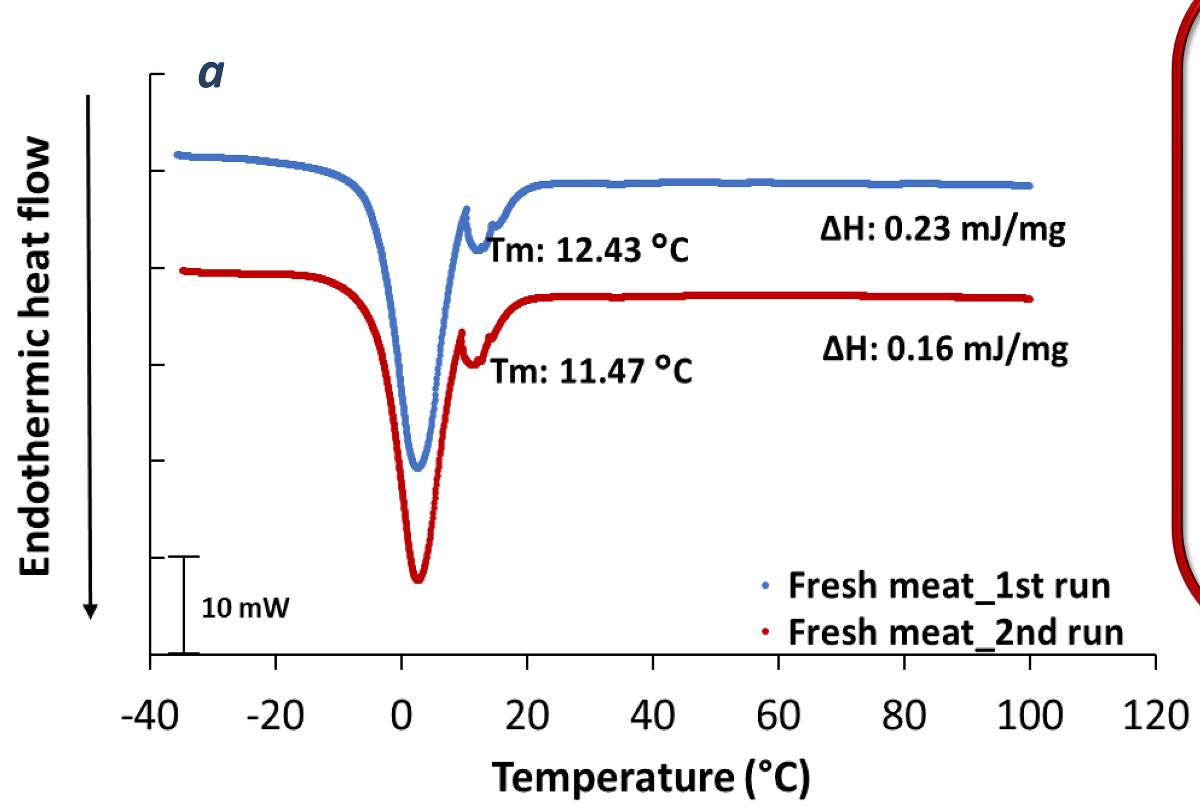
Objective

Investigate the effect of low temperature on meat structure using differential scanning calorimetry

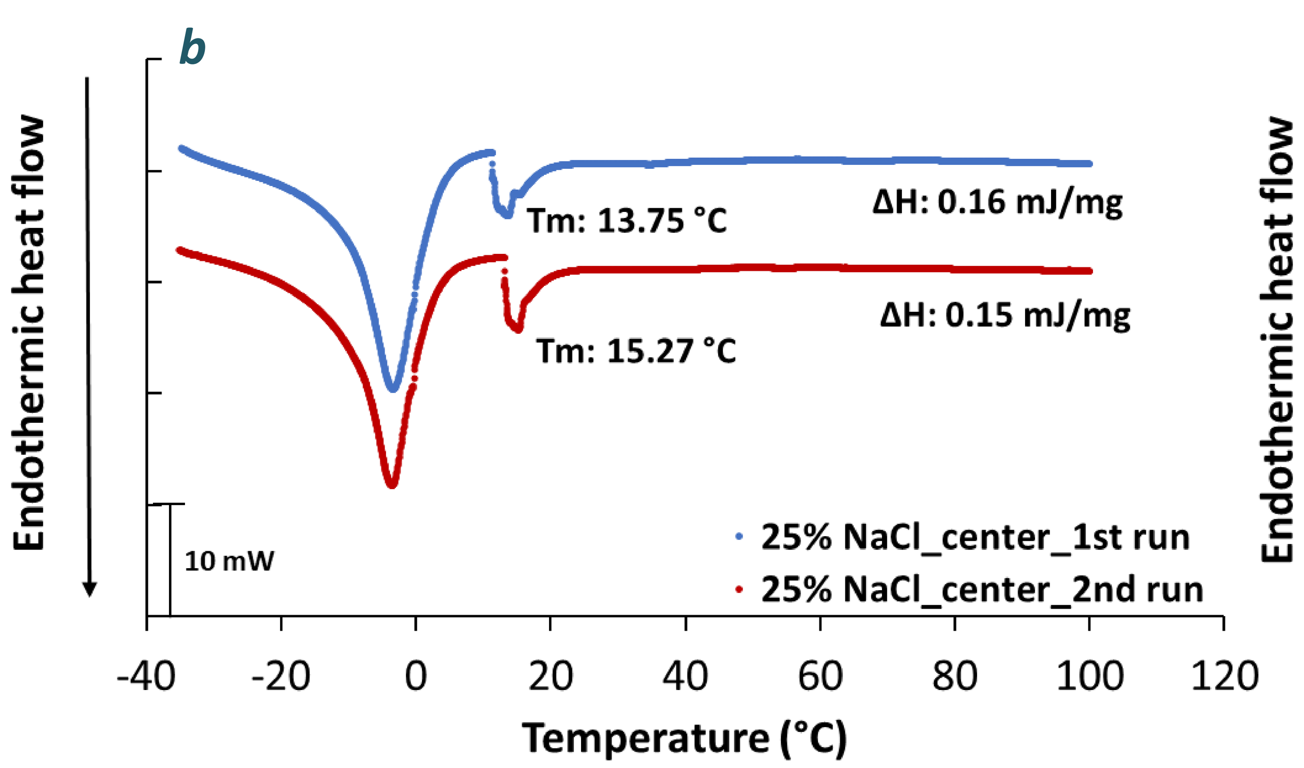
Material & Methods

- **Beef Meat** (*Semitendinosus* muscles): parallelepiped pieces (5x5x1cm)
- **Process parameters:** Osmotic solution: 25% NaCl (w/w)
  Temperature: 15 °C, Time: 3 hours
- **Samples:** (a) fresh and osmotically dehydrated meat (50 – 60 mg)
  (b) freeze-dried samples (8 – 10 mg)
- **DSC:** -40 to 100 °C at a heating rate of 3 °C/min (DSC-Gold calorimeter, Polymer Labs. Ltd, Epsom, UK)

Results & Discussion



- Endothermic transition at 0 °C corresponds to ice melting (**Fig. 1*a***). The transition shifts to lower temperatures in the case of samples with salt (**Fig. 1*b,c***). The salt content of the samples was 11.4% on the surface and 5.3% in the center of the meat tissue.
- Minor transitions were also noted at ~ 55, 65, and 73 – 77 °C (not visible in **Fig. 1**) that correspond to meat protein denaturation.
- Endothermic transition at 12 °C can be attributed to changes in cell membrane physical state and, most likely, reflect the thermally modulated order-disorder structural changes in the membrane lipids fraction of the meat tissue.



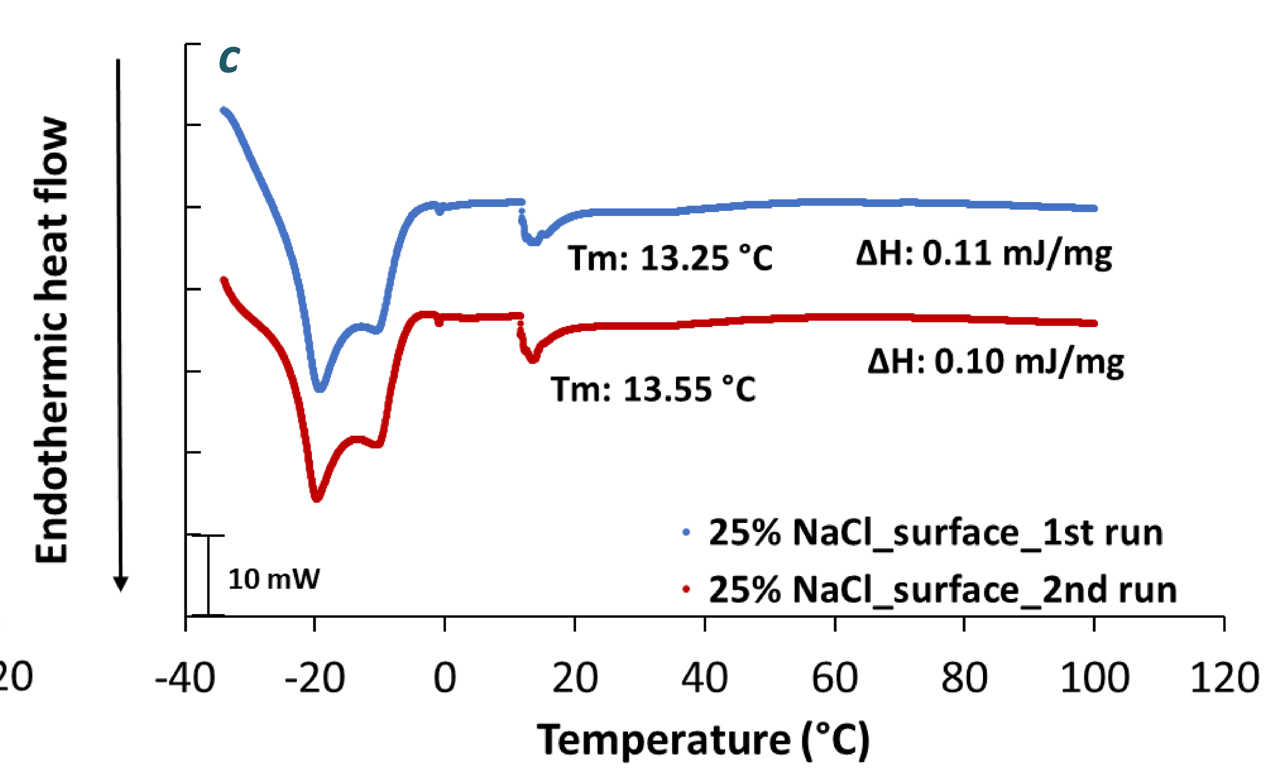


Figure 1. DSC thermograms of raw (*a*) and osmotically processed meat (*b*, *c*).

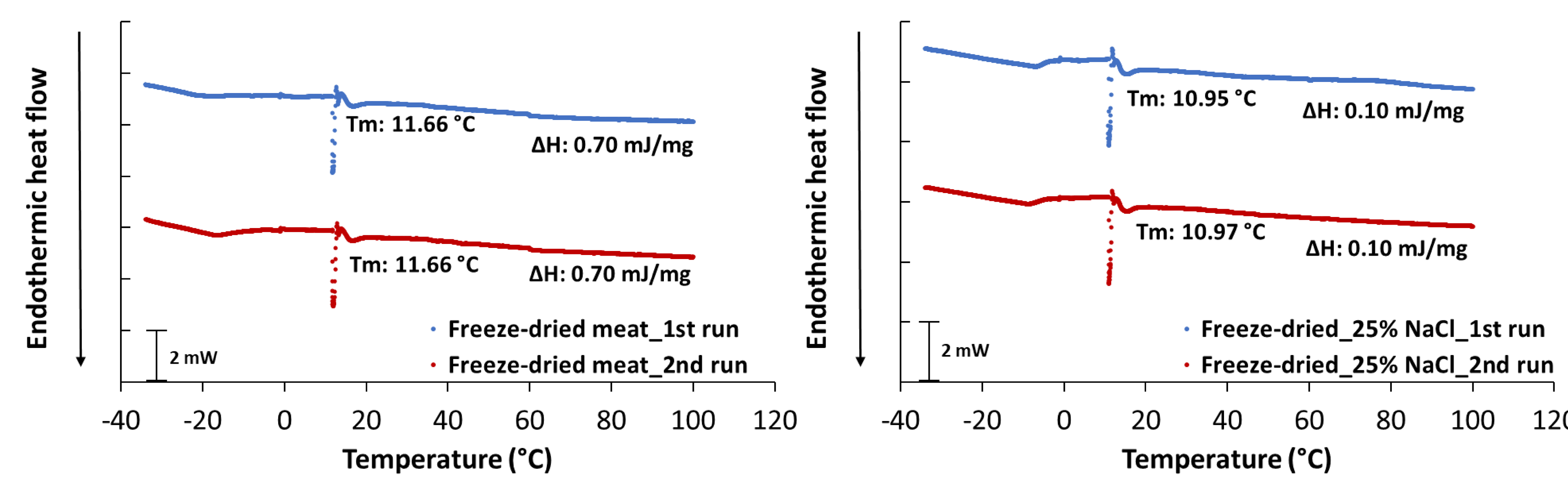


Figure 2. DSC thermograms of freeze-dried raw and osmotically processed meat samples.

- Freeze-dried samples were evaluated in order to eliminate the large ice melting peak (**Fig. 1**).
- The endothermic transition at 11 – 12 °C was again observed and it was reversible in every subsequent thermal scan upon cooling and reheating of the samples (**Fig. 2**).

Conclusions

- **The endothermic transition observed at ~ 11 – 12 °C corresponds to the transition of the hydrated membrane lipids from the gel phase to the disordered liquid-crystalline phase.**
- **This transition affects the permeability of the membranes.**
- **Low temperature processing of meat tissues may greatly affect the physical state of the cell membrane structures and thereby exert a strong impact on water and salt diffusion kinetics.**

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