CFX Analysis of the Heat and Mass Transfer During the Chilling of a Lamb Carcass using a 3D Model

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**Introduction**

- Lamb meat is a popular meat product which must undergo a complex refrigeration process before being served at the dinner table to ensure sustained quality, food safety and to prolong its shelf life.
- A major disadvantage of meat chilling is the associated drip losses which contribute to a carcass weight loss of between 2 and 3%.
- Drip losses occur when water diffuses from within the carcass and evaporates away from the surface due to a difference in pressure between the surface layers of the carcass and the surrounding chiller.
- The analysis of chilling processes involving complex shapes such as beef and lamb carcasses is difficult using empirical formulae.
- Therefore, the use of numerical models is vital to simulate complex geometries.

**Aims**

- To determine the temperature history of a lamb carcass in a +4°C chilling scheme using a 3D Solidworks model in ANSYS CFX

**Materials & Methods**

- A representative 3D model of a lamb carcass was created in the Solidworks program using photographs [1], X-rays and CT-scans sections [2].
- CT-Slices
- Photograph
- X-Ray
- Figure 1. One of the 15 CT-scans used
- Figure 2. Photograph of a lamb carcass
- Figure 3. X-ray of the lamb carcass showing the 15 CT-scan sections (coloured lines)
- The lamb chilling simulations were carried out in two stages:
  1. Determination of the flow field and heat transfer coefficient using a 3D model (Chiller included)
  2. Determination of the temperature history of the carcass applying the heat transfer coefficient from the previous simulation to the outside of the carcass (Chiller excluded)
- A cylinder of similar dimensions to the carcass was used to establish the modelling methods.

**Results**

- Temperature histories for the deep round of the lamb carcass were plotted over 24 hours as seen in Figure 8 and 9.

**Discussion & Conclusions**

- This study has led to the development of a 3D CFX model of a lamb carcass chilling process.
- Using a cylindrical model to establish the mesh and modelling methods in ANSYS saved time and computational power.
- Including a two step (transient and steady state) process to simulate the lamb chilling process contributed to a reduction in time and computational power required for the simulations.
- The position of the temperature probes within the lamb carcass and chiller air velocity were found to have the greatest effect on the temperature history of the lamb carcass.
- The inclusion of an inflated mesh was vital to the success of the simulations.
- Convection and evaporation had a significant effect on the heat transfer in the system.

**References**


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