Using CT scanning to measure tissue volume – What is the problem?

Dennis B. Nielsen, Lars B. Christensen, Peter Vorup and Eli V. Olsen
Danish Meat Research Institute, Danish Technological Institute, Denmark

DANISH MEAT RESEARCH INSTITUTE

INTRODUCTION

Today CT scanning of carcasses is used as a volumetric reference of tissue to calibrate online equipment. Before the method can be considered general performance of a medical CT scanner must be assessed.

AIM

The aim of this study was to investigate the source and size of the underlying measurement errors and to enable consistent volumetric measurements over time and between different medical CT scanners, Figure 1.

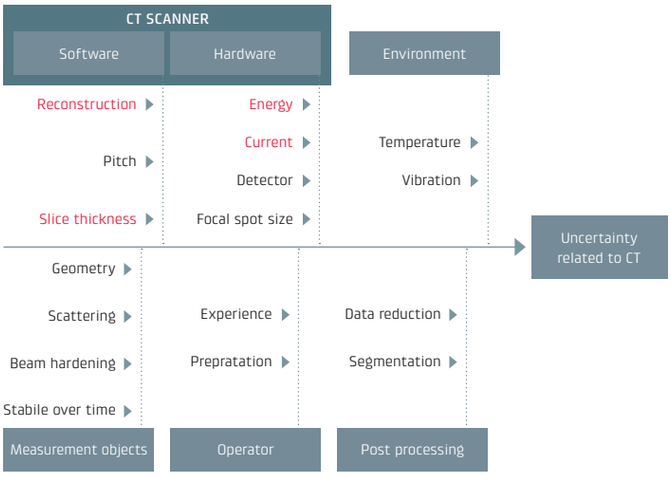
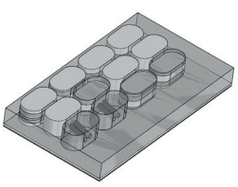


Figure 1: Cause and effect chart of factors related to the uncertainty of using CT

MATERIALS AND METHODS

Pig carcasses (n=13) were scanned on two different CT scanners, and the difference in volume was investigated between the scanners using phantoms. The phantoms (n=5) were constructed to mimic a known lean meat percentage made from different well-defined types of polymers simulating meat, fat and bone.



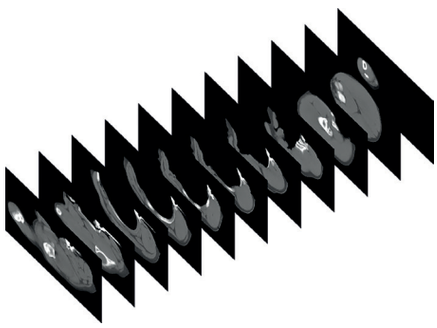


Figure 2: Example of a CT scanner, a phantom and a stack of images from a scanned pig carcass.

CONCLUSION

The difference between the two CT scanners could not be explained by the selected settings alone. Care should be taken when comparing volumetric results from different CT scanners, and the use of phantoms as a standard for volume measurement needs to be fully evaluated.

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RESULTS

The results showed some uncertainty related to the CT scanners.

The results from the phantoms showed an effect of CT scanner and all scanner settings except for the X-ray current. An interaction effect was found between the CT scanner and phantoms, slice thickness and the reconstruction kernel.

EFFECT	PHANTOMS	EFFECT	CARCASS SKIN
Scanner | Phantom	***	Scanner | Carcass	***
Energy	***	Energy	NS
Current	NS	Current	NS
Scanner | Slice thickness	***	Scanner | Slice thickness	***
Scanner | Reconstruction	***	Scanner | Reconstruction	***

*The level of significance of the difference between the two CT scanners in meat and skin volume where /indicates interaction. *** indicates p-value < 0.001, NS indicates non-significance, p-value >0.05.*

Handling of thin complex structures such as the carcass skin also revealed an effect of the CT scanner, slice thickness and the reconstruction kernel.

Only a limited range of scanner settings were possible to test on both CT scanners measuring the meat volume. The standard error of the scanner effect for carcasses was 0.89 liter, while it was only 0.003 liter for the phantom measurement.

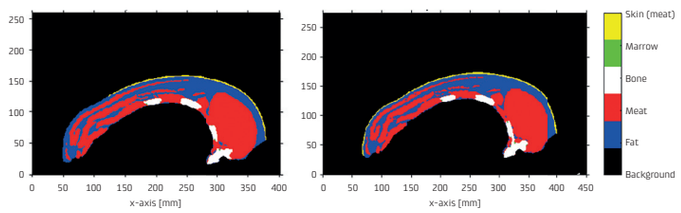

Figure 3: Comparison of a segmented image between the two CT scanners.

DENNIS B. NIELSEN
DBN@DTI.DK

DANISH TECHNOLOGICAL INSTITUTE
GREGERSENSVEJ 9
DK-2630 TAASTRUP