The effects of including CT in pig breeding programmes

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CT-background

The first CT for animal science research was established at our University in 1981. Many years with CT-experiments in live pigs and in carcasses have been carried through over these years. The projects of the 1980s concentrated on testing the accuracies of CT in live pigs (Allen, P. and O. Vangen, several papers 1980s). It was shown that fat was estimated with 97-99 percent accuracy, while protein/muscle content was predicted with accuracies of 90-95 percent. In the 1990's the CT experiments in pigs were mainly at measuring maintenance requirements and growth of different body tissues in different pig breeds and breed combinations (Kolstad, K., PhD degree and several papers), showing genetic differences in maintenance requirements and that growth and mobilization of different body tissues differed between breeds.

Additional experiments have been attempts to measure intramuscular fat (Walach-Janiak & Vangen, 1984) by CT. The results were not very promising with the CT machine and software available at that time. Another experiment was comparing accuracies and costs of CT as an alternative to dissection of pig carcasses. The results showed that CT was cost effective and with comparable accuracies to dissection. International cooperation with other CT units around the world included Armidale, especially in meat science and sheep breeding during those years.

Based an all these years of research and the new developments of CT-technologies and software, the Norwegian Pig Breeders'Association (NORSVIN) in 2008 established a CT unit at their central boar testing station. The purpose was to measure meat percentage, bacon side quality and other carcass traits directly on the live boars and the sib testing station was closed. The calculations showed this to be a cost-effective investment also in terms of genetic progress. Additionally, the CT scanning of boars initiated data for research on product quality and health traits with another new potential for genetic progress.

The NORSVIN DELTA CT-unit

The new NORSVIN CT unit was established to increase the accuracy in the selection programme. The increased accuracy of selection was due to the increased accuracy in recording of traits and the fact that selection was on the breeding candidates themselves rather than on full sibs. NORSVIN estimated the yearly increased genetic progress to be between 17 and 30 percent (Olsen, 2008). This included the extension of the boar testing capacity from 2500 to 3200 boars per year.

The chosen CT machine was a GE LightSpeed Select 32 machine. It is doing 32 crossectional images per second, with a slice thickness of 0.625 or 1.25 mm. The CT machine includes an X-ray tube, X- ray detectors, X-ray beams and a gantry that rotates around the object. The maximum length of the pig/carcass that can be analysed in one run is 190 cm. One boar is scanned within 15 seconds, leaving 1200 images to be stored from each animal. Each cross-sectional image consists of voxels with different densities. As the different body tissues (fat, muscle, bone etc) have difference densities the areas of the different tissues are calculated and turned to volumes as all the images are added to each other. As the weight of each volume depends on the measured densities, volumes are transformed to weights (the Cavalieri principles). The image analyses are done in MATLAB (an imaging processing toolbox). Several authors of scientific papers dealing with CT have focused on the importance of accuracies of separating the different tissues, earlier done manually, and the time consuming drawing of regions to separate carcass part from the internal organs of the live pig (Jopson, N and C.A. Glasbey, publications in 1990s). With the present new software technology the inner organs are removed automatically, as is the separation of fat, meat and bone in each image. This is saving much manual work and is increasing the accuracy of image handling.

The main traits are the traditional body composition traits like backfat thickness, area of *m.longissimus dorsi*, kg and/or percentage meat, fat and bone in the carcass part of the animal (including meat percentage). The amount valuable cuts like percent ham and/or loin can be analysed in the same way as the total "carcass", as can the bacon side (meat% in belly) or other interesting carcass parts to be analysed separately.

The analyses of the product quality traits are intramuscular fat content, fatty acid composition etc. are in an experimental stage and so far not included from the CT images (the present recording of these traits, see later). However promising results have been obtained in predicting intramuscular fat. Work is as well in progress on including analyses of osteochondrosis status, shoulder ulcer and exterior traits (a robust pig project launched) into the breeding program. Organs, like for example hearth size and kidney and/or liver health is under investigations. Some of these traits may be of interest for the future breeding programme as the CT gives these new possibilities of recordings on the live boars.

The first genetic analyses of CT traits measured on live boars

In a PhD study (Gjerlaug-Enger et. al. 2010a,b,c), the first genetic analyses of CT traits from this new CT boar test facility is to be published. The results are presented in Table 1 and Table 2 for the two breeds. Heritabilities are on the same level or higher than from conventional methods for measuring heritabilities for lean meat percentage and growth of different body tissues. The number of animals in each breed covers a period of a bit more than one year of data collection. These results underline the accuracy of CT traits for body composition in pigs. The genetic correlations between these traits reveal that total growth and lean growth are different traits with very low genetic correlations, while the correlations between total growth and growth of the other body components are high. Even if meat percentage have a reduced economic value in future breeding goals in lean breeds, the higher accuracies of CT meat percentage allows more selection pressure to be put on other traits. This is an additional important improvement from the use of CT in boar testing.

Table 1. Mean values and heritabilities of production traits and growth of different tissues from CT analyses in Landrace boars (Gjerlaug-Enger *et al*. unpubl.)

Trait	N	Means	Heritabilities
Lean meat %	3835	65.3	0.50
Daily gain, g/day	3832	905	0.41
Feed conversion ratio, MJ/kg	3604	20.1	0.29
Muscle growth birth-100kg, g/day	3835	278	0.19
Carcass fat growth birth-100kg, g/day	3835	98	0.53
Bone growth birth-100kg, g/day	3835	50	0.37
Non-carcass tissue growth, birth-100kg, g/day	3830	219	0.38

Table 2. Mean values and heritabilities of production traits and growth of different tissues from CT analyses in Duroc boars (Gjerlaug-Enger *et al*. unpubl.).

Trait	N	Means	Heritabilities
Lean meat %	3139	58.6	0.57
Daily gain, g/day	3139	874	0.42
Feed conversion ratio, MJ/kg	2956	20.6	0.42
Muscle growth birth-100kg, g/day	3139	233	0.43
Carcass fat growth birth-100kg, g/day	3139	112	0.59
Bone growth birth-100kg, g/day	3139	53	0.58
Non-carcass tissue growth, birth-100kg, g/day	3136	214	0.50

Future strategies for improved meat and fat quality traits

Research is underway based on data from the same CT tests to reveal the accuracies of selection on quality traits for these boars as well. However, so far the Norwegian breeding strategies implies that meat and fat quality traits are measured on the boars not selected for breeding, and thus slaughtered. As only 3-7 percent of the tested boars are used for breeding (all through AI), a large proportion of the CT tested boars are slaughtered. To reduce costs of testing for quality traits, several rapid methods are installed on the partial dissection line. The traits analysed are the meat quality traits pH, colour, intra muscular fat content and drip loss. The fat quality traits are fatty acid groups (linked to human health), iodine value, moisture and colour of the fat. The main rapid methods are near infrared spectroscopy (FossNIR Systems), Minolta Croma Meter (colour) and EZ-DripLoss methods. Reasonable heritabilities are found (Gjerlaug-Enger et.al. 2010,a,b), and until the CT methods are tested and found to have accuracies high enough, the rapid methods from the partial dissection line are shown to be cost effective in these two breeds where the quality traits have an important role in the breeding goals. The investments are justified by the genetic parameters and the genetic progress obtained in these quality traits.

References

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