APPLICATION OF ULTRASONICS IN PIG CARCASS CLASSIFICATION

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SUMMARY

Classification in the EU has to be based on objective measurements that enable estimation of the lean meat percentage. In The Netherlands slaughter pigs are uniformly classified using the Hennessy Grading Probe (HGP), which is based on optical principles. However, about 11% of the pigs produced for slaughter are exported alive and information about their lean meat percentage is lacking. Because it was felt necessary to classify these pigs also, experiments were conducted using ultrasonic equipment in live pigs as well as in the slaughterline.
Results indicated that application in the slaughterline is not well feasible. High temperatures (felt to be necessary for reasons of hygiene and dehairing) during singeing, possibly in combination with a time component, introduced tiny air cavities in the skin hampering the ultrasonic signal.
For live classification animals are routinely collected at central places and weighed before transportation. An ideal construction would be a short type of restrainer through which animals go and above which the ultrasonic instrument is installed. Several measurements on pigs (n = 86) were carried out along the backfat layer 6 cm off the midline (as in operation in the slaughter-lines), starting at the rounding of the last rib (LR) into cranial direction at intervals of 2 cm. There was a gradual increase in backfat thickness from 9.6 mm at LR to 12.5 mm at 26 cm cranially from LR. The distance over the midline from tail implantation to LR and total distance from tail implantation to a point just between the ears were measured. The 50% point of total distance was between 14 to 16 cm cranial from LR. This 50% point happens to be very close to the 3rd/4th from last rib position where regularly backfat depth is measured by HGP at classification. Over 60% of the animals were within a distance of ± 2 cm from this point. Correlation coefficients were calculated between HGP classification results and every single measurement point and combinations of two or three of them. The relationships with HGP backfat depth were highest around the 50% point (r = 0.88 to 0.89 for the combinations of adjacent backfat depths), and the correlation coefficient between the 50 % point and HGP lean meat percentage amounted to 0.83.
It was concluded that an ultrasonic classification system for live pigs can be developed based on the 50% point including two or possibly three measuring points.

Introduction

In pig breeding application of ultrasonic techniques is widely used to select animals for their ability for lean meat production. Classification of slaughter pigs in the EU is bound to regulations that require that the classification is based on objective measurements that enable an estimation of the lean meat percentage. The main conditions for approval of instruments are that the estimation has an $R^2 > 0.64$ and an RSD < 2.50. In member states mainly optical probes are in use, but in a number of countries also ultrasonic instruments have been approved as well. In the Netherlands slaughter pigs are uniformly classified using the Hennessy Grading Probe (HGP). However, 10 to 15 % of the pigs produced for slaughter are exported live and slaughtered abroad mostly without a feedback of information about the lean meat percentage of these animals. If such information does become available this percentage may be wrong because the estimation formulas used were not developed for foreign types of animals. The export industry for live animals feels it necessary that information on carcass quality becomes available comparable with the inland classification results.
Since in live pigs classification by means of ultrasonic techniques is the obvious way, experiments were conducted using this technique. Experiments were also conducted to study the use of ultrasonics in the slaughterline because of a uniform classification system in the country. Particularly in live pigs the measuring

positions had to be assessed in order to develop a classification system with approximately the same accuracy as the current system with HGP in the slaughterlines.

Material and methods

Measurements in the slaughterline.

Ultrasonic (US) measurements were made with the Renco LM (Renco Lean-Meater type 1m-8, Renco Corp. Minneapolis, MN, USA) and partly also with the Pie Medical (Pie Medical Scanner 400 c, Pie Data Medical B.V., Maastricht, The Netherlands) as an inventory in 18 slaughterhouses. The measurements were made at various positions in the slaughterline, such as after scalding, just before and after singeing and at weighing at 45 min post mortem (p.m.) where classification is normally done. In each slaughterhouse 50 carcasses were chosen randomly and measured at about the 3rd/4th from last rib position, 6 cm off the midline (3/4 LR). The skin surface at these positions was wetted. If no ultrasonic signal was emitted the measurement was repeated once.
In pilot experiments US measurements were also performed in the institute's experimental slaughter facility on some pigs to get more insight of various variables of the singeing process on the US readings. Temperatures were measured at the skin, subcutaneously and between the fat and muscle layer. After that measurements were carried out again under commercial conditions by manipulating, as far as possible, conditions with respect to the singeing procedure.

Measurements on live animals.

Measurements were carried out on animals at the institute's experimental farm.
Because of the many measures to be taken and the US readings needed, the animals had to be fixed. This was performed in a weighing apparatus in which a small hydraulic band restrainer was installed. In a series of experiments 86 animals were used in total. All pigs were slaughtered the day after the measurements were taken. Average carcass weight at slaughter was 88.4 kg and the lean meat percentage amounted to 57.0 % as measured with the HGP.

The measurements (in cm) taken on the live animal were:

- on the midline:

1. Length from implantation of the tail to the middle of the shortest distance between the ear bases. Also the 50 % point of this length was calculated. This 50 % point was expected to be workable in practice later on and it should fall within the region for measurement of backfat depth at the regular classification with HGP in the slaughterline.
2. Length from implantation of the tail to opposite to last rib; the position of the last rib was assessed by palpation and tattood.

- for backfat depth by Renco LM, 6 cm off the midline:

3. At the last rib (LR).
4. At every 4 cm (marked) in cranial direction up to 16 cm from LR. Sometimes US readings were made up to 20 cm from LR in cases when the 50 % point was not within 16 cm from LR. Measuring positions were identified as 4LR, 8LR, 12LR, 16LR and 20LR (Renco 1).
5. Transducers of two Renco apparatusses were bound together, so that there was a fixed distance of 6 cm between them. In this way measuring points in between those of Renco 1 were made at 6LR, 10LR, 14LR, 18LR, 22LR and sometimes at 26LR.

In the slaughterline the last rib (tattood) position was checked at the carcass by sticking a pin from the inner side of the carcass next to the backbone.
The measures taken at the *carcass on the midline* were:
6. Length from implantation of the tail to the middle of the shortest distance between the ear bases (because of the slaughtering the real implant of the tail is missing).
7. As 2. (same remark as in 6.)

8. Distance from implantation of the tail (same remark as in 6.) to last rib check (pin).
9. Distance from implantation of the tail (same remark as in 6.) to opposite to the HGP measuring position at 3/4LR.

Correlation coefficients were calculated among Renco backfat thickness readings and for Renco backfat thickness readings with HGP backfat thickness and lean meat percentage.

Results and discussion

Results of ultrasonic measurements in the slaughterlines

In 6 out of the 18 slaughterhouses in the inventory ultrasonic signals became available for all 50 carcasses and at all places in the slaughterline, so including the normal position at classification at 45 min p.m. In 2 slaughterhouses no signals at all could be obtained at the latter position. In 4 slaughterhouses repeated measurements were necessary, while in the remaining 6 the result was inferior at the position 45 min p.m. In all cases an ultrasonic signal was found at the position before the singeing oven. This position, however, has some disadvantages. Both room for classification and the environment for the apparatusses are of concern. Besides that, classifiers are not at the right position given the task to look after a proper way of slaughtering. From the pilot experiments it appeared that temperature/time combinations are of importance for obtaining a proper ultrasonic signal. The moment that obtaining an ultrasonic signal becomes problematic, is reached earlier at higher singeing temperatures. Also the distance of the flames to the skin surface and the condition of the skin (wetness) do play a role. The smaller the distance to the skin the earlier the moment that no signal is obtained any more. Increasing the distance means that the temperature at the skin surface as well as subcutaneously raises less high. The temperature between fat and muscle layer was not affected. A microscopic investigation revealed that at higher temperatures, especially when the skin gets burned (brownish colour), tiny air cavities develop, which may explain the poor results from ultrasonic measurements.
In some slaughterhouses permission was given to manipulate with the singeing ovens. In one slaughterhouse where no problems had been encountered with the normal procedure earlier, the time of burning was increased by 2 to 3 seconds. This increased the temperature at the burning columns from 580-680 °C (measured by thermocouple) to 700-800 °C. In this case the ultrasonic signal did not disappear. In a second slaughterhouse where no appropiate US signals had been obtained, changes were introduced with respect to the continuously burning columns. Ignition of the columns was only initiated when carcasses approached. This change resulted in lower temperatures in the singeing ovens. The problems observed before diminished. Problems also diminished when carcasses were wetted before entering the ovens. With a further lowering of the time of burning the problems totally disappeared. In a third slaughterhouse with another type of singeing oven, temperatures of over 1000 °C were measured during the singeing process and no ultrasonic signals were obtained here. No improvement in the readings was obtained by changing the ratio of the gas/air mixture.
The conclusions from the various measurements in the slaughterline are:
- in many slaughterhouses no ultrasonic signal could be found at the time of normal classification (45 min p.m.)
- the idea that certain temperature/time combinations during the singeing procedure could be found as a condition for obtaining a proper ultrasonic signal could not be confirmed; the results were inconsistent
- there are indications that manipulating the gas/air mixture (temperature level) and duration of burning lead to improvement of US readings, but not in all instances. In practice slaughterhouses have their limitations to possibiilties to vary these parameters for this purpose. Arguments about the degree of dehairing and hygiene of the carcasses play a role as well.

Because of the variable results and in order to maintain uniformity in the classification, it was concluded that ultrasonic measurements in the slaughterline would not be an option at present for classification in the Netherlands.

Results of ultrasonic measurements in live animals

The measurements of backfat depth showed a gradual increase from the last rib (LR) onwards to a position 26 cm cranial of LR as can be seen from Table 1. The backfat depth at 50 % of the length from implantation of the tail to a position just between the ear bases (50 % TE) fitted well between the 14LR and 16LR position, not far from 16LR. This position is in general around the 3rd/4th LR position where normal classification with the HGP is performed.

The average backfat depths of 4LR and 6LR were taken together as 5LR; 6LR and 8LR as 7LR etc. The correlation coefficients for these mean backfat thicknesses with the Renco backfat thickness at 14LR and 16LR, as well as with the HGP backfat depth (at 3/4LR) and HGP lean meat percentage, are shown in Table 2. The correlation coefficients again increase with onward positions in cranial direction. The correlations between the pairs of backfat thicknesses and the HGP backfat depth are only slightly lower than with the Renco LM measurements at 14LR and 16LR. High correlations were found between the Renco LM and the HGP lean meat percentage. The correlation coefficient of 50 % TE (0.83) was practically as high as the highest ones given in Table 2. An illustration of the correlation coefficients between the pairs of the Renco measurements and the HGP lean meat percentage is given in Figure 1. To ensure sufficient accuracy in a classification system for live pigs transducers should give an integrated US signal from two or three measuring points around the 50 % point.
In an attempt to show the potential of the 50 % TE point as a reference point for the start of live classification, measures on the live animals and on the carcasses were compared. The mean distance from implantation of the tail to the mid point between the ear basis was 116.4 cm, hence the 50 % point is 58.2 cm. The mean distance from implantation of the tail to a position opposite LR (marked) amounted to 42.9 cm, while at the carcass this distance was 34.0 cm. So, 8.9 cm is missing because at slaughtering parts around the tail are removed. The distance on the carcass between the position opposite the marked point LR at the midline on the live animal and the point at last rib checked near the backbone on the carcass was 3.1 cm. At normal classification from the latter point on, the length of the plate of the HGP (12.0 cm) is used to find the 3/4 LR probing position. Addition of the distances 42.9 + 3.1 + 12.0 gives 58.0 cm which means that the HGP measuring position is around the 50 % point (58.2 cm) on the live animal. The measured distance at the carcass between implantation of the tail to the position opposite to the HGP probing position was 49.4 cm; adding the earlier mentioned difference of 8.9 cm gives 58.3 cm which also depicts the 50 % point. In Figure 2 these measures are visualized.

The conclusions from the measurements on the live animal are:
- the correlation coefficient between backfat depth at the 50 % point and the HGP lean meat percentage appears to be one of the highest in comparison to the other backfat depths measured; this correlation coefficient (0.83) is sufficiently high
- the 50 % point at the live animal is around the regular probing position for the HGP at classification.

General conclusions

From the results it appears that in many slaughterhouses in the Netherlands ultrasonic equipment will fail to measure backfat depths at the 45 min p.m. position where normally classification is done. The main reason is the high temperature, sometimes combined with a time component, during singeing leading to skin aberrations. In addition, because of uniformity in the classification system, application of ultrasonics in the slaughterline is at present not further pursued.
In live animals the middle (the 50 % point) of the distance between the implantation of the tail to a position between the ear basis approximates the HGP measuring point at 3/4LR at carcass classification. Also the correlation coefficient for this 50 % point on the live animal with the HGP lean meat percentage is sufficiently high. Based on the information obtained a classification system for live slaughter pigs will now be further developed. To ensure sufficient accuracy in such a system, transducers should be used that give an integrated ultrasonic signal from two or three measuring points around the 50 % point.