Simultaneous grading and meat quality measurements by the Hennessy Grading System

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INTRODUCTION

Since April 1984 all pig carcasses in Sweden have been classified according to lean meat content by means of the Hennessy Grading System (HGS). The calculation of percentage lean meat is based on three thickness measurements, two of fat and one of muscle, recorded by the probe when pushed through the back of the carcass. The tip of the last rib and a point between the 3rd and 4th last rib (3/4 last rib) are the measuring sites. The system was more fully described by Hansson & Andersson (1984). No scoring for conformation or type is applied in this system.

If a meat quality estimation is performed in meat production, it is based on a subjective assessment of the meat's colour and wetness. This evaluation is performed just prior to cutting, or as a special quality check on each individual cut. Because of the magnitude of the problem, some cutting plants have called for the introduction of an objective classification procedure for meat quality too and, if possible, actually on the slaughterline. This classification must be easy to perform and must not damage the carcass. A price differentiation scheme related to meat quality should help intensify efforts to minimize the problem.

In a recent investigation (Lundström et al., 1985) the use of instruments for quality control, chiefly the measurement of internal reflectance by means of a probe, was discussed. It was regarded as being of special interest to test whether the instrument used for grading could also be used for the meat quality assessment. A drawback of too early assessment is, however, that not all carcasses have developed their ultimate meat quality even 30-45 minutes after bleeding. With a new Danish meat quality probe, also tested on the slaughterline, about half of all carcasses with ultimate PSE were identified (Andersen, 1984). However, if the quality score can be obtained without extra cost at the time of grading, a 50 per cent identification can be a valuable aid in efforts to overcome the problem.

The purpose of this investigation was to establish whether the Hennessy Grading System used for grading in Sweden can be complemented by functions to predict also ultimate meat quality, with respect to PSE, on the basis of slaughterline measurements.

MATERIAL AND METHODS

The commercial grading in Sweden is performed with the Hennessy Grading System (HGS; Hennessy and Chong Ltd, Auckland, New Zealand). The system is used in 38 abattoirs in Sweden, i.e. all plants slaughtering more than 2.000 pigs annually. During 1985 about 4 million carcasses were graded with this system. The grading includes the measuring of fat and muscle thickness at two sites along the back (Fig. 1): one at the tip of the last rib (fat thickness, F_1) and the second 12 cm cranially between the 3rd and 4th (3/4) last rib, where both fat, F_2, and muscle (M) thickness are measured. The proportion of lean meat in the carcass is estimated by the equation LEAN MEAT % = $65.10 - 0.20 \cdot F_1 - 0.54 \cdot F_2 + 0.12 \cdot M$.

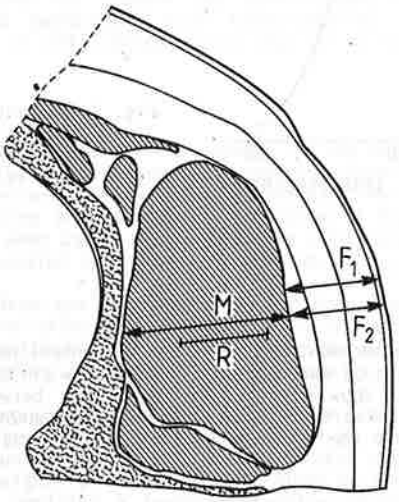

Fig. 1. Cross-section of the back with measurements for grading indicated. The reflectance value is registered within the section denoted by R.

All the registered data are fed into the connected computer. Both the registered values and the calculated lean percentage are used in a control program that produces statistics for use by the operative and State Board staff to check the systems being applied according to given rules. If the probe does not register a thickness value within given limits, standard values are inserted in the equation. The number of standard values used per day are, together with the difference between F_1 and F_2, used as the most sensitive checks of the system. The control program also produces data for use with production statistics over longer periods.

Probes used in this ordinary grading were equipped with extra software functions to obtain the reflectance value from the longissimus dorsi muscle displayed and printed out. The probe wavelength used is 570 nm. Each value displayed is an average of five recordings per mm within the distance denoted by R in Fig. 1. Probes were installed at the two lines at one of the largest plants in Sweden and were used during a 3-day test. 4.980 carcasses were measured during the 3 days. A sample series of carcasses (2.040) were remeasured after they had passed the blast cooler, in order to get an estimate of the colour changes during the first hours after slaughter. About half of the carcasses were cut at the plant. Just prior to cutting, 1.840 were evaluated with respect to PSE, with the Fibre Optic Probe (FOP; TBL, Leeds, UK). Both the original version and the new version (MkII) of the instrument was used. The probes were inserted into the middle of the longissimus muscle at the tip of the last rib between the spines on the split carcass. One reading was made with each instrument. To get improved accuracy, the two independent FOP-values were standardized and combined into an index with equal weighting.

In addition, one Hennèssy probe was equipped with a special software function and connected to a Philips personal computer P 2000 C, in order to display and print out the reflectance profile. This probe was used for measurements made on both warm and chilled carcasses at the Uppsala abattoir.

RESULTS

Grading

During the 2 years the Hennessy Grading System has been in use, more than 8 million pig carcasses have been graded regarding percentage lean meat. During 1985, the average fat thicknesses at the two sites were 15.8 and 17.1 mm respectively and the muscle thickness at 3/4 last rib was 47.7 mm. Carcasses with a low content of lean meat have in general a greater difference in fat thickness between the two sites. Recordings falling outside the test limits applied for fat and muscle have been rare. Fewer than 1% of the carcasses required standard values to be used in the equation. For the whole of 1985 the average percentage lean meat was 58.4. Fig. 2 shows the variation in lean meat percentage. About 60% of the carcasses fall within the range 56-60%. Very few carcasses had a lean meat content below 50%. The average carcass weight (kidney and flare fat excluded) was 76.5 kg. A variation in percentage lean meat was found during the year, with the highest values during the winter and the lowest during the warmer period, May to July. No serious problems with the systems have occurred and in very few cases has grading required the use of the (formerly used) intrascope.

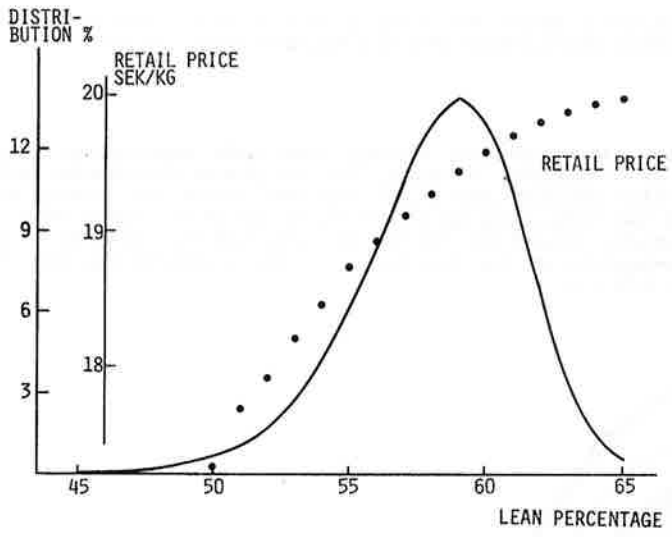

Fig. 2. Distribution of carcasses according to lean percentage and the relation between percentage lean and retail price in SEK/kg.

Meat colour

Reflectance profiles have been registered from measurements made on the slaughterline as well as when cutting. Fig. 3 presents two profiles from measurements made on warm carcasses. They show reflectance values for fat and muscle at the 3/4 last rib. The profiles also show clearly the difference between fat and muscle. The reflectance value from muscle must be very high if the inner edge of the muscle cannot be found. Profiles taken at the last rib (not presented here) clearly show the difficulty of obtaining a valid measurement of muscle thickness at that site.

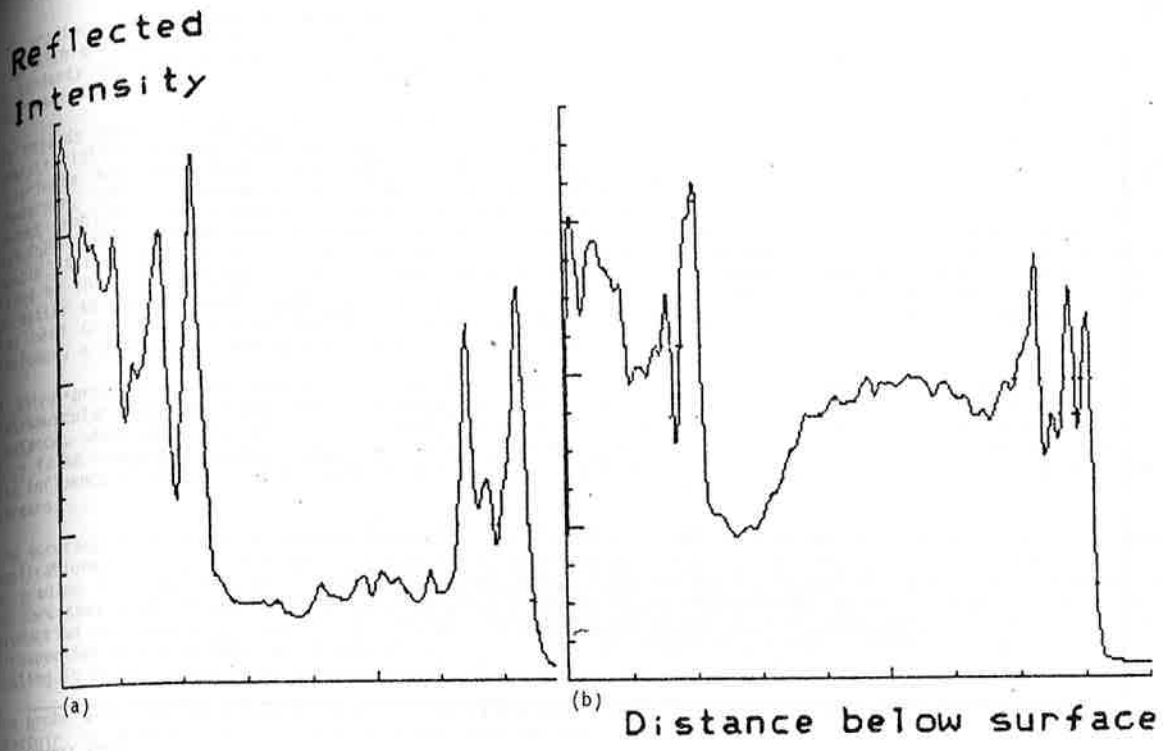

Fig. 3. Reflectance profiles captured at time of grading on carcasses without (a) and with (b) developed PSE characteristics.

The high reflectance value of the muscle shown in Fig. 3b indicates a very rapid development of PSE characteristics compared with the low level in 3a. The peaks within the muscle are due to thin streaks of intramuscular fat. In most carcasses the intramuscular fat content in the longissimus muscle is sufficiently low as to have a negligible influence on the reflectance value.

During the 3-day test, most of the carcasses measured had low reflectance values, both at the time of grading and at cutting. The relation between reflectance values obtained with the grading probe (an average from the two sites) and FOP index (average of two readings standardized according to variation) is illustrated in Fig. 4. Most of the carcass values fall in the lower left corner, indicating an acceptable quality both at grading and at cutting. About 20 carcasses of the 1.840 had high values at the time of grading without being pale next day. The limit of acceptance influences the proportion of carcasses with ultimate PSE that will be found at grading. Compared with our earlier investigations (Lundström et al., 1985) the proportion found was lower in the present study. When measuring just after blast cooling, higher reflectance values were obtained than those at grading. Due to the harsh working conditions, the carcasses were too cold and sometimes difficult to measure with good precision. We can therefore not present any satisfactory estimate of the advantage in PSE prediction of re-measuring the carcasses immediately after blast-cooling. The plot illustrating this relationship (Fig. 5) shows an increased number of reflectance values that are in the upper right corner, indicating muscles that are pale on both occasions.

DISCUSSION

The control program produces a statistical summary at the end of each week (or other selected period) which is used to keep a check on the system. The most important items of information are the number of standard values used and the difference between the two fat measurements. The latter increases in proportion to the increase in total fat content, indicating an undesirable deposition of fatty tissue in the fore part of the carcass. Very few problems have arisen when using the system. The occasional errors led either to a breakdown of the probe function or else it was revealed by the control program.

The information obtained from the grading system has been used to give detailed advice to farmers to help them make their production more effective. During the first months of use, the grading system showed that many farmers were raising fatter pigs than was found with the previous system of intrascope measuring. This problem has now been overcome by making changes in feeding intensity.

Simultaneously with the introduction of lean meat grading, a new payment system based on lean meat content came into force. Fig. 2 shows how the increase in price per kg carcass levels off as the content of lean increases. The intention is to discourage the production of overlean pigs. Fat carcasses give a poor return. The price is also related to carcass weight, carcasses in the 70-80 kg range commanding the best prices. Production economy can thus be maximized by applying a feeding intensity giving carcasses with a lean content of 58-62% and an average carcass weight of 75-78 kg.

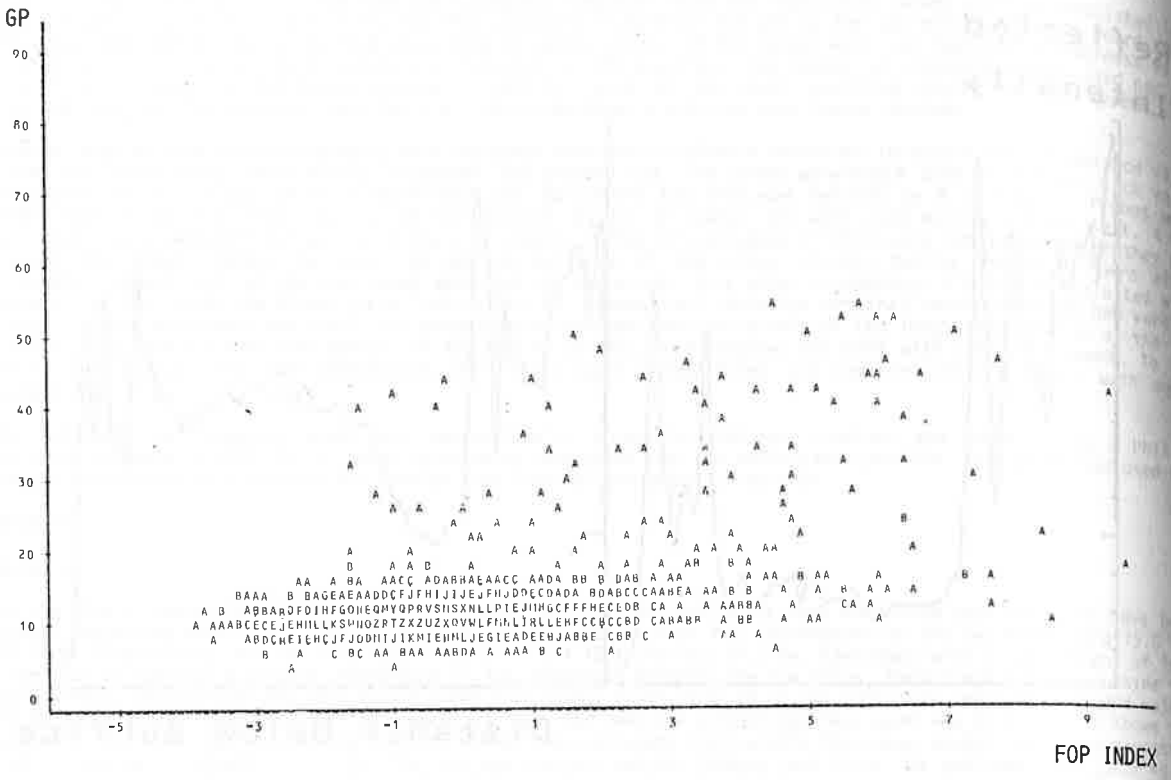

Fig. 4. Relationship between Hennessy Grading Probe values (GP), the day of slaughter, and FOP index the day after slaughter. A: 1 observation; B: 2 identical observations, etc.

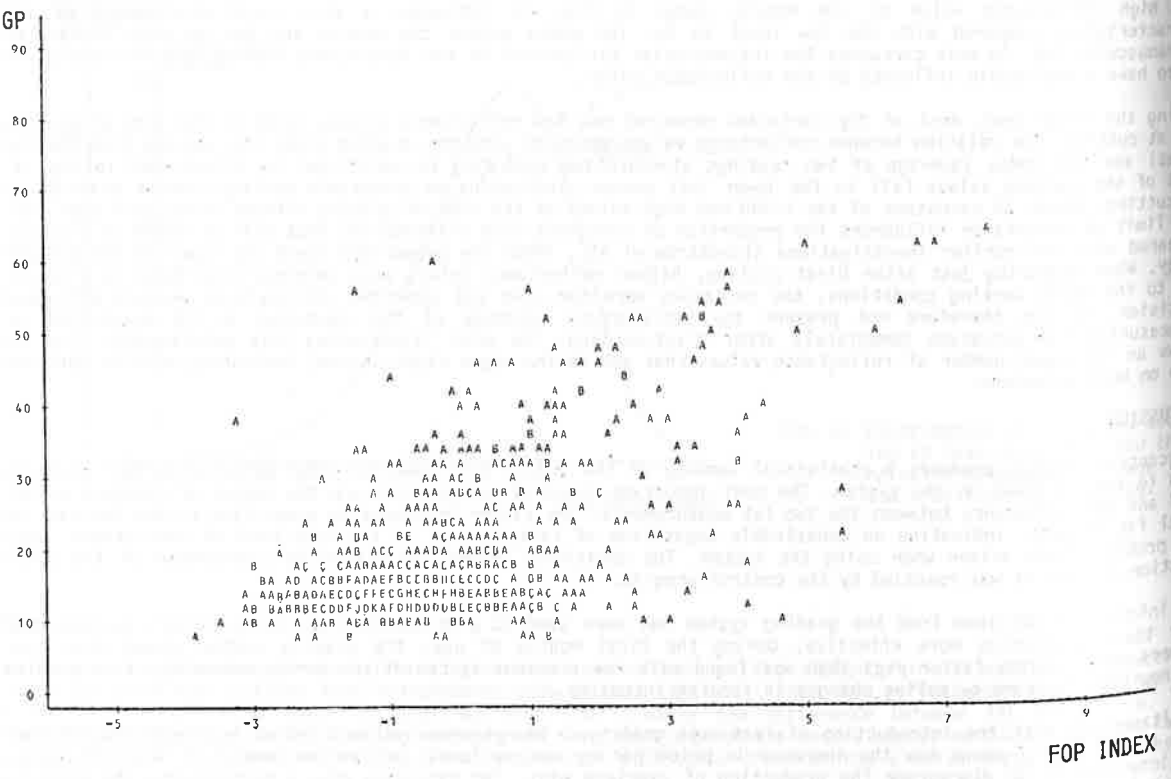

Fig. 5. Relationship between Hennessy Grading Probe values (GP), measured after the blast cooler, and FOP index the day after slaughter (see Fig. 4 for abbreviations).

The grading system in use in Sweden does not involve any type or conformation scoring. The number of crossbred pigs with a Hampshire boar as the terminal sire is steadily increasing. These animals have a shorter carcass and a tendency to meatier hams, and there is still a risk that they might be underestimated. Farmers who can guarantee the use of a Hampshire boar will therefore receive a bonus for carcasses so produced.

As regards early estimation of meat quality, at least three problems remain to be tackled. The fact that PSE characteristics develop late in some carcasses makes it impossible to identify all of them when grading. Experience has shown that about half of all carcasses with PSE at cutting can be identified at grading (Andersen, 1984; Lundström et al., 1985). This proportion will affect the way the information is used. The second problem is the variation in meat quality along the longissimus dorsi muscle, as discussed by Lundström & Malmfors (1985). At the grading points at the last and 3/4 last rib, quality is better than at the ends of the muscle. Reflectance values measured at those sites will therefore underestimate the problem. These sites are fixed by the grading requirements. If the intention is to use the system for quality assessment only, it would be better to make the measurements proximally in the muscle. So far in these studies, only the longissimus dorsi has been used as indicator muscle for meat quality. If measurements on some of the ham muscles are also included, a better accuracy will be obtained. This is possible but will require software changes.

A third problem is the effect on reflectance values of variations in pigment content and of streaks of intramuscular fat. With the currently used wavelength in the HGS, muscle pigment does present problems. For instance, when measuring at a single site, variation in muscle colour in conjunction with streaks of fat can give false readings. However, when several readings are taken, as when the probe is pushed through the muscle, the influence of spot deviations will diminish. Changes in software are planned to overcome the problem of fatty streaks.

The accuracy necessary when estimating ultimate meat quality depends on how the information is applied. Various applications have been discussed in detail in the paper by Lundström et al. (1985). If a meat quality assessment at grading is to be used as a basis for payment, most of the PSE carcasses must be identified. If a proportion of carcasses with slightly poorer quality pass undetected, the information can still be used by the plant's production management to identify procedures causing stress. Steps can then be taken to resolve the problem. Irrespective of the proportion of poorer carcasses found, some form of quality assessment must be performed when cutting in order to guarantee optimum quality of the entire production.

One probe with a quality function has been tried out for 8 weeks in the ordinary grading position at the Uppsala abattoir. No practical or technical problems arose during this period.

Our results and experience so far are promising. Accumulated data from the practical use of the Hennessy Grading System will provide more guidance as to how the system can be further developed for future use.

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