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## EARLY PREDICTION OF PSE AND DFD BY INFRARED THERMOGRAPHY ON LIVE ANIMALS

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SUMMARY

By using infrared thermography prior to stunning of pigs, we have been able to detect animals that yielded subsequent PSE and DFD meats as measured by water holding capacity and colour. Increased incidence of meat quality defects was observed with an increasing skin surface temperature from 70°F to 95°F. Seventy three percent of the pigs having thermographic values between 90°-95°F showed meat quality problems classified as moderate PSE (6%), PSE (39%), moderate DFD (22%) and DFD (33%). Although infrared thermography cannot predict whether the meat will be PSE or DFD, it seems a practical and rapid method to detect meat problems from live animals. An early postmortem identification of meat quality by fiber optics for example, could well supply the missing information.

INTRODUCTION

The halothane test is a useful means for the screening of PSS pigs. Since stress is well known to increase metabolic rate in pigs (Ludvigsen, 1954), it could be argued that the subsequent heat produced could be measured as a stress indicator among live animals and used as an early detection of PSE and DFD meats. Unfortunately, a rectal thermometer cannot be of practical use on slaughterlines where over 500 pigs are killed per hour.

Since animals which lack fur, such as aquatic mammals and pigs, can achieve insulation by means of a layer of cold skin which is vascularized and can be quickly changed from an insulator to a radiator or conductor through circulatory adjustments (Hoar, 1975), we thought that the skin surface temperature emission measured by infrared thermography on the live animals prior to stunning could serve as a stress indicator and enable us to predict subsequent meat quality.

MATERIALS AND METHODS

Skin surface temperature emission was measured once a week on commercial crossbred pigs mainly from Hampshire, Yorkshire, Duroc and Landrace by a portable radiometer Raynger II (Raytek Co., N.Y., U.S.A.) from Febryary 15th to March 15th in a commercial slaughter house.

For the measurements we calibrated the surface emissivity at 0.95 on the radiometer according to the retailer instructions. The radiometer takes four readings per second. The minima, maxima and average values are shown on a digital display. Having no reference point about the expected values, we first measured over 500 pigs to obtain an average of their skin temperatures just before electrical stunning. Thereafter we scanned over 2000 pigs on the dorsal part from the neck to the tail with the radiometer held at two feet from the surface. The average temperature was retained. Only 81 pigs having thermographic values over 70°F were retained for further meat quality analysis.

At 45 minutes postmortem, a longissimus dorsi sample was taken at the fifth lumbar vertebra and pH 1 measured with a glass needle electrode (Orion 91-06). Samples were kept overnight at 4°C. The next day, muscle colour (LD) was measured with a colorimeter system 05 (Pacific Scientific Co., Silver Spring, MD, USA) using the Hunter Lab scale calibrated with the pink tile (Lh= 70.38, ah= 22.71, bh= 9.59). L, a and b indexes were retained. pH2 and water holding capacity by the press method of Wierbicki and Deatherage (1958) were also measured; water holding capacity was expressed as the % free water.

RESULTS AND DISCUSSION

By correlation analysis, the parameters ratained for meat quality classification were water holding capacity and lightness (Lh) and Yellowness (bh) of the Hunter system. No correlations were established between redness (ah) and meat quality. Furthermore, pH1 does not seem to be related to PSE meats, whereas pH2 gave good agreement for DFD.

A scale was established from muscles where normal and extreme PSE and DFD were evident (Table 1). This table was used to assess the meat from each animal, grades being ascribed on the basis of 2 or more of the 3 parameters which provided measurements corresponding to the same category of meat quality.

Yellowness values between 7.41 and 8.33, lightness values between 40.63 and 43.56 and free water values between 24.0 and 28.15 have been chosen as the limits for a normal meat appearance at 24 hours postmortem. According to Jones et al. (1984), lightness is an important quality parameter of PSE Meats. We obtained a low but significant correlation between lightness and water holding capacity (r= 0.58) which is higher than that published by Yang et al. (1983). On the other hand, work by Swatland (1982) showed that changes in lightness are more relevant to PSE than slight changes of chroma coordinates (a and b). Our results showed that the increase in lightness from DFD to PSE conditions are paralleled by an increase in b values. Since the colour change of normal meat toward PSE seems to be from pink to beige, it is conceivable to expect a response on the yellowness axis of the Hunter system as a consequence of metmyoglobine formation due to lactate accumulation. In support of this view, it can be seen in table 2 that these is no further decrease in yellowness values between muscle classified slightly DFD and those classified DFD as was the case for free water and lightness.

Table 2 summarizes values obtained for parameters for each meat quality classification according to the limits presented in table 1, thus allowing somewhat high standard deviation for some parameters since the lightness, yellowness and free water values were not always is the same class as mentioned earlier. The table 1 classification is, however, valuable and is supported by the pH2 values obtained for normal, slightly DFD and DFD meats (Table 2). According to Honikel and Fischer (1977) DFD meats have pH2 values higher than 5.8. Moreover, it can be seen that pH1 is of no value for PSE identification. This had now been widely demonstrated (Martin et al., 1975; Overstreet et al., 1975; Barton-Gade, 1979; Smatland, 1982).

We finally correlated thermographic values with meat quality classification. The results are shown in figure 1. There is an increasing incidence of meat quality defects with an increasing skin surface temperature from 70° to 95°F. Seventy three percent of pigs having thermographic values between 90° and 95°F showed meat quality defects, classified as moderate PSE (6%), PSE (39%), moderate DFD (22%) and DFD (33%). This confirms that higher frequency in meat quality problems is related to higher temperature emission. For the purpose of this study, however, 50 of the 81 pigs retained for meat quality analysis were in the 90-95°F range, probably not leaving enough pigs at lower temperatures to get a real estimate of the meat quality defect that could be encountered in the more normal range of 70-80°F. Whether or not heat generating pigs could be associated with the hyperthermia of PSS pigs is not clear. The high incidence of slight PSE and DFD suggests a thermographic value associated with a physiological response to a stressful environment. In that sense, the ambient temperature should be taken into account in a further experiment, and correlations established with the halothane test.

## CONCLUSION

Although this new approach still needs improvements with larger populations over a wide temperatures range, thermography seems to be a practical, rapid, inexpensive and non-intrusive method that could be used on live animals to detect meat quality problems related to PSS. However, it cannot differentiate PSE and DFD, but an early postmortem measurement other than pH1 could give interesting information.

Table 1. Scale for meat quality classification

| Meat quality | bh | Lh | % free water |
|---|---|---|---|
| PSE | ↑ | ↑ | ↑ |
| | 9.21 | 46.50 | 32.30 |
| moderate PSE | ↕ | ↕ | ↕ |
| | 8.33 | 43.56 | 28.15 |
| normal | ↕ | ↕ | ↕ |
| | 7.41 | 40.63 | 24.0 |
| moderate DFD | ↕ | ↕ | ↕ |
| | 6.50 | 37.70 | 19.85 |
| DFD | ↓ | ↓ | ↓ |

Table 2. Mean values and standard deviation for meat quality parameters according to their classification from table 1.

| Meat quality | Free water (%) | Lightness (Lh) | Yellowness (bh) | pH1 (45 min) | pH2 (24 hr) |
|---|---|---|---|---|---|
| PSE | 29.7 (3.7)[1] | 49.53 (3.8) | 9.65 (1.57) | 6.45 (0.98) | 5.74 (0.09) |
| moderate PSE | 28.7 (3.7) | 44.21 (3.21) | 8.89 (0.68) | 6.43 (0.92) | 5.74 (0.11) |
| normal | 25.3 (3.0) | 42.26 (2.37) | 8.27 (1.19) | 6.52 (0.25) | 5.75 (0.08) |
| moderate DFD | 22.4 (3.0) | 37.42 (2.06) | 6.58 (0.60) | 6.35 (0.01) | 5.88 (0.11) |
| DFD | 21.8 (3.7) | 37.1 (3.11) | 6.79 (1.33) | 6.42 (0.17) | 6.27 (0.22) |

( )[1] = Standard deviation.

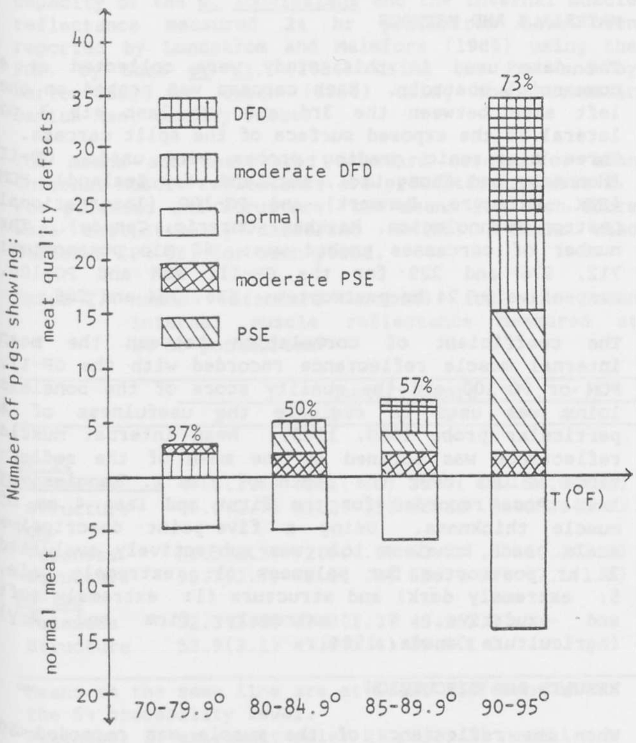


Figure 1. Incidence of pigs showing normal and meat quality defects according to heat generated.

REFERENCES.

Barton-Gade, P.A., 1979.
Acta Agri. Scand., suppl. 21:71.

Hoar, W.S., 1975.
General and comparative physiology, 2nd ed.
Prentice-Hall Inc. London.

Honikel, K.D. and C. Fisher, 1977.
J. Food Sci., 42:1633.

Jones, S.D.M., A. Fortin and M. Atin., 1984.
Can. Ins Food Sci Techn., 17:143.

Ludvigsen, J., 1957.
Acta endocrinology, 26:406.

Overstreet, J.W., N.D. Marple, D.L. Huffman and R.F. Nachreiner, 1975.
J. Anim. Sci., 41:1014.

Swatland, H.J., 1982
J. Anim. Sci., 54:264.

Wierbicki, E. and F.E. Deatherage, 1958.
J. Agric. Food Chem., 6:387.

Yang, T.S., Z.J. Hawrysh, M.A. Price and F.X. Aherne, 1984.
Meat Sci., 10:243.