PREDICTION OF MEAT QUALITY IN LIVE PIGS FROM BIOPSY SAMPLES OF *M. LONGISSIMUS DORSI*

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SUMMARY

Prediction of potential meat quality in live pigs was performed by a skeletal muscle test using small biopsy samples of *M. longissimus dorsi* (LD). The sensitivity of the test was evaluated using pigs of three halothane genotypes comprising 33 NN, 107 Nn and 33 nn pigs of various breeds. Innate variations in meat quality ranging from normal through intermediate to PSE were observed for Nn pigs, and normal and PSE meat for NN and nn pigs, respectively. Predictions of potential meat quality in live pigs were confirmed by post-mortem assessments measurements of pH_{1h}, colour, fibre optic probe (FOP) and drip loss using LD muscles. Our results further demonstrate the usefulness and reliability of the skeletal muscle test in predicting the potential meat quality in live pigs, and support the possible application of the test for selecting breeding pigs with superior water-holding capacity (WHC).

INTRODUCTION

It is well established and accepted by the pig industries that much of the variation in pig meat quality is attributed to genetic disposition and/or pre- and post-slaughter management. Inferior meat quality, particularly PSE and meat of poor WHC is responsible for a substantial loss in the pig industries. The WHC is one of the most important factors affecting the economic value and quality of pig meat. It is responsible for weight loss in raw, cooked and processed meat, for poor colour in cured meat products such as ham, and can influence meat palatability traits. A recent USA survey (Cassens et al., 1992) reported great variations in pig meat quality with only 15% being considered "ideal" (reddish-pink, firm and non-exudative).

Various procedures for predicting meat quality in pigs have been devised using both non-invasive and invasive techniques (Cheah, 1991) in an attempt to improve pig meat quality. Most of these methods are devised for reducing the incidence of PSE meat through elimination of the porcine stress syndrome. The DNA test, based on the mutation of the ryanodine receptor of the sarcoplasmic reticulum (Fujii et al., 1991) provides an excellent procedure for eliminating meat quality deficiencies associated only with the halothane gene but is incapable of predicting meat quality in live pigs. The DNA test is therefore unable to identify pigs prone to producing PSE meat and meat of poor WHC despite being free of the halothane gene (Jensen, 1981; Pommier and Houde, 1993; Cheah et al., 1994a).

A meat quality test based on the measurements of the rate of glycolysis and WHC on biopsy samples of LD has been devised and applied successfully to live pigs (Cheah and Cheah, 1991; Cheah et al., 1993, 1994a). This contribution extends the application of our meat quality test to further evaluate its sensitivity and to establish innate variations in meat quality using a larger number of pigs and also pigs of different breeds of three halothane genotypes.

MATERIALS AND METHODS

One hundred and seventy-three pigs of three halothane genotypes comprising 33 NN, 107 Nn and 33 nn pigs of various cross-breeds were used. The pigs were identified by a combination of halothane testing, blood typing (Gahne and Juneja, 1985) and DNA test (Otsu et al., 1992; Hughes et al., 1992). Biopsy samples (550-650 mg) of LD were taken just below the last rib from individually-penned pigs (60-75 kg live wt) using either the shot (Pfeiffer et al., 1981) or the Biotech spring (Kovac et al., 1992) biopsy instrument. Potential meat quality was determined by measurements of the relative weight and pH of the 12,000 g supernatant, designated fluid (F) after incubation of 500 mg biopsy LD samples with an equal volume of 150 mM KCl at 39°C for 45 min (Cheah and Cheah, 1991; Cheah et al., 1993), and biopsy samples were classified either as normal ($F < 0.50$; pH (F) > 6.00) or PSE ($F \geq 0.50$; pH (F) $\leq$ 6.00). The pigs (80-100 kg live wt) were slaughtered at least 3 weeks after muscle biopsies to allow the wounds to heal. The post-mortem meat quality parameters (pH_{1h}, FOP, L-value (Minolta), drip loss) were determined on LD samples (Cheah et al., 1994), and meat was classified as either normal ($pH_{1h} > 6.00$; FOP 25-5 0; L-value < 58; drip loss < 6.0%) or PSE ($pH_{1h} \leq 6.00$; L-value > 58; drip loss > 6.0%). The results in the table and text are expressed as means $\pm$ s.e. The correlation coefficient (r) was determined using Cricket Graph (Version 1.3.2.), and the means $\pm$ s.e. and P values using StatWorks (Version 1.1.).

RESULTS AND DISCUSSION

Figure 1 illustrates the prediction of the potential meat quality in live pigs of three halothane genotypes from biopsy LD samples. Innate variations in both the rate of glycolysis indicated by pH (Fluid), and WHC indicated by Fluid were observed for all three halothane genotypes. The NN (●) pigs showed a slower rate of glycolysis and better WHC than nn (■) pigs (A). The Nn pigs on the other hand showed innate variations ranging from normal to the PSE-range (B). In all three halothane genotypes, significantly high correlation coefficients were observed between the rate of glycolysis and WHC. The biopsy data indicated that NN and nn pigs would produce normal and PSE meat respectively, and Nn pigs would produce both normal (53.3%) and PSE (46.7%) meat post-mortem.

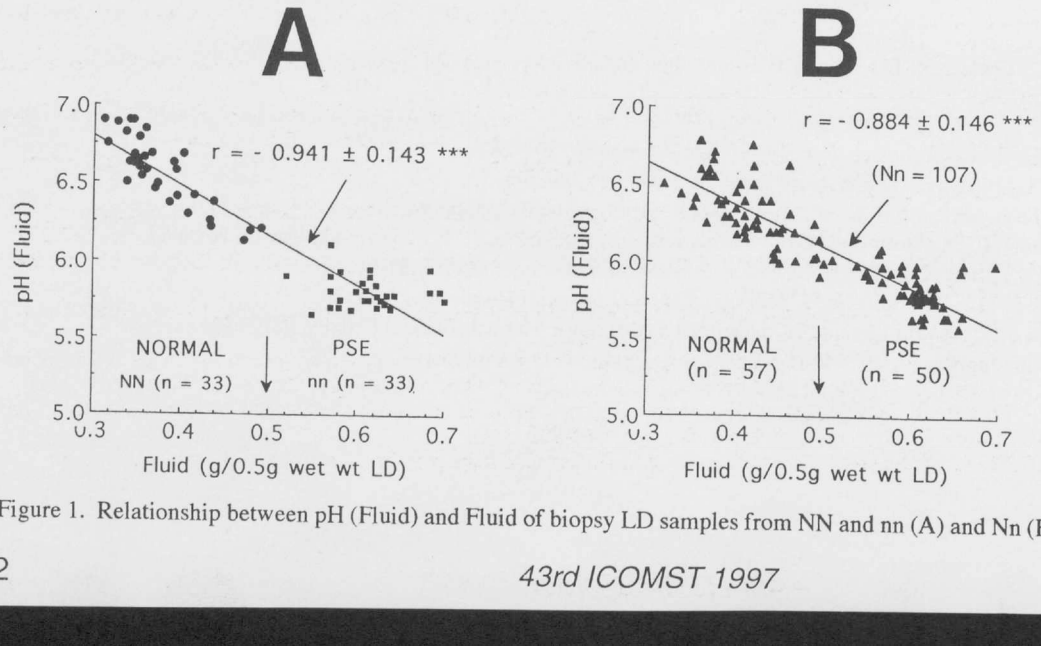

Figure 1. Relationship between pH (Fluid) and Fluid of biopsy LD samples from NN and nn (A) and Nn (B) pigs.

The prediction of potential meat quality in the live pigs of three different halothane genotypes was confirmed by post-mortem assessments on LD muscle as shown in Table 1. The normal Nn pigs showed a significantly faster rate of glycolysis than NN pigs in both the biopsy and post-mortem data, and also a higher drip loss than NN pigs. The PSE-prone Nn pigs showed a significantly slower post-mortem rate of glycolysis and a lower FOP value than nn pigs, but no difference in the rate of glycolysis in the biopsy data. The difference in the post-mortem rate of glycolysis could be due to difference in the rate and amount of calcium released from the sarcoplasmic reticulum stimulating glycolysis post-mortem (Cheah et al., 1994b). No significant differences in pH_{ult} and no DFD carcasses were observed in any of the three halothane genotypes.

Considering all genotypes as one group, significant ($P < 0.001$) correlations (r) were observed between biopsy F with post-mortem pH_{1h} (- 0.845), drip (0.722) and FOP (0.568), and also between biopsy pH (F) with post-mortem pH_{1h} (0.844), drip (- 0.704) and FOP (- 0.577). Our biopsy and post-mortem data thus support that the skeletal muscle test could be employed to reduce the incidence of inferior pig meat that is due to physiological or genetic factors. The test, however, cannot eliminate pig meat quality deficiences induced by either poor pre- or post-slaughter management.

Table 1. Comparative Studies of Various Biopsy and Post-Mortem Parameters of *M. longissimus dorsi* from three Halothane Genotypes

Genotypes	Biopsy Data			Post-mortem Data				
	Fluid (F) (g/0.5g LD)	pH (F)	Quality*	pH_{1h}	Drip (%)	FOP	L-value	Quality
NN (n = 33)	0.38 ± 0.01^a	6.57 ± 0.04^a	Normal	6.61 ± 0.02^a	5.0 ± 0.4^a	-	55 ± 1	Normal
Nn (n = 57)	0.41 ± 0.01^a	6.34 ± 0.03^b	Normal	6.21 ± 0.04^b	7.3 ± 0.4^b	41 ± 2^a	-	Normal
Nn (n = 50)	0.60 ± 0.01^b	5.83 ± 0.02^c	PSE	5.77 ± 0.03^c	$9.4 \pm 0.8^{b,c}$	57 ± 2^b	-	PSE
nn (n = 33)	0.61 ± 0.01^b	5.80 ± 0.02^c	PSE	5.62 ± 0.03^d	10.5 ± 0.5^c	70 ± 3^c	-	PSE

* indicates predicted meat quality; results are means ± se; -, not determined; n indicates number of pigs used except post-mortem data for Nn pigs (normal, n = 30 and PSE-prone, n = 38). Within columns, means with different superscripts are significantly different at $P < 0.001$.

CONCLUSION

The skeletal muscle test using small biopsy samples of LD could be used to predict potential meat quality in live pigs as shown by experiments with three halothane genotypes having a wide range in rate of glycolysis and WHC. The experimental data show that the test could be employed to select (1) pigs with superior WHC and (2) normal Nn pigs to maximize the beneficial economic effect of leanness and muscularity associated with Nn pigs (Simpson and Webb, 1989).

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