# PREDICTING WATER-HOLDING CAPACITY IN POST-RIGOR PORK

R. G. Kauffman[1], J. M. Norman[1], S. Gunasekaran[1], R. van Laack[2], S. Lee[1], and T. Toliver[3].

[1] Muscle Biology Lab., 1805 Linden Drive, University of Wisconsin, Madison, WI 53706, USA
[2] Dept. Food Sci., University of Tennessee, Knoxville, TN, USA
[3] Rochelle Foods, Rochelle, IL, USA

KEYTERMS: Pork Quality, Water-holding Capacity, Electrical Conductivity, $pH_u$

BACKGROUND: The quality of fresh pork varies considerably in the traits of appearance, shrinkage, processing properties and palatability (Kauffman et al., 1992). Of all the muscle characteristics that affect these traits, perhaps water-holding capacity (WHC) is the most important.

Little has been accomplished to overcome the variation in WHC. One of the main reasons has been the lack of practical procedures to assess WHC. Measures such as $pH_{45}$, light reflection and scattering, electrical conductivity (EC) or resistance, or carcass stiffness have not been accurate predictors (Kauffman et al., 1993). Many of the procedures developed to predict WHC are erroneously based on color. This is because color and WHC are not linearly or perfectly related as reported by Warner (1994) and Laack et al. (1994). Pork can be reddish pink and yet soft and exudative (RSE).

If pork carcasses could be quickly, accurately, and economically classified according to WHC, then this information could be used by swine producers to select against undesirable WHC, and by packing plants to sort carcasses on quality. RSE and PSE, as compared to normal reddish pink, firm, non-exudative (RFN) and DFD pork, contain significantly more 'free' fluids that leak out during post-rigor storage. These fluids (containing about 85% water) include charged compounds that enhance EC. As suggested by Kleibel et al. (1983), it would be expected that PSE and RSE pork are less resistant to a current, whereas DFD pork would be more resistant than RFN. A recent report by Honikel (1993) suggests that WHC may be more dependent on color and $pH_u$ fluctuations than electrical properties.

OBJECTIVE: To re-examine the interrelationships among $pH_u$, EC and WHC, and to test if EC and $pH_u$ can be used to predict WHC as well as accurately classifying post-rigor pork into one of four categories (PSE, RSE, RFN, DFD).

METHODS: At 24 hr. postmortem (PM), 47 pork loins were selected. Samples represented a wide variation in quality as based on WHC [% drip (PD)], L* values (Chromameter 200), and ultimate pH ($pH_u$). Samples were classified either as PSE (N=13), RSE (N=14), RFN (N=13), or DFD (N=7) (Warner, 1994). The two instruments used to measure EC of the muscle included the NWK LT K21 (Landsberg, Germany), and a device developed at the University of Wisconsin (UW). Appropriate statistical procedures including correlations, coefficients of determination (CD = $r^2$ x 100), regressions, logistic discriminate analysis (LDA) and ANOVA were used to determine the effectiveness of assessing WHC as well as determining separate quality classes.

RESULTS AND DISCUSSION: In Table 1, the properties of the four classes of loins are included. UW EC was highly related to PD at 24 hr PM (CD = 66%), and CD remained high when DFD and PSE samples (N=20) were excluded from the analysis (CD = 58%). The other measure of EC was not as highly related to WHC as UW EC. The predictive value of $pH_u$ for WHC was similar to UW EC. However, when DFD and PSE samples were excluded, UW EC for WHC -(CD = 58%) was more accurate than $pH_u$ (CD = 47%). As graphically illustrated in Figures 1 and 2, the relationship between WHC and UW EC, and between WHC and $pH_u$ are significant. When $pH_u$ and UW EC are combined to predict WHC [% drip = 229.6 + (0.4 x mS) - (73.1 x $pH_u$) + (5.8 x $pH_u^2$)], the CD increased from 66% to 84%.

When UW EC and $pH_u$ are applied to LDA to predict the four classes of pork from this same set of data, 70% of the samples were correctly classified. When the 47 samples were divided into low (> 6% drip), medium (2 - 6% drip) and high (< 2% drip) WHC, UW EC alone correctly grouped 80% of the samples. The accuracy in predicting groups increased to 94% when three borderline examples were ignored. When UW EC values were < 6 mS, the mean PD was 2.1%. When values ranged from 6 - 9 mS, PD averaged 4.0%, and when it was > 9 mS, the mean value was 8.3%. However, these observations must be treated with caution until methods can be tested on an independent population.

CONCLUSIONS: EC can serve as an accurate predictor of WHC in pork muscle when measured at 24 hr PM. EC measurements can be quickly, economically, and accurately performed on a commercial line. It is conceivable that EC can be used independently, or with even better success in combination with $pH_u$ (such as the NWK automated instrument) to classify pork carcasses for WHC.

ACKNOWLEDGEMENT: The authors appreciate the support of the following organizations to complete this research: NWK binär, Landsberg, Germany; National Pork Producers Council, Des Moines, IA, USA; Rochelle Foods, Inc., Rochelle, IL, USA; Grennan Meats, Rochelle, IL, USA; and The Graduate School, University of Wisconsin-Madison, USA.

REFERENCES:

Honikel, K. 1993. Fleischwirtsch. 73:(1).

Kauffman, R. G., R. G. Cassens, A. Scherer and D. L. Meeker. 1992. National Pork Producers Council, Des Moines, IA.

Kauffman, R., G. W. Sybesma, F. J. M. Smulders, G. Eikelenboom, B. Engel, R. L. J. M. van Laack, A. H. Hoving-Bolink, P. Sterrenburg, E. V. Nordheim, P. Walstra and P. G. van der Wall. 1993. Meat Sci. 34:283.

Kleibel, A., St. Pölten, H. Pfützner and E. Krause. 1983. Fleischwirtsch. 63:(3).

Laack, R. L. J. M. van, R. G. Kauffman, W. Sybesma, F. J. M. Smulders, G. Eikelenboom and J. C. Pinkeriro. 1994. Meat Sci. 38:193.

Warner, R. 1994. Ph.D. Thesis, University of Wisconsin, Madison, WI, USA.

TABLE 1. Characteristics of Four Pork Quality Classes

| Quality Class | N | % Drip | L* | $pH_u$ | Electrical Properties: UW-EC,mS[1] | Electrical Properties: NWK-EC,mS |
|---|---|---|---|---|---|---|
| | | $\bar{X} \pm sd$ | $\bar{X} \pm sd$ | $\bar{X} \pm sd$ | $\bar{X} \pm sd$ | $\bar{X} \pm sd$ |
| PSE | 13 | $9.6^{a} \pm 1.9$ | $52.8^{a} \pm 3.2$ | $5.36^{a} \pm .1$ | $12.6^{a} \pm 1.6$ | $3.6^{a} \pm 1.2$ |
| RSE | 14 | $8.1^{b} \pm 1.1$ | $47.5^{b} \pm 1.2$ | $5.48^{b} \pm .2$ | $12.2^{a} \pm 2.0$ | $3.6^{a} \pm 1.6$ |
| RFN | 13 | $4.0^{c} \pm 1.3$ | $45.3^{c} \pm 2.0$ | $5.63^{b} \pm .1$ | $7.6^{b} \pm 2.5$ | $2.6^{ab} \pm 1.4$ |
| DFD | 7 | $1.3^{d} \pm .4$ | $39.2^{d} \pm 2.2$ | $6.18^{c} \pm .2$ | $5.7^{c} \pm 2.0$ | $2.0^{b} \pm .7$ |

[1] mS = micro Siemens

Means within a column having different superscripts are significantly different ($P < .05$)

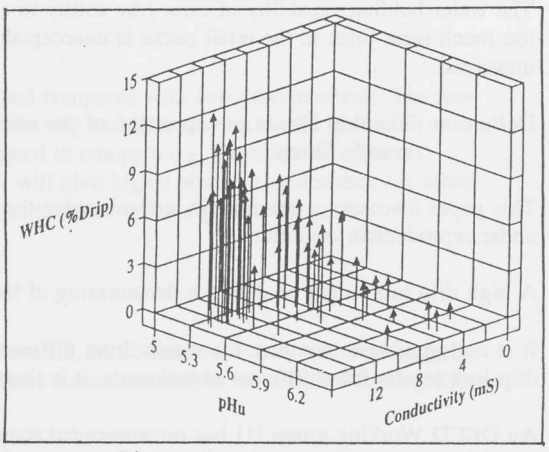


Figure 2. Interrelationship of Water-Holding Capacity, $pH_u$ and Electrical Conductivity for Fresh Pork. N = 47

Figure 1.