IDENTIFICATION OF PALE, SOFT AND EXUDATIVE (PSE) PORK AND PREDICTION OF PORK QUALITY EFFECTS ON FINISHED PROCESSED PORK PRODUCT QUALITY

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SUMMARY

Correlations between the finished product and the raw loin characteristics were determined on 16 pork loins of widely varying quality, per replicate. Those raw loin characteristics which were most highly correlated to finished product characteristics were used in regression analysis to develop a prediction equation. After completing 2 replications, fresh pork loin quality characteristic correlations to finished product characteristics were rather acceptable (most r values above 0.65). Prediction equations with R^2 values of -0.76 and 0.84 were generated for finished product cooking loss. Prediction equations for finished product color and texture had relatively unacceptable R^2 values.

Introduction

The need exists in the United States for identification of objective methods for evaluating post rigor pork quality, which can best distinguish pale, soft and exudative (PSE) pork from normal and other quality types of pork (Walstra et al., 1977), and which can predict cooked or finished product quality based upon fresh meat characteristics. U.S. meat companies often sort fresh pork by using rather subjective means to determine pork quality (e.g., visual color, visual surface wetness or texture assessment by pressing thumbs into the ends of loins). In addition, each packer or processor prefers a particular method(s) or uses unique standards for evaluating pork quality characteristics for classification as normal, PSE, which means that there is no common objective standards for pork quality.

Currently more objective methods are available for evaluating pork quality, such as surface color and reflectance, internal reflectance by fiber-optics, direct muscle pH, etc. and some of these methods are being used by U.S. meat companies to sort pork by quality levels. These more objective methods for evaluating pork quality have been developed and evaluated by comparing the results of each method to water-holding capacity as determined by centrifugation (Swatland et al., 1986), press method (Jones et al., 1984), and drip loss (Warris et al., 1989; Somers et al., 1985); ultimate pH (pH_U) (Swatland, 1986); pH at forty-five minutes postmortem (pH_{45}) (Barton-Gade, 1981; Warris and Brown, 1987); subjective color and structure scores (Fortin and Raymond, 1987; Swatland, 1989; Warris et al., 1989); carcass weights and fatness (Chizzolini and Malagoli, 1988); consumer panels (Somers et al., 1985); or whether the carcasses were from halothane positive or halothane negative pigs (Eikelenboom and Nanni Costa, 1988).

In addition, researchers have worked on developing fiber optic probes as rapid, non-destructive methods to identify PSE pork (Swatland, 1986; Eikelenboom and Nanni Costa, 1988; Jones, et. al., 1984; and Barton-Gade and Olsen, 1987; Forten and Raymond, 1987; Warriss and Brown, 1987; Somers et al., 1985; and Warriss et al., 1989, and Warner, et al. 1992), and have studied surface reflectance and microscopy methods for evaluating pork carcass quality. In the studies mentioned above, very little research has been done to correlate the fresh pork characteristics to finished, cured and cooked product characteristics, in order to predict the functionality of the fresh pork in the production of processed products, such as ham or sausage.

In addition, much of the research, to date, has also looked at each quality characteristic individually. Recently it has been observed that some pork is pale, but not soft and exudative, and vice versa. Kauffman and co-workers (1992) described 5 categories of pork quality which were identified as: pale, firm and non-exudative (PFN); red, soft and exudative (RSE); red, firm and non-exudative (RFN); pale, soft and exudative (PSE); and dark, firm and dry (DFD). Therefore, combining results from more than one objective method, in the form of an equation or index, could sort out what is truly PSE and what quality problems have other causes in addition to the porcine stress syndrome.

More recently, several studies have evaluated and compared the many available methods for evaluating pork quality. Kauffman (1991) found, in a very comprehensive evaluation of methods, that muscle pH was the only method which showed any predictive potential, and in this case, pH_{45} was relative good in predicting water-holding capacity and color in fresh pork. Trout (1992) evaluated a number of these methods and found that Minolta L and b values, Colormet L values, and fiber-optic probe values at 45 minutes postmortem, were most promising in being able to separate Australian pork samples into 5 quality categories. To date, objective methods have not been developed which accurately select PSE pork based on the true functionality of the meat during further processing (i.e., curing and cooking), and little attempt has been made to predict finished product quality from fresh pork quality characteristics.

Materials and Methods

Sixteen pork loins of varying levels of quality (from extreme PSE to extreme DFD) were selected from a local pork slaughter plant, by both visual color and surface pH at the plant. Loins typically varied from pH 4.9 to 6.8. Loin surface color was assessed nby averaging three readings each from midloin and sirloin cross-sections with the Hunter Labscan Spectrocolorimeter and the Minolta Chromo-meter. pH measurements were made using standard methods with a standard-ized Accumet 925 pH/ion meter. Water-holding capacity was determined by a modified press method (Grau and Hamm, 1953) and a filter paper absorption method (Kauffman et al., 1986). Loin texture was evaluated by Instron compress-ion using a 7.8 mm (dia.) probe, compressed across (perpendicular to direction of muscle fibers) the dorsal side of 4 cm thick raw chops. Warner-Bratzler shear measurements of 3 raw (12.3 mm dia.) cores were made both perpendicular and parallel to muscle fiber direction. Five readings were made for firmness, by using the Effeggi Penetrometer Model FT 327 (Italy). Internal and surface relec-tance by light scattering and absorbance were determined by a CTM Sensoptic surface and invasive probes (Westerendem, The Netherlands), conductivity by Sensoptic surface and invasive probes (Westerendem, The Netherlands), by measuring parallel to muscle fiber orientation at three locations (rib end, midloin and sirloin end) on the loins. Electrical impedance measurements were taken on each uncured loin, using 20 gauge needles, spaced 5 cm apart, with a BIA 101A meter (RJL Systems, Inc., Detroit, MI). After curing and cooking, the finished product was evaluated for quality characteristics such as cooking yield, texture (by consumer sensory panel and Instron Warner-Bratzler shear), juiciness (by consumer panel scores), and cured color (by consumer sensory panel, Minolta Chromometer and Hunter Lab).

The finished product characteristics were compared to the quality charac-teristics of the uncooked loins. Correlations between raw product characteristics and finished product characteristics were calculated and used as selection criterion to establish independent variables in prediction equations for cured color, cooking loss and cured texure. Only characteristics with an r value greater than or equal to 0.65 were considered for use in the cooking loss and cured color equations. However characteristics with r greater than or equal to 0.45 were selected in the equation for cured texture. Through regression analysis, the prediction equations in table 21 were derived. This study was replicated two times, with plans to do at least one more replication in the future.

Results and Discussion

Raw pork loin characteristics which were highly correlated (r>0.65) to finished product characteristics are shown in Table 1.

Equations for predicting cooking loss and cured color (based upon consumer panels) of cured pork loin are presented in Table 2. The first prediction equation for cooking loss was developed based upon the practical use of on-line equipment (Sensoptic conductivity probe) and had an R^2 value of -0.76. The second prediction equation for cooking loss was developed based upon the highest possible R^2 value, which was 0.84 (Table 2).

While the simple correlations for cooked product color had r values of approximately 0.65 or higher, the resulting prediction equations were not very good. The first prediction equation for finished product color was developed based upon practical use of on-line equipment (pH reading and CTM internal reflec-tance probe) and had an R^2 value of 0.57 (Table 2). The second prediction equation for finished product color was developed based upon the highest possible R^2 value, which was 0.57.

All correlations for cured and cooked product texture had r values of less than 0.65, with the result that the best prediction equation which could be develop-ed had an R^2 value of 0.51 (Table 2). This equation included raw quality measure-ments of pH, CTM invasive reflectance probe, CTM surface reflectance, Hunter

L values, Minolta L values and b values. The prediction equation based upon pract-ical use of on-line equipment (CTM surfce probe, light scattering and absorption)

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