Quality Assessment Instrumentation for the Pork Industry

Eric Berg & Jerry Cannon

Importance of Pork Quality

The quality of fresh pork will have many definitions in today s world market-place. Like beauty, quality is most definitely in the eye of the beholder or, more specifically, the eye of the customer. In a paper reviewing pork quality and the requirements of consumers, Kortz (2003) identified five pork quality traits in the literature (Andersen, 2000). The first, **consumption quality**, is associated with the appearance, flavor, tenderness, and juiciness of pork. Next is **nutritional quality**, which relates to the protein, fat, vitamin, and mineral content of pork. The digestibility of the particular pork product was also identified as a component of nutritional quality. **Technological quality** is likely the trait that we are most familiar with as meat scientists. Technological quality includes all the standards such as water-holding capacity, pH, protein and lipid status, connective tissue, etc. **Hygienic quality** may top the list of many consumers of pork and is relative to risk of microbial contamination, presence of *harmful substance* residues, and pollutants. The last trait that Andersen (2000) identified is a definition of quality that has grown in acceptance in recent years; **ethical quality**. The attributes of ethical quality pertain to organic farming, religion, production environment (outdoor production), and swine welfare. Identification of markets willing to pay for these or other definitions of pork quality constitutes a value-added opportunity for the pork production chain.

The ultimate *quality* of any marketable product is arguably the most important factor for establishment of customer loyalty. Improvements made to the quality of a product should increase consumer demand and, if the quality is consistent, lend itself to repeated purchases of that product. United States pork purveyors not only want to establish new markets for their pork, they must maintain the satisfaction of that customer. Customer satisfaction is maintained through delivery of consistent, high quality pork. Therefore, pork quality criteria are established with the buyer and standard operating procedures are put in place to identify and sort product meeting these established specifications. Pork purveyors rely on several methods (both objective and subjective) to attempt to objectively take the guesswork out of identifying pork destined for a given market that will consistently and repeatedly satisfy the customer based on their definition of quality.

Quality Evaluations Conducted by United States Pork Processors

A Pork Quality Survey questionnaire (Meisinger and Berg, 2006) was developed as a follow-up to the National Pork Board (NPB) Check-off funded 2002 Pork Benchmarking Audit (PBA). Respondents to Phase I of the PBA revealed that the incidence of pale, soft, and watery loins and hams had increased to 15.5% occurrence. Members of the NPB Check-off Pork Quality Solutions Committee noted that this was a high number and suggested that the respondents filling out the PBA questionnaire may have mistaken the question for addressing just *pale* pork or just *watery* pork. The Quality Solutions Committee is comprised of many of the pork processors that participated in the 2002 PBA. The industry representatives suggested that it is very rare that they identify fresh pork that is pale *and* soft *and* exudative; classic/textbook PSE pork. Out of this discussion, the National Pork Quality Survey was developed as a follow-up survey issued to PBA contributing packing plants to further clarify the incidence rate of PSE pork and to more clearly categorize the levels of quality defects present in the fresh pork loin. Although the objectives were to gain greater understanding with regard to the level of PSE pork in U.S. packing plants, it provided valuable information relative to technology used in the industry to identify and segregate pork loins based on in-house quality standards.

A survey questionnaire was developed and sent to nine pork processing companies, representing 82.5% of the total pork carcasses processed in the United States (2004, Estimated Daily United States Slaughter Capacity Report: http://www.porkboard.org/porkfacts/porkFactPDFS/pg77.pdf). Each region of the country was represented and, in total,

Eric Berg
University if Missouri-Columbia
S138 Animal Science Research Center
920 East Campus Drive
Columbia, MO 65211

Email: BergEP@missouri.edu

Proceedings of the 59th American Meat Science Association Reciprocal Meat Conference *(pp. 35-38)*
June 18-21, 2006, Champaign-Urbana, Illinois
www.meatscience.org

11 completed questionnaires were returned representing all nine processing companies.

Measurements of pH

All (100%) respondents confirmed that they routinely measure the pH of pork loins in their plants. All 11 respondents measured ultimate pH (> 24 h postmortem) with a rate of frequency ranging from a high of 400 per day to 300 per week. Three of the respondents noted measurement of initial (< 1 h postmortem) pH at a frequency from less than 100 to 400 carcasses per day. The average initial pH reported in the survey was 6.12 and ultimate pH of 5.76. The most common brand of pH meter was the SFK pH Star probe, followed by MPI meter, and Hannah probe. Other instruments named included NWK, Mettler-Toledo, Centron, and Ingold. The contributors were specifically asked to fill in the blank for the following question: *Approximately one out of ____ loins is unacceptable for pH.* On overage, 1 in 24 loins were reported as unacceptable for pH.

Measurements of Color

All respondents to the Pork Quality Survey indicated that they objectively measure fresh pork loin color in their plants using the Minolta colorimeter. There was consistency across the industry with regard to the specific brand of instrumentation used to evaluate color, however, this is where the similarities ceased. Different companies/ plants calibrated the instrument to different calibration plates (white tile only, multiple color tiles, white and black tile, white and zero calibration), used different settings for the standard illuminant (Illuminant C or D65 standard observer), and had instruments of varying size/ diameter of colorimeter orifice (8, 10, 11, 50 mm). The frequency of on-line evaluation was reported from a high of 300 per day to 50 per week. When asked for the plant average L*-value, the response spanned from 42.40 to 53.80 and averaged 45.61. The threshold level of acceptability also spanned a wide range with all respondents using the L* reading to determine their threshold of acceptability. The range of acceptability for L*-value reported was wide for some companies (40 to 60 is acceptable) to narrow for another (42.3 to 44.2).

Nine of the 11 respondents indicated that they still routinely evaluate subjective color. Half of the respondents used the Pork Board color standards and seven of nine respondents use the Japanese color standards. All respondents that evaluate subjective color indicated that their method of evaluation and level of acceptability was product and (or) customer dependent. When asked the question; *Approximately one out of ____ loins is unacceptable for subjective color* the average response was 1 in 50 loins were unacceptable.

Measurement of Exudate (Product Moisture Loss)

The ability of pork to retain moisture is the largest contributor to the technological quality of pork. Many of the pork processors participating in the survey (8 of 11) evaluate fresh pork loins for moisture loss. Several descriptors for moisture loss were used; exudate, drip loss, water-holding capacity, and (or) purge. Five of the eight plants that measure moisture loss use small plastic drip loss tubes while other methods mentioned included the filter-paper method and vacuum packaged purge loss reported after a plant specific number of days cold storage. The range of acceptability was wide and completely dependent on the method of evaluation. The response to the question *Approximately one out of ____ loins is unacceptable for exudate* indicated that 1 in 20 loins was unacceptable by company standards.

Measurement of Marbling

Seven of the 11 pork processors responded to the survey that they evaluate fresh pork loins for marbling, yet nine (out of 11) responded that they utilize the Pork Board marbling standards and the remaining two respondents indicated that even though they did not evaluate for marbling, they did use the Pork Board marbling cards. Five companies/ plants evaluated marbling on the cut lean surface adjacent the 10th rib, another from a chop removed adjacent the last rib, and another indicated that marbling was evaluated on the main body after rib removal . The average level of marbling reported by the respondents was approximately 1.5% intramuscular fat with a threshold of acceptability that was plant, product, and (or) customer dependent.

Fresh Pork Quality Assessment

A special symposium was held at the 54th annual Reciprocal Meat Conference titled ***Beyond pH***. Based on the response to the 2006 Pork Quality Survey, U.S. packers have not yet moved beyond pH. Despite over 60 years of meat science research focusing on pork quality, the industry continues to use the classics for evaluation: pH, color, moisture loss, and marbling. We have long heard that You cannot change what you can t measure yet reliable on-line instrumentation has yet to emerge that can routinely and accurately sort fresh pork based on standards set for maximum quality. Howard J. Swatland (University of Guelph) has spent his career developing, testing, and critically evaluating electronic instrumentation for on-line assessment of fresh pork quality. Swatland (personal communication) states that electronic instruments must be rapid enough to keep pace with modern on-line production, objective with no input from human judgment, nondestructive, and pose no risk of product contamination. The instrumentation must be compliant with current industry goals including;

1. Feed-back information to swine producers
2. Useful for incentive-based payment for delivery of superior pork quality
3. Possess objective quality control and grading
4. Be capable of detecting tough meat
5. Can detect pale meat
6. Can predict potential for fluid loss
7. Can determine intramuscular fat content
8. Capable of sorting for niche markets

9. Can be incorporated into a feed-forward computer information system to improve meat processing.

Conceivably this tall order could be met through adaptation of existing technology and be applicable across genetic and environmental influences on pork quality. Advances in biological engineering have been made with regard to near infrared probes and video image analysis, yet development has not progressed to the stage of application. Therefore, industry remains tentatively loyal to the old standards .

Issues relative to pH

If you are reading this paper, chances are you are familiar with the influence of postmortem pH decline relative to the conversion of muscle to meat; therefore, a description of this process would be redundant. Obtaining ultimate (or 24 h) pH has been shown to be a decent predictor of attributes of technological quality. It can be used to sort fresh cuts of pork and is the most familiar pH measurement to the pork processing industry. Intramuscular pH obtained at 45 minutes postmortem has also been a standard measurement criterion of pork quality research. Modern advances in swine production and discovery of genetic anomalies (such as the RN genotype) have rendered this early postmortem pH measure as a mediocre indicator of technological quality. Its value in the modern pork processing chain may be more indicative of ethical quality pertaining to preslaughter handling, stunning, and (or) harvest floor activities. It has long been stated that intramuscular pH is a *predictor* of pork quality and not an actually quality trait. This statement is currently being challenged as researchers evaluate the role of pork pH on sensory panel evaluation of acceptable pork flavor. There is also concern over the use of glass-tipped pH probes in the industry. A rapid, reliable, non-glass technology must be developed to avoid incidence of probe shattering inside product destined for human consumption. Another important issue associated with using pH as a means of establishing thresholds of acceptability has to do with instrument-to-instrument variation. What is acceptable in one plant using one instrument, may not be acceptable in another plant under similar conditions.

Issues Relative to Fresh Pork Color

Visual assessment of fresh pork color is simple. Applicable reference standards have been developed for reference by the National Pork Board and the Japanese color standards. These standards are very familiar across the industry and are easily incorporated into evaluation protocols through training of personnel. However, no matter the level of training, they remain subjective in there level of assessment.

Colorimeters are objective and the values are relatively easy to interpret. However, meter-to-meter variation makes it difficult to compare color space readings obtained from different sources. When reporting colorimeter data, the brand of meter, orifice aperture, light source setting, calibration methodology, and length of time allowed for bloom must be described. Even when all this information is presented, the values reported will be difficult to interpret for means of direct comparison. Variation associated with the biological system also plays a factor in interpreting colorimeter readings. A colorimetric measurement obtained on the posterior or anterior end of a fresh pork loin may not be a strong indicator of acceptability of color in the center portion of the loin.

Issues Relative to Marbling Assessment

Like the color standards previously mentioned, photo standards of degree of marbling have been developed and distributed by the National Pork Board. Reporting of these standards are easily interpreted, easily understood and widely accepted in the industry. Evaluation of marbling in fresh pork loins has been described as an indication of consumption quality, yet this issue remains a point of debate. Pork Board studies of consumption quality indicate that consumers served cooked chops of varying level of intramuscular fat prefer the pork chops possessing a higher degree of marbling (up to 4%; NPPC, 1998), yet as the recent Pork Quality Survey indicated, the average percent intramuscular fat level is approximately 1.5%. The drawbacks of marbling assessment are:

1. It is highly subjective
2. Visual assessment often has a low correlation to actual chemically determined levels of IMF
3. It is necessary to cut into the muscle to effectively evaluate, and subsequently
4. Evaluations obtained on the posterior or anterior ends of fresh pork loins may not be indicative of the center portion of the loin

Options for Assessment

On-line

The pork processing industry would welcome technology capable of accurately assessing fresh pork quality as it would save literally millions of dollars attributed to product devaluation and loss of repeated sales. This technology must be able to operate at line speed of approximately 1,000 carcasses or primal cuts per hour, must be accurate and repeatable, and must possess the capacity for traceability and (or) provide the opportunity for segregation of product; predicting quality sooner rather than later in processing would provide more options.

Quality Control Audit

The customer s definition of quality is used to establish quality specifications and dictates the criteria for evaluation of fresh pork quality. Therefore, many pork processors rely on off-line evaluations to monitor daily fluctuations in pork quality traits. This is done not only to segregate product for the buyer, but is also due to existing limitations in technology. Instruments may not be capable of obtaining accurate measurement at on-line speeds and (or) there may be a potential for physical injury to the operator or customer (such as a broken probe tip from a glass-tipped pH probe) as they attempt to keep pace with rapid on-line processing. Ulti-

mate pH and color are the primary traits measured. These plant specific quality control audits are also used to monitor and evaluate processing changes such as genetics, animal handling, time on the harvest floor, chilling rate, etc. on fresh pork quality. These processor-specific audits are an effective means of predicting potential pork quality deviations associated with process changes and a necessary means of predicting the availability of product to meet certain product specifications.

Summary

Fresh pork quality assessment within United States packing plants is currently being conducted using the old classics; pH, color, moisture loss, and marbling. The 2002 Pork Benchmarking Audit estimate of color, firmness, and structure of ham and loin muscles of U.S. market hogs reported an average 15.5% carcasses exhibiting pale, soft, and watery pork. This follow-up Pork Quality Survey revealed that pork processing companies that conduct 82.5% of the daily hog slaughter identify true (classic) pale, soft, and exudative pork in approximately 3% of their daily pork loin processing. Until technology is developed that accurately assesses fresh pork quality, processors will continue to assess pork quality based on the criteria set by the customer.

References

Andersen, H. J. 2000. What is pork quality? Quality of meat and fat in pigs as affected by genetics and nutrition. EAAP publication No. 100: 15-26. (as cited by Kortz, 2003).

Kortz, J. 2003. The quality of pork its characteristics and the requirements of the consumers and meat processing plants. Proc. Effect of genetic and non-genetic factors on carcass and meat quality of pigs. Pp. 77-92. April 24-25. Sidlce, Poland.

National Pork Producers Council Pork Quality Solutions Team. 1998. Pork Quality Targets. In Pork Facts. #04366 - 10/98. NPPC. Des Moines, IA.

Swatland, H. J. 2006. Personal communication. University of Guelph, Canada.

.