Comparison of Restructured Chops Manufactured from Prerigor and Postrigor Pork

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ABSTRACT

Restructured chops from prerigor (P) and conventionally boned (C) pork were unsalted (U) or salted (S) with 2.0% sodium chloride (NaCl) and 0.25% sodium tripolyphosphate (STP). After storage for 5, 14 and 42 d, samples were subjectively evaluated for amount of discoloration, consumer desirability, juiciness, tenderness, and flavor. Objective measurements included Hunter color difference meter readings and TBA values. Generally, objective and subjective appearance traits and flavor deteriorated (P<0.05) with increased storage time. No consistent differences (P>0.05) in subjective and objective appearance traits and flavor were found between P and C samples. Objective and subjective evaluations revealed that salted P and C chops were generally inferior (P<0.05) in appearance but not different (P>0.05) from unsalted P and C samples in flavor. No differences (P>0.05) in juiciness existed between P and C samples, whereas salted (P and C) chops were generally more (P<0.05) tender and juicy than unsalted counterparts. Samples with higher juiciness scores usually had superior tenderness scores. No consistent differences (P>0.05) were found between chops manufactured from prerigor pork and conventionally boned counterparts.

Pork is recognized as one of the most versatile and nutritious muscle foods. New processing techniques that incorporate restructuring and portion control of pork offer opportunities for increased utilization and merchandising, especially through the institutional market.

Production of restructured pork cuts offers the opportunity to produce a product with mechanically controlled portioning of shape and weight. Composition can be closely controlled through monitoring fat, lean and moisture content of flaked products to be restructured. Mandigo (6) has incorporated this production method for addition of functional ingredients and fortification with protein, vitamins and minerals during blending of flaked meats. Restructuring also permits control of texture through regulation of particle size and amounts of other ingredients to vary mouth feel, tenderness, juiciness and flavor.

Although restructured pork is an alternative to conventional pork products, the compatibility of restructured prerigor pork with retail and institutional merchandising practices is not known. Henrikson (3) has reported potential energy savings of up to 50% through hot-boning before rigor onset, which suggests the viability of this concept. Marriott et al. (7) reported that accelerated processing of retail cuts of prerigor pork is an alternative to conventional fabrication practices. This study was done to determine the potential of accelerated processing and restructuring of prerigor pork. The objectives of this study were to compare prerigor (P) and conventionally (C) boned pork shoulders in the manufacture of restructured pork chops, and to determine the effects of these materials (P and C) and selected adjuncts on the stability of appearance traits and taste attributes.

MATERIALS AND METHODS

Sampling

Shoulders from the left side of five slaughter hogs weighing from 105 to 125 kg were boned 1 h postmortem (prerigor samples). Control samples were boned 24 h postmortem from the chilled right side of each carcass sampled. All samples were packaged in freezer paper, frozen immediately after boning at -20°C and stored for 6 d at -20°C to simulate industry practice and conditions.

Restructuring process

After 6-d frozen storage, samples were cubed and tempered to -4°C in a -4°C storage environment. When this temperature was attained, one-half of the P and C samples was flaked separately into approx. 4-mm (Phase I) or 3-mm (Phase II) particle size with a Ross Industries Unicorm meat flaker prototype. Samples in the first study (Phase I) were not salted, whereas one-half of the P and C samples in the second study (Phase II) was blended with 2.0% sodium chloride (NaCl) and sodium tripolyphosphate (STP) in a ribbon-paddle mixer for 3 min. All samples were stuffed into 74-mm-diam. casings. Stuffed samples were then frozen and stored at -20°C for 24 h.

After 24-h storage, the meat logs were tempered in a 25°C environment to -4°C and formed into the shape of a bonless pork loin with a Ross Industries press. Restructured samples were cut into chops 2 cm thick, wrapped in freezer paper and stored at -20°C until evaluated. Evaluations were done on chops in the frozen state at 5, 14 and 42 d to simulate short, intermediate and long storage periods between manufacture and consumption.

Traits measured

At 5, 14 and 42 d after manufacture, samples from both phases were subjectively rated for color, overall appearance, tenderness, juiciness and flavor by a five-member rating panel according to a scaling method described by Larmond (5). Panel members were given samples before

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evaluation for instruction and coordination according to Rainey (8) to ensure maximal accuracy and precision. Rating scales were as follows: (a) an 8-point scale to measure discoloration (8 = very bright; 1 = gray or green); (b) an 8-point scale for overall appearance to identify consumer desirability (8 = extremely desirable; 1 = extremely undesirable); and (c) an 8-point scale for tenderness, juiciness and flavor (8-very desirable; 1-very undesirable). Samples from Phase I were also objectively evaluated for color by use of the Hunter color difference meter, although only a-values will be discussed. Oxidative rancidity was objectively measured by the thiobarbituric acid (TBA) test (11).

Sample allocation
Total sample size was: (a) Phase I, 2 materials × 3 periods × 12 replications = 72 samples and (b) Phase II, 2 materials × 2 formulations × 3 periods × 5 replications = 60 samples.

Statistical analyses
Statistical analyses included: product-moment correlations, linear and multiple regression, conventional analyses of variance (1,10), and mean separation techniques described by Duncan (2).

RESULTS AND DISCUSSION

Phase I
Phase I was done primarily to obtain a comparison of prerigor and conventionally boned pork for traits related to appearance, taste and oxidative rancidity. Tenderness, juiciness and flavor did not differ (P>0.05) between P and C samples or among the three storage periods. Oxidative rancidity as measured by the TBA test did not differ due to storage time or between P and C chops. Although P and C samples sustained (P<0.05) degradation of color and overall appearance scores during storage, no consistent differences could be attributed to raw material (P or C pork). However, high color and appearance scores among some of the P samples and other results mentioned previously suggested that prerigor pork can be effectively incorporated in the manufacture of restructured pork. Thus, the second study (Phase II) was done to obtain additional data and to compare other processing variables. Since the effects of adjuncts such as NaCl and STP on restructured meats have been previously elucidated (4,9,10), further discussion in this paper will relate primarily to comparisons of restructured prerigor and postrigor chops.

Phase II
As illustrated in Fig. 1, unsalted restructured chops from prerigor pork (PU) received higher (P<0.05) scores from the rating panel after 5 and 14 d of storage than unsalted chops manufactured from conventionally boned pork (CU). After 42 d of storage, discoloration scores of PU and CU samples were not different (P>0.05), nor did scores for the CU samples differ (P>0.05) among the storage periods. The PU samples, at 14 and 42 d were not different (P>0.05) from each other but did have lower (P<0.05) scores than those stored for 5 d. While material (P and C pork) did not affect scores at 42-d storage of salted (PS and CS) restructured chops (Fig. 2), it did affect discoloration at 5 and 14 d when compared to the PU and CU counterparts. Although this observation cannot be explained, it is suggested that the increased color degradation among PS chops over the CS counterparts was related to pH. The pro-oxidative effect of salt appeared to be greater among the PS samples which are known to have a higher pH. The PS chops that were stored for 14 and 42 d were not different (P>0.05) from each other but had lower (P<0.05) scores than those stored for 5 d. The CS chops sustained color degradation (P<0.05) with each increase in storage time.

Figure 1. Effect of raw material and days of storage on discoloration scores of unsalted pork chops (8 = very bright; 1 = gray or green).

Figure 2 Effect of raw material and days of storage on discoloration scores of pork chops formulated with 2.0% NaCl and 0.25% STP (8 = very bright; 1 = gray or green).
Subjective evaluations for consumer desirability are not presented because these values closely paralleled subjective color scores. Although overall appearance scores of CU and PU chops did not differ consistently, CS chops scored higher (P<0.05) at 5 and 14 d than PS samples. Addition of NaCl and STP to P and C samples caused lower (P<0.05) overall appearance scores with increased storage time. Results from evaluation of color and overall desirability suggest that material did not consistently affect appearance of restructured chops but storage time was responsible for deterioration of appearance traits.

Tenderness scores (data not shown) for PU and CU samples did not differ (P>0.05) within or among days of storage. These subjective evaluations suggested that prerigor boning of pork did not affect tenderness of restructured chops. The effects of manufacturing material, adjuncts and storage time on juiciness as evaluated by the taste panel closely paralleled their effects on tenderness. Therefore, these data are not presented. Juiciness scores of prerigor pork were not different from those of conventionally boned pork nor were there differences (P<0.05) in juiciness scores among storage times.

A comparison of differences in oxidative rancidity as measured by the TBA test was done (data not shown). Data agree with the flavor scores and observations reported by Huffman et al. (4) and Schwartz and Mandigo (9,10) in that oxidative rancidity increased (P<0.05) with increased storage time. Flavor scores of PS and CS chops were higher (P<0.05) than those for PU and CU samples at 5 d and not different (P>0.05) at 14 and 42 d. Therefore, differences (P<0.05) in TBA values of PS and CS samples between 14 and 42 d suggest that TBA values were not always in agreement with subjective evaluations for flavor.

A prediction equation was developed to illustrate the effect of the different variables on TBA values. When adjuncts, days and their interaction were considered, the R^2 value was 0.7561 (P<0.01). Therefore, 75% of the variation in TBA values could be attributed to variation in the components of the model, i.e., adjuncts, days and their interaction. The highly significant prediction equation selected was:

\[ Y = b_0 + b_s \times s + b_d \times d + b_{sd} \times d \times s + e_{ijk}, \]

where \( b_0 \) is the y-intercept, \( b_s \) is the level of adjuncts, \( b_d \) is the number of days of storage, \( b_{sd} \) is the interaction effect for the particular combinations of \( s \) and \( d \), and \( e_{ijk} \) is the error.

**SUMMARY**

This study revealed that:

1. Color differences (measured objectively) were small (P>0.05) between prerigor and conventionally boned samples. Likewise, subjectively measured color did not differ (P>0.05) when samples were stored for 42 d.
2. NaCl and STP were detrimental to color of prerigor and conventionally boned samples that were evaluated both objectively and subjectively (P<0.05).
3. Tenderness did not differ (P>0.05) between prerigor and conventionally boned samples.
4. Chops treated with NaCl and STP were generally more (P<0.05) tender for both prerigor and conventionally boned samples than counterparts without these adjuncts.
5. Flavor scores of prerigor and control samples were not different (P>0.05).
6. Flavor (measured subjectively) of prerigor and conventionally boned samples was not generally affected (P>0.05) by NaCl and STP.
7. Generally, restructured chops manufactured from prerigor pork were not different from those manufactured from conventionally processed pork; therefore, prerigor

![Figure 3. Effect of raw material and days of storage on Hunter a-values (redness) of pork chops formulated with 2.0% NaCl and 0.25% STP.](image-url)