Effect of Deboning Time, Muscle Tensioning, and Calcium Chloride Marination on Texture Characteristics of Chicken Breast Meat

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ABSTRACT Tenderness is the most important organoleptic characteristic of meat, and various methods have been developed to improve it. The purpose of this experiment was to evaluate the effect of different conditioning treatments of broiler carcasses on pH, cooking losses, shear values, R-values, and sensory tenderness of breast meat. All measurements were collected for breast muscle as follows: after 24 h of carcass aging (T1); after 24 h of carcass aging with muscle tensioning (T2); after 24 h of carcass aging with muscle tensioning, followed by muscle collection and marination in CaCl2 (T3); after hot-boning 15 min following slaughter (T4); after hot-boning 15 min following slaughter and marination in CaCl2 (T5). pH values in meat treated with CaCl2 were significantly lower than those in untreated meat from the aged carcass group (T3) or the hot-boning group (T5). Breasts from carcasses aged for 24 h (T1, T2, and T3) showed lower cooking loss than breasts harvested immediately after slaughter (T4 and T5). CaCl2 marination produced meats with cooking losses significantly higher than those observed for untreated meats. Regardless of muscle tensioning or marination treatments, aging of the carcass for 24 h (T1, T2, and T3) produced meats with lower shear values than those from hot-boned carcasses (T4 and T5). Hot-boned breasts treated with CaCl2 (T5) were judged less tender by panelists than breasts aged under muscle tensioning (T2 and T3).

(Key words: chicken breast meat, tenderness, deboning time, calcium chloride)

INTRODUCTION

Marketing of chicken parts is one of the fastest growing segments of the food industry around the world. Special interest in this area is partially due to the convenience and nutritional value of cuts such as chicken breasts and thighs. Early collection of meat from carcass (hot-boning), however, has induced some preoccupation about texture and juiciness characteristics of filets and other breaded types of chicken portions. Toughness of cooked broiler breast meat continues to be a problem for processors, and postchill deboning time is the most significant factor on the ultimate texture of intact breast meat (Lyon et al., 1998). Because chilling is an important cost to the industry, several treatments have been proposed to minimize or reduce the toughness of chicken meat collected soon after slaughtering. Some methods have been developed to reduce broiler carcass toughness in the industry. Young et al. (1991) and Young and Lyon (1997) reported the infusion of meats in CaCl2 solution as a way to accelerate postmortem tenderization. According to these authors, treatment of early harvested breast meat with CaCl2 would reduce toughness due to the activation of muscle Ca-dependent proteases (calpains). Tensioning of the breast muscles through wing restraint has been proposed to improve the texture of broiler meat (Young et al., 1992; Janky et al., 1992; Cason et al., 1997; and Veeramuthu and Sams, 1999). Pulling the wings behind the back of the carcass and securing them causes a tensioning or stretching of the pectoralis major muscles. The result of this treatment is that less force is necessary to shear the cooked meat, and postmortem aging time may be reduced (Cason et al., 1997). Janky et al. (1992) observed that shear values for breast fillets harvested 1.25 h postmortem from muscle-tensioned carcasses were significantly lower than shear values of cooked fillets harvested at a similar time postmortem from conventionally handled broiler carcasses. The objective of this work was to study the effect of deboning time, carcass muscle tensioning, and CaCl2 marination on texture characteristics of chicken breast meat.

Abbreviation Key: ATP = adenosine triphosphate; T1 = carcass aging for 24 h at 0 C; T2 = carcass aging for 24 h with muscle tensioning at 0 C; T3 = carcass aging for 24 h with muscle tensioning at 0 C, followed by marination in CaCl2 solution; T4 = hot-boning breast collection (15 min after slaughter); T5 = hot-boning breast collection (15 min after slaughter) and marination in CaCl2 solution.
TABLE 1. Comparison of treatment means or grouped treatment means by orthogonal contrast analysis for pH, cooking losses, shear force, and R-values of broiler breast meat

<table>
<thead>
<tr>
<th>Variables</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Effect of deboning time</td>
<td>Effect of carcass wing restraint</td>
<td>Effect of CaCl₂ on muscle tensioning carcasses</td>
<td>Effect of CaCl₂ on hot deboned meat</td>
</tr>
<tr>
<td>pH (units)</td>
<td>NS</td>
<td>NS</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Cooking losses (%)</td>
<td>0.05</td>
<td>NS</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Shear force (kg f)</td>
<td>0.01</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>R-Value (units)</td>
<td>0.01</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

1T1 = 24-h carcass aging; T2 = 24-h carcass aging with muscle tensioning; T3 = 24-h carcass aging with muscle tensioning and CaCl₂ marination; T4 = hot-boning; and T5 = hot-boning and CaCl₂ marination.

2C1 = (T4 + T5) vs. (T1 + T2 + T3).

3C2 = (T1) vs. (T2 + T3).

4C3 = (T2) vs. (T3).

5C4 = (T4) vs. (T5).

MATERIALS AND METHODS

One hundred male Hi-y broilers, 47 d of age, were hung on metallic funnels and killed by bleeding for 90 s from a single cut that severed the carotid artery and jugular vein.

After bleeding, birds were scalded at 65 C for 45 s, defeathered in a rotary drum picker for 35 s, and manually eviscerated. Fifty birds were used to determine meat pH, cooking losses, and shear force. Meat R-value and sensory tenderness were determined with the other 50 birds. All analyses were made on breast meat that was subjected to one of the following treatments: T1, carcass aging for 24 h at 0 C before breast collection; T2, carcass aging with muscle tensioning for 24 h at 0 C before breast collection; T3, carcass aging with muscle tensioning for 24 h at 0 C, with breast collection followed by marination in CaCl₂ solution; T4, hot-boning breast collection (15 min after slaughter); or T5, hot-boning breast collection (15 min after slaughter) and marination in CaCl₂ solution.

Carcasses subjected to muscle tensioning (T2 and T3) were kept with the wings tied back to restrain the pectoralis major muscle. Breasts treated with CaCl₂ (T3 and T5) were submersed in 0.3 M CaCl₂ solution in individual plastic containers for 1 h. After collection, skinless breast samples were packaged in plastic bags and were kept on ice until analysis on the same day.

Meat pH was measured in the right breast by direct insertion of an electrode into the raw meat according to Young and Lyon (1997). pH values varied from 5.83 in meats from aged carcasses to 6.09 in hot-boned meat (Figure 1). Marination in CaCl₂ significantly decreased pH values of breasts collected from aged carcasses and from hot-boned birds (Table 1). Sensory evaluation of tenderness was conducted with cooked meat cubes (1.9 cm per side) (Lyon and Lyon, 1990). An ordination sensory test was conducted according to Stone and Sidell (1985).

RESULTS AND DISCUSSION

Meat pH

According to Young and Lyon (1997), after slaughter the pH of chicken meat rapidly decreases from values close to neutrality to pH 5.6 to 5.8 in 6 to 8 h. In this study, pH values varied from 5.83 in meats from aged carcasses to 6.09 in hot-boned meat (Figure 1). Marination in CaCl₂ significantly decreased pH values of breasts collected from aged carcasses and from hot-boned birds (Table 1). Sensory evaluation of tenderness was conducted with cooked meat cubes (1.9 cm per side) (Lyon and Lyon, 1990). Although Sams et al. (1990) reported that hot-boned fillets had significantly higher pH values than fillets separated after aging of a carcass, no effect of deboning time was observed in this study (Table 1). Also, muscle tensioning had no effect on pH of broiler breast meat.
Cooking Losses

Breasts from carcasses aged 24 h had lower cooking losses than breasts harvested immediately after slaughter (Table 1). Figure 2 shows that meats treated with CaCl₂ had greater cooking losses than untreated meats (Table 1). Young and Lyon (1997) have reported similar results. According to these authors, cooking losses are often ascribed to pH effects. Young et al. (1991) also observed higher cooking losses from fillets treated with divalent cations (such as CaCl₂) than from untreated fillets. Muscle tensioning had no effect on the broiler breast cooking losses.

Shear Values

Figure 3 shows that carcass aging for 24 h before breast collection produced meat with lower shear values than that from hot-boned carcasses (Table 1). These results agree with observations made by Sams et al. (1990). These authors found that hot-boned broiler breast fillets were significantly tougher (increased shear values) than chill-boned fillets. Papa and Lyon (1989) reported that for breast muscles removed from the skeleton prior to the depletion of adenosine triphosphate (ATP), the subsequent contraction would result in cooked meat that is tough. Muscle tensioning and CaCl₂ treatment, however, had no effect on chicken breast shear value. Janky et al. (1992) observed that carcass muscle tensioning resulted in a significant reduction in shear values of broiler breast meat. Young et al. (1991) reported that CaCl₂ marination of prerigor broiler fillets reduced the Warner-Bratzler shear value.

R-Value

The R-value corresponds to the ratio of the concentration of various adenine phosphatidyl compounds (ATP, adenosine diphosphate, adenosine monophosphate, and others) to that of a major breakdown product, inosine.
monophosphate, and serves as a good monitor of ATP depletion (Thompson et al., 1987; Sams et al., 1989). In the present study, R-values were higher in carcasses aged for 24 h than in hot-boned carcasses, probably reflecting a more extensive degradation of ATP (Figure 4). Muscle tensioning and CaCl2 treatment had no effect on R-values. Young and Lyon (1997), nonetheless, reported that CaCl2 treatment increased R-values, indicating that rigor mortis was hastened by calcium treatments.

**Sensory Tenderness**

Aged meats subjected to muscle tensioning (T2 and T3) were more tender than those collected immediately after slaughter (hot-boned) and treated with CaCl2 (T5), suggesting that muscle tensioning and boning time has important effect on the acceptance of cooked broiler meat (Figure 5). Lyon and Lyon (1990) reported that breasts deboned at 24 h postmortem had higher sensory responses for tenderness than breasts collected immediately after slaughter. CaCl2 treatment had no effect on improving meat tenderness. Morgan et al. (1991) observed that beef treated with CaCl2 had higher sensory responses than controls with no CaCl2 treatment.

**Conclusions**

Breasts collected after 24 h had lower shear values than breasts collected immediately after slaughter. Carcass muscle tensioning during the aging period improved sensory tenderness of broiler breast meat. Marination in CaCl2 decreased meat pH and increased cooking losses without affecting shear force. The results suggest that different times and temperatures should be further studied to assess the economic impact of this practice in tropical areas.

**REFERENCES**


