BROILER TENDERNESS: EFFECTS OF POSTCHILL DEBONING TIME AND FILLET HOLDING TIME

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Primary Audience: Quality Assurance Personnel, Researchers, Marketing

SUMMARY

The tremendous increase in volume of new products containing broiler breast meat has caused many processors to abbreviate the traditional postmortem aging period necessary to ensure ultimate tenderness in the cooked meat. Differences in the tenderness of broiler breast muscle were examined by varying the time prior to deboning breast muscle (0, 1, or 24 hours postchill) and by holding the deboned muscles at refrigerated temperature for various times prior to freezing (0, 12, or 24 hours). Removing breast muscles immediately postchill resulted in the toughest meat. Muscles left on the carcass for 1 hour postchill were less tough than the muscles removed immediately postchill, and the muscles removed after 24 hours were the most tender.

Key words: Postchill deboning time, broiler breast meat, texture


DESCRIPTION OF PROBLEM

An article published in 1954 [1] noted that generally there is sufficient time in chilling and transporting to allow for the normal resolution of rigor and subsequent development of tenderness in poultry muscles. The authors concluded that breast muscles became relatively tender within 24 hours. They also noted that tenderness of broiler breast meat was unaffected as long as ice-packed whole carcasses were the commodity being marketed. However, in the period from 1962 to 1988, the percentage of broilers sold as whole carcasses decreased from 83% to 21%, and the percentage of carcasses either cut-up and/or further processed increased significantly [2].

Various researchers have identified the pros and cons of cutting the carcass into parts or deboning the major muscle groups of the

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carcass without traditional postmortem aging. Nontraditional harvesting does not require whole carcass chilling prior to muscle removal, which saves both space and equipment costs [3]. It has also been reported [4, 5] that pre-rigor muscle binds more moisture and forms a stronger emulsion than postrigor muscle. However, cutting chicken breast muscle within 1 hour after slaughter, or removing the muscle prior to chilling, induces toughening which persists even after prolonged aging prior to cooking [6, 7, 8].

A study conducted in 1985 [9] under commercial processing conditions established that a minimum of 4 hours postchill prior to breast muscle removal was necessary to achieve tenderness in broiler meat. The authors also reported no statistical difference in tenderness for muscles removed 6, 8, or 24 hours postchill. The researchers used a Warner-Bratzler shear value of 7.5 kg to separate "tender" from "tough", based on their perceptions of tenderness. They noted that 95% of the shear values of the cooked meat from muscles deboned 6 hours postchill were less than 7.5 kg. Because this study [9] used only 2 panelists, both of whom were familiar with the treatments, and did not use a structured scale to rate the tenderness of the breast meat samples, we felt that a less biased study should be conducted to determine the effects of postchill deboning time and fillet holding time on the tenderness of broiler breast meat.

**MATERIALS AND METHODS**

All broilers were grown and processed under commercial conditions to ensure that any differences noted would be realistic on a commercial processing scale. Male and female broilers were processed on separate days of the week. The Peterson by Arbor Acre cross birds were 54 days old when processed. Carcasses were soft scalded at 129°C and chilled for approximately 40 minutes in an auger type chiller. Size and weight differences of breast muscles from male and female broilers have been reported [10], and those differences were

![Figure 1](image.png)

**FIGURE 1.** Tenderness expressed as Warner-Bratzler shear values (kg) for breast meat from male broilers deboned immediately postchill (0) or 1 hour postchill and held as fillets 0, 12, or 24 hours prior to freezing. The horizontal line through the graph represents the shear value for breast meat deboned 24 hours postchill (3.6 kg). Lower shear values correspond to more tender meat. Bars with different letters are significantly different (P < .05).
FIGURE 2. Tenderness expressed as Warner-Bratzler shear values (kg) for breast meat from female broilers deboned immediately postchill (0) or 1 hour postchill and held as fillets 0, 12, or 24 hours prior to freezing. The horizontal line through the graph represents the shear value for breast meat deboned 24 hours postchill (3.0 kg). Lower shear values correspond to more tender meat. Bars with different letters are significantly different (P < .05).

The combination of postchill deboning time and fillet holding time prior to freezing was used to determine if there was a detectable change in the pattern of rigor development due to either the time that the breast muscles were left on the frame, or to the time they were held as fillets prior to freezing. The contraction pattern of the broiler breast muscle removed prerigor compared to postrigor has been documented [13]. The 0 and 24 hours postchill deboning times represent extremes, while the 1 hour postchill treatment represents an alternative to deboning immediately after removal from the chiller. This 1 hour postchill treatment might be feasible on a commercial basis if a significant reduction in objective shear values (more tender meat) occurred due to the additional time that the muscles were attached to the skeletal frame. It was anticipated that increasing the fillet holding time prior to freezing would have no significant effect on tenderness.

The relationship of the shear values generated in this study to tenderness was determined by fitting the shear values on a regression line generated from previous research [14]. In that study, acceptable ranges of shear values were established by correlating the shear values to a panel's perception of tenderness. The panel used a category intensity scale ranging from "very tough" to "very tender" to rate breast samples that had been deboned at various postmortem times.

RESULTS AND DISCUSSION

RAW WEIGHTS AND COOKED YIELDS

There were no statistically significant differences in raw breast weight within each sex for any of the postchill deboning times or fillet holding times prior to freezing. The overall
FIGURE 3. Frequency distribution of shear values across sensory tenderness categories for commercially processed broiler breast meat deboned at 3 postchill times. The category intensity scale range was: 5 = "very tough", 4 = "moderately tough", 3 = "slightly tough to slightly tender", 2 = "moderately tender", and 1 = "very tender".
mean weight for breast muscles from male broilers was 163 grams or 5.7 ounces, and for breast muscles from females, 122 grams or 4.3 ounces. Cooked yield value ranges were small, and no effect due to the treatments was noted. Overall cooked yield values were 76.4% for the males and 76.8% for the females. The muscles were thawed prior to cooking in order to rebag and record the initial weight. Accordingly, there was a loss of fluids from the muscle due to thawing, resulting in a lower cooked yield.

TENDERNESS, OBJECTIVE TEXTURE VALUES

Tenderness values for the breast meat from male and female broilers are presented in Figures 1 and 2. The 0 hour postchill deboning time resulted in the toughest meat (highest shear values) noted in the study for both sexes. The mean shear force value for this postchill deboning time (averaged over fillet holding time) was 17.5 kg for the male samples and 15.9 kg for the female samples. The mean shear values for the 1 hour postchill group were 11.4 kg for the males and 9.8 kg for the females, both significantly lower than the 0 hour postchill samples. Leaving the breast muscles attached to skeletal restraints for 24 hours postchill resulted in the most tender meat. Shear values for this group were 3.6 kg for the males and 3.0 kg for the females. These values are noted in Figures 1 and 2 as horizontal lines through the graph.

Meat from female broilers was more tender than meat from male broilers for all treatments. There are conflicting reports [8, 15, 16] in the literature on the effect of sex of the bird on tenderness. The larger size and weight of male broilers probably contributed to the increase in force necessary to shear the samples from this sex. Another factor contributing to the difference in tenderness between male and female samples deboned at 0 and 1 hour postchill may have been increased contraction of the larger muscles from male broilers. The removal of intact broiler breast muscles from the skeletal restraints in the early postmortem period results in a loss of area and an accompanying increase in thickness [13]. The difference in tenderness between muscles from males and females deboned 24 hours postchill was small (3.6 kg vs 3.0 kg) because very little contraction would be expected for muscles removed from the carcass at that time. This difference between males and females was statistically significant, yet it is doubtful that a .6 kilogram difference is of practical importance.

The most important finding of the present study was that an increase in tenderness, or reduction in force required to shear the meat, resulted from a 1 hour postchill time prior to deboning. The decrease in shear values from 0 to 1 hour postchill time, averaged over fillet holding times, was 34% for males and 38% for females. These values compare favorably to a 30% reduction in Warner-Bratzler shear values reported [9] for commercially processed, mixed sex broilers that were treated in a fashion similar to those of the present study.

To determine the practical significance of the numerical decrease found in shear values, the objective results were superimposed on a tenderness scale established by a 24-member untrained sensory panel [14]. Frequency distribution of Warner-Bratzler shear values for male and female samples which correspond to the panel's perception of tenderness are shown in Figure 3. Since fillet holding time prior to freezing did not have a significant effect on tenderness, the data were combined into a single value for postchill time prior to deboning; percentage of the values corresponding to that portion of the tenderness scale are shown. Eighty-five percent of the muscles removed from female broilers immediately postchill (0 hour) were found to be moderately to very tough, categories 4 and 5. This percentage decreased to 43% if the muscles were removed from female broilers 1 hour postchill. The same pattern is evident for the muscles removed from male broilers. Muscles removed from male and female broilers 24 hours postchill were all in the moderately to very tender portion of the scale, categories 1 and 2.

CONCLUSIONS AND APPLICATIONS

1. Deboning the breast muscles from male and female broilers 1 hour postchill resulted in lower shear values compared to muscles deboned immediately postchill.
2. Superimposing the shear values on a sensory tenderness intensity scale indicated that the muscles deboned 1 hour postchill were less tough than muscles deboned immediately postchill.
3. Lengthening the fillet holding time prior to freezing had very little effect on tenderness of the cooked meat.
4. The large decrease in shear values between 0 and 1 hour postchill indicates that this time period is critical to the ultimate texture of broiler breast meat. While the meat deboned 1 hour postchill cannot be considered tender, there may be some physical and/or chemical treatment to further reduce the toughness in an abbreviated time which would lend the process to commercial operations.

**REFERENCES AND NOTES**


11. Both Pectenolidus major muscles were removed from the postchill carcasses by plant personnel utilizing a cone system. Carcasses assigned to the 0 postchill treatment were deboned within 5 minutes of chilling. Carcasses held for 1 or 24 hours prior to muscle removal were maintained at 2°C. Likewise, fillets held for 12 or 24 hours prior to freezing were maintained at 2°C. Muscles in the 0 fillet holding time were frozen immediately. After the Pectenolidus major were removed, they were placed in individual plastic bags, and identified by postchill holding time, and fillet holding time, and then frozen at -30°C. Frozen samples were thawed for approximately 20 hours at 2°C, removed from the bags and weighed. Any adhering fat or skin was removed prior to weighing. The individual muscle was then sealed in a boilable bag and cooked in 85°C water for 30 minutes. This time and temperature combination resulted in a minimum internal temperature of 80°C. After cooking, the bag was opened, fluid removed, and the sample reweighed. Cooked yield was determined for each sample. For objective texture evaluation, two 1.9 cm wide strips were removed from each sample and evaluated with a Warner-Bratzler shear apparatus. For a detailed description of the Warner-Bratzler procedure, see Reference 14. Five carcasses were used to provide 10 breast samples per fillet holding time prior to freezing. This resulted in 15 carcasses per postchill time prior to deboning per replication. The study was replicated 3 times for each sex. Each of the strips was sheared twice, for a total of 4 shear values per breast. These values were averaged for statistical analysis, resulting in a total of 30 observations per replication, or a total of 90 observations.

12. The data were analyzed using the General Linear Model Procedure of SAS (1987). The interaction of replication by treatment (postchill deboning time and fillet holding time prior to freezing) was used as the error term to test the main effects of replication and postchill deboning time and fillet holding time. When differences were noted, they were separated using Duncan's multiple range test. Significance implies P < .05. For frequency distribution, the fillet holding times were combined, and the data grouped by postchill time prior to deboning.


