EFFECTS OF MARINATION HOLDING TIME AND TEMPERATURE ON CHICKEN BREAST HALVES

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Story in Brief

Fresh broiler chicken breast halves were skinned, deboned and trimmed of fat and tenders. Breast halves (n=144) were divided into 3 replications. These were assigned to marination temperature treatments of -4, 0, and 4°C. Breast halves and 25% marination solution (96.24% H_2O, 2.0% NaCl, and 1.76% PO_4) were equilibrated and then vacuum tumbled (20 min). After tumbling, breast halves were assigned to marination holding times (0, 4, 8, 12 hours). After the appropriate holding times, breast halves were cooked in an impingement oven at 218°C to an end point temperature of 71°C. Cooked breast halves were crusted with CO_2 snow and frozen in a -17°C freezer until further analysis. Marination times (0, 4, 8, 12 hours) did not affect ($P>0.05$) proximate composition, chloride concentration or Kramer Shear tenderness results. Marination temperatures did not effect ($P>0.05$) cook yield or marinade pickup. The -4°C temperature treatment had lower proximate moisture analyses, chloride concentration, and higher shear force values ($P<0.05$). Marination temperatures of 0 and 4°C were not different ($P>0.05$) for proximate composition, chloride concentration or Kramer Shear tenderness values. In conclusion, this study indicates that length of the marination holding time from 0 to 12 hours does not effect yield, proximate composition, chloride concentration or tenderness. However, marinating chicken breast halves at temperatures below 0°C may have a detrimental effect on product quality.

(Key Words: Chicken Breast, Marination, Yield, Tenderness)

Introduction

The quality of cooked meats, such as chicken, are primarily judged by tenderness (Bratzler et al., 1978). Marinating has long been recognized as a

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practical method used to enhance tenderness and flavor. Extensive research has been conducted on the effects of marination on beef (Wenham and Locker, 1976; Harrel et al., 1978; Gualt, 1985), however very little research has been conducted to study the effects of marination on chicken. Jankey et al. (1976) reported that the use of salt marinades prior to smoking cornish game hens significantly lowered shear values for both light and dark meats. Oblinger et al. (1976) also reported that broilers soaked in a salt marinade had lower shear values than broilers that were unmarinated. As the market for ready to cook marinated chicken products expands, so must a manufactures' understanding of marinades on product quality. The temperature and length of marination can have a substantial financial impact on a company's fixed cost overhead if coolers are kept at unnecessarily low temperatures and are occupied by marination tanks longer than necessary. Optimizing marination times and temperatures, which may increase yields and tenderness, should result in greater profits and increased customer satisfaction. The objective of this study was to determine the effects of marination holding time and temperature on chicken breast tenderness, chloride concentration, proximate composition, and cook yields.

Materials and Methods

Rock Cornish cross chickens (8 weeks old) were slaughtered on two different days and primary processed within 24 hours at the OSU poultry facility. Whole chickens were cut up and boned using a procedure recommended by the National Broiler Council. Fresh broiler breast halves were skinned, deboned, trimmed of fat and the tenders removed. Each replication (n=3) was processed on different days. Four day postslaughter breast halves were randomly assigned and equilibrated (24 hours) to each of the three treatment temperatures (-4, 0, 4°C). The marinade (96.24% H_2O, 2.0% NaCl, 1.76% PO_4) was also equilibrated to each of the 3 treatment temperatures. Breast halves (n=16), for each temperature treatment, were weighed and a 25% weight/volume marinade solution was added to a tumbler (Globus VMS-37-526), vacuumized (one minute) and tumbled (20 minutes). Immediately after tumbling, the breast halves were removed and randomly subdivided into marination holding times of 0, 4, 8, 12 hours and held at the appropriate temperature (-4, 0, 4°C).

All breast halves were cooked in an impingement oven (Lincoln) at 218°C until an internal end point temperature of 71°C was reached. Internal end point temperatures were recorded using copper constantan thermacouples placed in the geometric center of the thickest part of each breast half. Each thermacouple was interfaced with a data logger (Omega OM 5000). Cooked breast halves were crusted with CO_2 snow using a CO_2 snow horn and subsequently frozen

in a -17°C freezer until further analysis.

To determine percentage cook yields, marinade lost during holding times, and marinade pickup, all breast halves were weighed unmarinated, after marination and tumbling, after each marination holding time, and after cooking. Cook yields were determined by dividing the cook weight of four breast halves (for each temperature time combination) by their weight after marination and expressing the result as a percent. Marination lost was calculated by subtracting the weight of the breast halves after marination and holding from the weight of breast halves after tumbling and dividing by the breast halve weight after tumbling and expressing the result as a percent. Marinade pickup was calculated by dividing the total weight of breast halves (16-breast halves in the temperature replication only) immediately after tumbling by the total weight of breast halves before tumbling (unmarinated) and expressing the result as a percent.

For tenderness evaluation, two of the cooked breast halves for each temperature time combination were randomly selected and allowed to thaw (25°C). Two 3.5 cm^2 sections were removed from each breast half, and compressed (load cell 10kN) using a Kramer Shear apparatus attached to an Instron Universal Testing Machine (Model 4502) set at a crosshead speed of 500.0 mm/min. Remaining breast halves were frozen for analysis using liquid nitrogen and pulverized using a blender (Waring). Chloride ion concentration was determined using Orion Procedure Number 204 and a Orion Model 901 micro-processor ionalyzer, Orion Model 94-17 chloride ion-selective electrode, and Orion Model 90-02 double-junction reference electrode. Proximate analysis for fat (ether extract), moisture (oven drying) and protein (Kjeldal) were conducted using AOAC procedures.

Data was analyzed using Analysis of Variance procedures (SAS Institute, Inc., Version 6.0) and means were separated using least significant differences.

Results and Discussion

There was not a significant effect ($P>0.05$) due to marination holding time on yields, marinade lost, marinade pickup, chloride concentration, proximate composition, or tenderness. There was no marination holding time temperature interaction for any of the test parameters.

Table 1 shows the effect of temperature on cook yields, marination lost, and marinade pickup. Cook yields, marinade lost, and marinade pickup were not effected ($P>0.05$) by temperature. Although marinade pickup and cook yields were not statistically significant, their results are pertinent to food manufacturers who often measure production efficiency by yields. By knowing that the temperature and marination holding times used in this study do not

Table 1. The effects of marination temperature on cook yield, marination lost, and actual pickup of marinade.

Temperature (°F)	Cook Yield (%)	Marination Lost (%)	Actual Pickup (%)
	Mean	Mean	Mean
24.8	67.7[b]	3.40[b]	14.8[b]
32.0	69.6[b]	1.90[b]	16.0[b]
39.2	69.6[b]	1.77[b]	24.9[b]
SE	.76	.35	4.58

SE= Standard error
[b] Means followed by a common superscript are not different (P>0.05)

Table 2. The effects of marination temperature on chloride concentration and proximate composition.

Temperature (°F)	Chloride	Moisture	Fat	Protein
	Mean	Mean	Mean	Mean
24.8	.493[b]	67.8[b]	.84[b]	30.1[b]
32.0	.690[c]	70.6[c]	.75[c]	27.1[c]
39.2	.717[c]	70.4[c]	.70[c]	27.9[c]
SE	.015	.236	.027	.276

SE= Standard error
[bc] Means followed by a common superscript are not different (P>0.05)

effect yields, manufacturers will be able to look at other processes for improvement.

The 0 and 4°C temperature treatments were not different (P>0.05) for proximate composition or chloride analysis (Table 2). However, the -4°C temperature treatment had (P<0.05) lower chloride and moisture contents and higher fat and protein than the other treatments. The numerically lower marinade pickup value (Table 1) at -4°C may have negatively impacted NaCl concentrations by decreasing the amount of marinade, and ultimately NaCl, available on the breast halves. The low NaCl concentrations, may also be indicative of the lack of marinnnade obsorption at the low temperatures. However, as actual marinade pickup was not different, the marinade may have been on the exterior of the product and subsequently lost in cooking. A lower NaCl concentration, in turn, would result in lowering the amount of moisture. Fat and protein values are relative percentages in proximate analysis and therefore would increase as moisture values decrease.

Table 3 shows the effects of temperature on Kramer Shear tenderness results. The -4°C temperature treatment did adversely effect Kramer Shear values. The -4°C treatment required greater (P<0.05) energy and force to shear than did the 0 and 4°C treatments. This may be due to the lower NaCl concentration and the inability of NaCl to bind with the breast meat and increase the water holding capacity, thus decreasing shear values. The 0 and 4°C temperature treatments were not different for the Kramer Shear values, indicating that temperatures in this range do not adversely effect the product.

Table 3. The effects of marination temperature on Kramer Shear tenderness results.

Temperature (°F)	Stress	Load (kN)
	Mean	Mean
24.8	1.51[b]	1.42[b]
32.0	1.14[c]	.829[c]
39.2	1.11[c]	.859[c]
SE	.83	.050

kN= 1000N
SE= Standard error
[bc] Means followed by a common superscript are not different (P>0.05)

Implications

Tenderness is a quality that can be impacted by chloride concentration (Jankey et al. 1976) and proximate composition. Marinating chicken breast halves at temperatures at -4°C will have an adverse effect on product quality by decreasing chloride concentration, altering proximate composition, and increasing shear force values. A particularly significant finding was that marination holding times did not effect yields, marinade pickup, chloride concentration, proximate composition, or shear force values. Therefore, manufacturers can increase profit margins by eliminating costly marination holding times. Continued research utilizing increased marination temperatures should be undertaken to study the effect on these and other test parameters.

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