BREAST TRIM LOCATION EFFECTS ON PINK DISCOLORATION IN COOKED, PRESALTED, GROUND TURKEY

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***Abstract*—Breast trim location (anterior, posterior, dorsal, and ventral) was studied relative to the formation of a pink color defect in uncured, cooked (76.7 °C), ground, salted (2%) turkey. In raw unprocessed ground turkey breast trim, no differences ($p > 0.05$) in nitrite content, CIE *a** value, nitrosyl hemochrome (rNIT, reflectance), and nicotinamide hemochrome (rNIC, reflectance) were found among different trim locations. Raw unprocessed meat from the anterior location had the highest ($p < 0.05$) pH and myoglobin content. The lowest ($p < 0.05$) pH was found in the posterior trim. When salted and ground turkey samples were cooked, no differences ($p > 0.05$) in nitrite content, percentage myoglobin denaturation, CIE *a** value, nitrosyl hemochrome (chemical extraction), total pigment, rNIT, and rNIC were found among the different trim locations. However, processed products made from posterior collected breast trim had lower ($p < 0.05$) cooking yield, pH, and oxidation-reduction potential compared to the others. This study demonstrates that anatomical location of breast trim does not appear to play a significant role in the generation of a pink defect.**

***Index Terms*—Ground turkey breast, NaCl, Pink color defect, Trim location.**

I. INTRODUCTION

In fully cooked poultry items, the presence of a pink or undercooked appearance is a major concern. This problem, while not a food safety issue, does present a quality issue as well as an economic concern to the processor (Friesen & Marcy, 2000). Much is known about the factors affecting the formation of the pink color defect (Ahn & Maurer, 1990; Claus, Shaw & Marcy, 1994; Cornforth, Vahabzadeh, Carpenter & Bartholomew, 1986) and some success has been reported in limiting the degree of pink through the use of non-meat ingredients (Sammel & Claus, 2003, 2007; Schwarz, Claus, Wang, Marriott, Graham & Fernandes, 1999). However, no information on the potential development of pink discoloration associated with breast trim locations has been reported. The industry often needs to remove lean trim from larger breasts to accommodate meeting a product weight specification. The lean trim is valuable for manufacturing further processed meat if it is not prone to creating a pink color defect. Certain trim locations (anterior, posterior, dorsal, and ventral) may cause pink discoloration in turkey products because there are likely differences in not only the pH but also other biochemical properties (redox form, native state of pigment) as affected by differential temperature exposure during harvest (defeathering, chilling). So far, limited research has been conducted exploring processing factors in poultry meat products. Thus the objective of this study was to investigate the difference in cooked color and pigment characteristics associated with turkey breast trim locations in presalted and stored ground turkey.

II. MATERIALS AND METHODS

A. Raw material preparation and processing

Fresh, skinless, boneless turkey breasts (1 day postmortem) were obtained from Jennie-O Turkey Store. Raw material was overnight shipped and refrigerated (2-3 °C) until used. To minimize variation, about 18 birds (one breast per bird) per replication were used. The processing procedure of the tested conditions from a previous research that produced the most intense and consistent pink color defect was used. Each turkey breast muscle was sampled in four locations (anterior, posterior, dorsal, and ventral) by removing approximately the same weight (60 - 80 g) from each region. Trim was kept separate by location and coarsely ground (0.95-cm plate; Model S4142, Hobart Corporation, Troy, OH). Coarse ground turkey was ground finely (0.32-cm plate) and ground meat (1 kg) was mixed (Model Max Watts 300, Kitchen Aid Inc., St Joseph, MI) with 2% sodium chloride for 5 min and then vacuum-packaged (Item # 75001875, Prime Source Vacuum Pouches, KOCH Supplies Inc., Kansas City, MO; Model EASY-PACK, Koch Supplies Inc., Kansas city, MO) at 9 vacuum dial setting. The salted meat was stored for 6 days under refrigerated temperature (2-3 °C) as a previous experiment demonstrated that storing salted preground turkey increased the incidence of the pink

discoloration in cooked turkey. Ground turkey breast from each location was stuffed into conical centrifuge tubes (50 g each). The tubes were centrifuged at 2000 × g for 10 min (Model J-6M, Beckman Instruments Inc., Palo Alto, CA) to remove air pockets. The tubes were stored overnight (2-3 °C) and cooked to internal endpoint temperature of 76.7 °C in a 90 °C water bath (Isotemp 228; Fisher Scientific, Pittsburgh, Pa., U.S.A.). The temperature was monitored by randomly placing five thermocouples attached to a 12-channel thermocouple scanner (Model #92000-00; Cole Parmer Instrument, Barrington, IL) in the center of extra samples throughout the water bath. Once cooked, the tubes were immediately cooled (20 min) in ice and stored (2-3 °C) overnight in the dark before analysis.

B. Analysis

Instrumental color and pigment determination. Immediately following grinding, raw ground turkey from each location was placed on white polystyrene trays (80 × 80 × 25 mm, Item No.:80055T, Fisher Scientific Co., Hanover Park, IL) and overwrapped with an oxygen permeable polyvinyl chloride (PVC) film. Overwrapped ground meat was allowed to bloom for 40 min (oxygenate) before color determinations were made. The colorimeter and reflectance were standardized against a white calibration plate (CIE L^* 97.06, a^* -0.14, b^* +1.93) through the corresponding package film. The color of the surface of ground turkey sample was measured on each package using a colorimeter (Model CR 310, Minolta Camera Co., Ltd., Osaka, Japan; 8 mm aperture, illuminant C). For cooked turkey breast, CIE $L^*a^*b^*$ values were measured on freshly cut surfaces of each product samples. An ultraviolet/visible scanning spectrophotometer (model UV-2401PC; Shimadzu. Corp., Kyoto, Japan) was used to collect percentage reflectance at individual wavelengths. Nitrosyl hemochrome (rNIT) was estimated using the percentage reflectance ratio, % reflectance at 650 nm divided by the percentage reflectance at 570 nm where a higher value indicated more pigment (AMSA, 1991) and nicotinamide hemochrome (rNIC) was estimated by the percentage reflectance at 537 nm divided by the percentage reflectance at 553 nm where a higher value equaled more pigment (Schwarz, Claus, Wang, Marriott, & Graham, 1998).

Cooking yield, pH and oxidation-reduction potential (ORP) determination. Cooking yield was calculated as: [cooked sample weight/raw sample weight] × 100. A pH electrode (910600; Thermo Orion, Beverly, Mass., U.S.A.) attached to a pH meter (Accumet AR50, Fisher Scientific, Pittsburgh, PA) was used to measure pH on a 10 g raw meat or cooked turkey samples homogenized in 50 ml of distilled, deionized water. Oxidation-reduction potential (ORP) was measured on cooked turkey products as a modification of John, Cornforth, Carpenter, Sorheim, Pettee and Whittier (2005) and Cornforth et al. (1986). Turkey meat products (10 g) with 20 ml 0.1 M sodium carbonate were homogenized and the ORP values were determined after 3 min of stabilization using a platinum Ag/AgCl combination electrode (No. 13-620-81, Fisher Scientific Co., Houston, TX) attached to the pH meter set to the milli-volt scale.

Myoglobin contents and percentage denatured myoglobin (PMD) determination. Myoglobin (Mb, undenatured) was extracted from raw meat, uncooked or cooked turkey breast using a procedure by Warriss (1979) and Trout (1989). Total myoglobin (Mb) and PMD were calculated using the following formulas (Trout, 1989): Mb (mg/g) = (A525 – A700) × 2.303 × dilution factor, PMD = [1- (Mb concentration after heating/Mb concentration before heating)] × 100.

Nitrite, nitrosyl hemochrome, and total pigment analysis. Residual nitrite content was determined on raw and cooked samples by the method of AOAC (2002). Nitrosyl hemochrome and total pigment concentration was measured after extraction in 80% acetone or acidified acetone (Hornsey, 1956). Nitrosyl hemochrome concentration (ppm) was determined by absorbance at 540 nm times 290. Total pigment concentration (ppm) was determined by absorbance at 640 nm times 680.

Statistical analysis. The experiment was replicated four times. Data were analyzed as a completely randomized block design using Proc Mixed procedure of SAS Institute (2002). Dependent variable means were separated ($p < 0.05$) by pairwise comparisons using the pdiff option of SAS.

III. RESULTS AND DISCUSSION

Effects of different trim locations on pH, residual nitrite, CIE a^*, and pigments in raw ground turkey breasts are shown in Table 1. Raw meat from anterior had the highest ($p < 0.05$) pH values and whereas the pH from the posterior region had the lowest ($p < 0.05$) values. Residual nitrite in raw ground turkey breasts used ranged 0.03-0.05 ppm and was not affected ($p > 0.05$) by trim locations. A similar finding was reported by Ahn and Maurer (1987), who observed concentrations of nitrite in raw turkey breast meat ranging from 0 to 0.7 ppm. Myoglobin content of raw ground turkey breasts in the anterior locations was higher ($p < 0.05$) than other trim locations which were all similar ($p > 0.05$) to one another. Trim location did not affect ($p > 0.05$) CIE a^* values, rNIT, and rNIT in raw ground turkey breasts.

When presalted and stored ground turkey breasts were cooked, the anterior, dorsal, and ventral locations had similar ($p > 0.05$) cooking yield but were higher ($p < 0.05$) than the posterior location (Table 2). The pH values of the cooked products were higher by approximately 0.25 units compared to raw meat due to cooking and the lowest values were observed ($p < 0.05$) in posterior location (Table 2). In the cooked turkey, pH values were the lowest ($p < 0.05$) in the posterior location (Table 2) as previously noted in raw samples. Cooked products from the anterior location had the highest ($p < 0.05$) pH values. The oxidation reduction potential (ORP) is an important factor to generate pink color formation and the high reducing conditions allow greater reactivity of pigments with certain pink generating molecules (Cornforth et al., 1986; Holownia, Chinnan & Reynolds, 2004). In our study, products made from the posterior location had more reducing condition (lowest ORP; $p < 0.05$) compared to those made from other trim locations (Table 2). However, there were no differences ($p > 0.05$) in ORP among samples from anterior, dorsal, and ventral locations. Although nitrite, in this study, was not intentionally added in to raw ground meat during processing, inherent residual nitrites were observed ranging from 0.34 to 0.40 ppm in the cooked products. However, the nitrite level was not affected ($p > 0.05$) by trim location (Table 2). The presence of nitrite could have been caused by the microbial conversion of nitrate to nitrite during storing as reported by Ahn and Maurer (1987). However, the amount of residual nitrite observed in our present study was less than 1 ppm shown to cause a pink color in turkey product (Ahn & Maurer, 1987). Nevertheless, CIE a^* values of cooked ground turkey products ranged from 6.10 to 6.50, although not significant by trim location, were relatively high (Table 3) and were indicative of turkey with visible pink. The development of this level of pink supported our preliminary results (unpublished data) that a pink color can be present from presalted and stored ground turkey. Myoglobin contents were greater ($p < 0.05$) in turkey products from anterior and ventral than from posterior and dorsal (Table 3). However, percentage myoglobin denaturation did not differ ($p > 0.05$) among the four locations. However, about 13.3% undenatured myoglobin still remained after cooking (Table 3). Trim location did not result in significant differences in nitrosyl hemochrome and total pigments of cooked turkey products (Table 3). From reflectance data, the rNIT and rNIC in cooked turkey samples were not influenced ($p > 0.05$) by trim location (Table 3).

IV. CONCLUSION

This study was conducted to investigate potential differences in cooked color (pink discoloration) and pigment characteristics associated with turkey breast trim locations. Minor differences in pH and myoglobin of raw turkey meat were found associated with the anterior location as well as limited effects on pH and ORP in processed products were found from the posterior location. None of the other parameters related to color and pigment properties demonstrated a practical effect on generating a pink defect in cooked turkey relative to breast trim location. Therefore, there is no need for processors to exclude trim from particular breast trim location in the manufacture of uncured cooked turkey products.

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Table 1. Effects of different trim locations on pH, residual nitrite, CIE *a**, and pigments in raw ground turkey breasts

Trim locations[2]	Dependent Variables[1]					
	pH	Nitrite (ppm)	Myoglobin (mg/g)	CIE *a**	rNIT	rNIC
Anterior	5.88[a]	0.04	0.73[a]	5.08	1.655	1.115
Posterior	5.74[c]	0.04	0.68[b]	5.24	1.669	1.100
Dorsal	5.79[b]	0.03	0.66[b]	4.81	1.653	1.110
Ventral	5.82[b]	0.05	0.68[b]	5.11	1.674	1.104
(S.E)	(0.03)	(0.01)	(0.02)	(0.26)	(0.026)	(0.015)

[1] Dependent variables: Myoglobin (amount of undenatured myoglobin), CIE *a** (redness), rNIT (reflectance estimator of nitrosyl hemochrome, %*R*650nm/%*R*570nm), rNIC (reflectance estimator of nicotinamide hemochrome, %*R*537nm/%*R*553nm).
[2] Trim locations: Trim was collected, ground according to four anatomical locations (anterior, posterior, dorsal, and ventral) and tested before further processing.
[a-c] Means within a column with unlike superscript letters are different ($p < 0.05$).

Table 2. Effects of different trim locations on cooking yield, pH, residual nitrite, ORP, and residual nitrite in cooked ground turkey products

Trim locations[2]	Dependent Variables[1]			
	Cooking Yield (%)	pH	ORP (mV)	Nitrite (ppm)
Anterior	97.3[a]	6.10[a]	-37.24[b]	0.38
Posterior	96.5[b]	6.01[c]	-39.30[a]	0.40
Dorsal	97.6[a]	6.05[b]	-36.91[b]	0.34
Ventral	97.4[a]	6.06[b]	-36.68[b]	0.38
(S.E)	(0.27)	(0.02)	(3.53)	(0.03)

[1] Dependent variables: ORP (oxidation-reduction potential).
[2] Trim locations: Trim was collected, ground according to four anatomical locations (anterior, posterior, dorsal, and ventral), mixed with NaCl (2%), and stored (7 days, 2 °C) before being cooked.
[a-c] Means within a column with unlike superscript letters are different ($p < 0.05$).

Table 3. Effects of different trim locations on color and pigment properties in cooked ground turkey products

Trim locations[2]	Dependent Variables[1]						
	CIE *a**	Myoglobin (mg/g)	PMD (%)	Nitrosyl hemochrome (ppm)	Total pigments (ppm)	rNIT	rNIC
Anterior	6.37	0.15[a]	86.2	0.44	19.00	1.302	1.056
Posterior	6.10	0.13[b]	86.9	0.48	17.76	1.285	1.059
Dorsal	6.17	0.11[b]	88.6	0.56	18.37	1.288	1.064
Ventral	6.50	0.15[a]	85.3	0.50	19.33	1.295	1.066
(S.E)	(0.28)	(0.01)	(1.1)	(0.06)	(0.93)	(0.009)	(0.003)

[1] Dependent variables: CIE *a** (higher value more red), myoglobin (amount of undenatured myoglobin), PMD (Percentage myoglobin denaturation), rNIT (reflectance estimator of nitrosyl hemochrome, %*R*650nm/%*R*570nm, higher ratio more), rNIC (reflectance estimator of nicotinamide hemochrome, %*R*537nm/%*R*553nm, higher ratio more).
[2] Trim locations: Trim was collected, ground according to four anatomical locations (anterior, posterior, dorsal, and ventral), mixed with NaCl (2%), and stored (7 days, 2 °C) before being cooked.
[a,b] Means within a column with unlike superscript letters are different ($p < 0.05$).