TENDERIZING NON-AGED BROILER BREASTS THROUGH HYDRODYNAMIC SHOCK WAVES

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BACKGROUND

Broiler processing involves a time consuming and costly (as evidenced by required storage space, equipment, purge loss and labor costs) aging step for breast muscle in order to produce an acceptably tender product. The industry currently ages the breast muscles intact on the carcass for 4-7 hours prior to deboning. Early deboning of non-aged breasts (immediately after the initial chill) results in a less tender product (Papa and Fletcher, 1988). The Hydrodyne Process, a unique technology that utilizes a hydrodynamic shock wave to tenderize meat, provides processors a potential approach to early deboned non-aged breasts without sacrificing product quality (Solomon *et al.*, 1997a,b). Meat is immersed in water and a small amount of high explosive, suspended in the water, is detonated to create the shock wave. In a fraction of a millisecond, the shock wave passes through the water and objects that are a mechanical impedance match to the water. Muscle cellular components are ruptured instantaneously, thus increasing tenderness.

OBJECTIVES

The objectives of this research were to determine the effects of hydrodynamic shock wave treatment on non-aged breast tenderness compared to that of traditionally aged counterparts. Furthermore, this study was designed to determine the quality and sensory characteristics of these treated samples.

METHODS

Objective Evaluations

Poultry aging refers to a conditioning process which allows the breast muscle to set up into rigor mortis prior to deboning. Treatments involved fresh boneless, skinless chicken breasts (*Pectoralis superficialis*) and consisted of: control aged breasts (AG); non-aged breasts (NA, boned immediately after initial chilling); and three hydrodynamic shock wave treatments applied to non-aged breasts. The three shock wave treatments were: Shock wave treated breasts vacuum packaged in 35 x 37.5 cm Cryovac™ Primal Bone-guard bags and positioned on the bottom of a stainless steel 1060 L capacity Hydrodyne tank supported by 8 rubber gasket lined mounting braces, 8 (HNA8) or 12 inches (HNA12) from the explosive; and shock wave treated breasts packaged in a heavy duty rubber bag, suspended in the water, 8 inches lateral to the explosive (HNAS). A certified explosive expert performed the explosive handling and detonation in a commercial pilot plant facility.

Broiler breasts were obtained from a commercial poultry processor 24 hours prior to shock wave treatment. All shock wave treatments utilized 200 g of explosive. Non-aged broiler breasts were divided into two lobes with one lobe receiving a shock wave treatment and the other serving as a non-shock wave treated, non-aged reference.

Breasts were cooked to an internal temperature of 77°C in an in-house manufactured circulating water bath preheated and maintained at this temperature. Breast strips (1.5-cm wide) were analyzed for Warner-Bratzler (WB) peak force (kg) and Lee-Kramer (LK) shear values (total energy) for all treatments. One strip was sheared perpendicular to the muscle fibers using a WB shear attachment mounted on the Instron. A 50 kg load transducer with a crosshead speed of 200 mm/minute was used. The strip was sheared three times with an average calculated. The second strip was sheared with the LK shear attachment mounted on the Instron. To determine the total energy (kg*mm), a 500 kg load transducer and a crossload speed of 200 mm/minute was used.

Sensory Testing

Early deboned broiler breasts were treated with the Hydrodyne process in two treatment groups: 150 g of explosive at 30.5 cm and 200 g of explosive at 20.3 cm. The breasts were cooked on a portable electric grill for about 20 minutes and an internal temperature of 77°C. The breasts were trimmed of outer edges and cut into 1.5-cm strips. An informal/untrained sensory test was performed to determine if a distinct difference in tenderness between early deboned and aged control breasts existed.

RESULTS AND DISCUSSION

The NA breasts had higher ($P<0.001$) WB peak force (5.41 kg) and LK total energy (72.3 kg*mm) than the AG breasts (WB 1.47 kg; LK 35.9 kg*mm) (Table 1). The HNA8 breasts (WB 2.92 kg) were 46% more tender ($P<0.001$) than the NA counterparts (WB 5.41 kg). The HNA8 breast samples were as tender ($P<0.01$) according to WB peak force as the AG breasts. The LK data followed a similar pattern (25% reduction, $P<0.01$, for HNA8 compared to NA). The HNAS breasts exhibited a 34% reduction ($P<0.01$) in WB and a 14% reduction in LK shear force compared to the NA counterparts. The lesser improvement in tenderness of the HNAS treatment demonstrated the importance of the location of the breasts in relationship to the explosive. The HNAS breasts were less tender ($P<0.001$) than the AG breast in WB and LK measurements. The HNA12 treatment did not reduce ($P>0.05$) WB or LK shear forces compared to the NA counterparts suggesting that this increased distance of explosive decreased the effectiveness of the shock wave treatment.

The early deboned, non-treated samples were described as rubbery and chewy. Companion treated samples for both levels of explosive were considered improved. The tenderness of the 200 g of explosive at 20.3 cm was described as easier to chew when compared to the other treatment group. The aged control samples were definitely the most tender and juicy of the samples tested. Early deboned breasts were less tender and more chewy than the aged control samples. The hydrodynamic shock wave treated samples were perceived as more tender than their counterparts, but there was not a distinct sensory response based on treatment level.

CONCLUSIONS

This tenderizing process generally resulted in an improvement in tenderness of non-aged breasts. However, distance to explosive and breast location affected tenderness improvement. Early on deboned breasts with unacceptable tenderness can be tenderized by hydrodynamic shock waves based on instrumental shear results. However, a higher level of explosive may be required to optimize tenderness improvement. Incorporating this technology, once optimized, on an industry production level will benefit the meat industry through the reduction of aging time.

An untrained panel can determine a distinct difference in tenderness between early deboned and aged controls. Hydrodynamic shock wave treatment improved the sensory response of tenderness of early deboned broiler breasts.

This project is part of the ongoing research with the Hydrodyne process. These studies will continue to include research with the hydrodynamic shock wave process by varying explosive level and location to determined more optimum conditions. Additionally, minolta color values, spectrophotometric color, cooking loss, purge loss, sarcomere length, and sensory tenderness, texture and flavor or untreated breasts will be evaluated.

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Table 1 – Warner-Bratzler and Lee-Kramer shear values for Hydrodyned non-aged broiler breasts, companion non-aged (no treatment) breasts, and aged (control) breasts

	Warner- Bratzler		Lee-Kramer	
Treatment[d]	Peak force (kg)	Total energy (kg*mm)	Peak force (kg)	Total energy (kg*mm)
GROUP 1				
AG (n=10)	1.47^{b} (0.53)	22.56^{c} (9.58)	2.20^{b} (0.43)	35.91^{c} (5.17)
NA (n=9)	5.41^{a} (0.59)	98.34^{a} (10.59)	5.69^{a} (0.48)	72.50^{a} (5.72)
HNA8 (n=9, WB) (n=8, LK)	2.92^{b} (0.59)	65.57^{b} (10.59)	3.59^{b} (0.52)	54.38^{b} (6.18)
P value	0.0005	0.0003	0.0003	0.001
GROUP 2				
AG (n=10)	1.47^{c} (0.61)	22.56^{b} (8.88)	2.20^{c} (0.36)	35.91^{c} (2.92)
NA (n=8)	6.27^{a} (0.75)	110.10^{a} (10.87)	7.03^{a} (0.44)	86.29^{a} (3.57)
HNAS (N=8)	4.11^{b} (0.75)	92.82^{a} (10.87)	5.40^{b} (0.44)	73.88^{b} (3.57)
P value	0.0008	0.0001	0.0001	0.0001
GROUP 3				
AG (n=10)	1.47^{a} (1.00)	22.56^{a} (17.23)	2.20^{a} (0.93)	35.91^{a} (8.37)
NA (n=4)	4.62^{a} (2.00)	88.98^{a} (34.45)	5.26^{a} (1.85)	69.01^{a} (16.73)
HNA12 (n=4)	4.62^{a} (2.00)	70.52^{a} (34.45)	5.40^{a} (1.85)	70.00^{a} (16.73)
P value	0.304	0.212	0.293	0.197

[abc] Means within a treatment group and column with unlike superscript letters are different at the listed P values.
[d] AG = aged (control) breasts; NA = non-aged, no treatment (control) breasts; HNA8 = hydrodyne treated non-aged breasts 8" from explosive (200g); HNAS = Hydrodyne treated non-aged breasts 8" suspended laterally from explosive (200g); HNA12 = Hydrodyne treated non-aged breasts 12" from explosive (200g)