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EFFICACY OF A REFRIGERATION STORAGE TECHNOLOGY TO IMPROVE TENDERNESS OF BROILER BREAST MEAT AT AN INDUSTRIAL PROCESSING PLANT

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Introduction

Consumer satisfaction with meat tenderness will determine if the purchase is repeated in the future (Morgan et al., 1991). Therefore it is critical for food industries and meat processors to consistently produce a tender meat product that meets or exceeds consumer expectations. In order to have a consistency in tenderness is necessary to standardize the procedures of ante- and post- mortem in particular handlings of carcasses. Several factors are known in order to explain this meat tenderness variation including the amount of intramuscularly fat, water holding capacity and actomyosin complex (Avery et al. 1996). Collagen and its crosslinking are factors involved as the birds advance in aging (Coro et al., 2002) and also the changes that occur during postmortem storage such as aging, type of rigor, sarcomere length, skeletal restraint and proteolytic activity (Pearson, 1987). Koohmaraie (1996) reported that prevention of sarcomere length shortening could prevent meat toughening. In poultry, cold shortening is not normally a cause of toughening in normal industrial processing providing the breast meat is not pre-maturely excised or otherwise altered (Papinaho and Fletcher, 1996). Papinaho and Fletcher (1996) described temperature induced shortening in broiler breast muscle sampled as intact, and excised muscle. The postmortem tenderization by proteolysis has been studied extensively and the calpain system has been known to initiate the myofibrillar framework enzymatic digestion (Goll, et al. 1997). Koohmarie (1996) pointed out that the breakdown of key proteins which maintains the sarcomere structure cause its weakening and the meat tenderness and the Z-line degradation was one of the main changes occurred during postmortem tenderization (Taylor et al., 1995)

Objectives

The objective of this work was to investigate a refrigeration technology of a broiler breast meat by measuring the myofibrillar fragmentation index, tenderness measurement, ultrastructural evaluation and sensory acceptance of intact and excised samples at an industrial processing plant.

Methodology

Samples

Seventy two chicken of Cobb lineage of 42 days were slaughtered according to the industry plant routine practice consisting essentially in sequence of electrical stunning, bleeding, defeathering, evisceration, carcass water cooling, deboning and refrigeration (Guarnieri et al., 2004). Samples were divided into two experimental groups in relation to breast meat (*Pectoralis major*), intact breast (n=36) and excised breast (n=36).

Refrigeration techniques

Both samples were stored in plastic boxes at 2°C ± 2. Six samples of each experimental groups were taken for analysis of MFI and shear force measurement at 0, 8, 12, 24, 48 and 72h post mortem.

Myofibrillar Fragmentation Index (MFI)

MFI was determined as indirect measurement of calpain activity according to Culler et al (1978).

Shear force measurement

Samples were packed in plastic bags and submitted for cooking in a water bath until the samples internal temperature reached the value of 75°C. After refrigeration at 2°C ± 2 for 12 h, samples were cut at the size of $1cm^3$, analyzed on a texturometer TATX-2i and results were expressed in Newtons.

Sensory Analysis

Intact and excised samples taken at 0, 24 and 72h from refrigeration conditions were submitted to acceptance test. Fillets were vacuum packed and submitted to cooking process in an oven at 80°C until the internal temperature reached the value of 75°C. Five samples for each intact samples and excised fillets were refrigerated down to 28°C and randomly served to 28 untrained panelists. Structured hedonic scale of 9 points, 1= dislike very much to 9= like very much, was used in order to the panelists evaluate the samples acceptance (Meilgraad et al., 1999).

Electron Microscopy

Seventy-two hours excised samples were fixed in 2% glutaraldehyde in 0.14M sodium cacodylate buffer, pH 7.4 and 0.18M sucrose. After being washed in phosphate buffer, samples were postfixed in 1% osmium tetroxide in phosphate buffer for 1 h, followed by dehydration in acetone and embedded in Araldite resin. Ultrathin sections (50 nm) were stained with saturated uranyl acetate in 50% ethanol and lead citrate for 1 h. The ultrastructure was observed with an electron microscope Philips CM 100 (Guarnieri et al. 2004).

Statistical Analysis

The experiment was entirely randomized and experimental treatments were intact and excised meat samples and evaluated at the refrigeration period of 0, 8, 12, 24, 28 and 72h post mortem. Statistical analysis was carried out using the Statistica Program version 5.0 (Oklahoma, 1995). Student test t was also applied to determine the significance level between two treatments: intact and excised samples in each period of in relation to MFI and meat tenderness. Variance analysis and Tukey test were used for samples acceptance comparison.

Results & Discussion

Myofibrillar Fragmentation Index

Figure 1 shows the MFI of intact and excised broiler breast meat. As it can be seen, MFI increased from the beginning to 24h period of refrigeration becoming virtually constant up to 72h of storage for both samples. These results indicated that calpain enzyme system reached the maximum activity in conditions of 2°C ± 2 around 24h of refrigeration process. However, intact breast presented MFI higher ($p \leq 0.05$) in relation to deboned samples throughout treatment and this difference was 13.2% from 24h onwards.

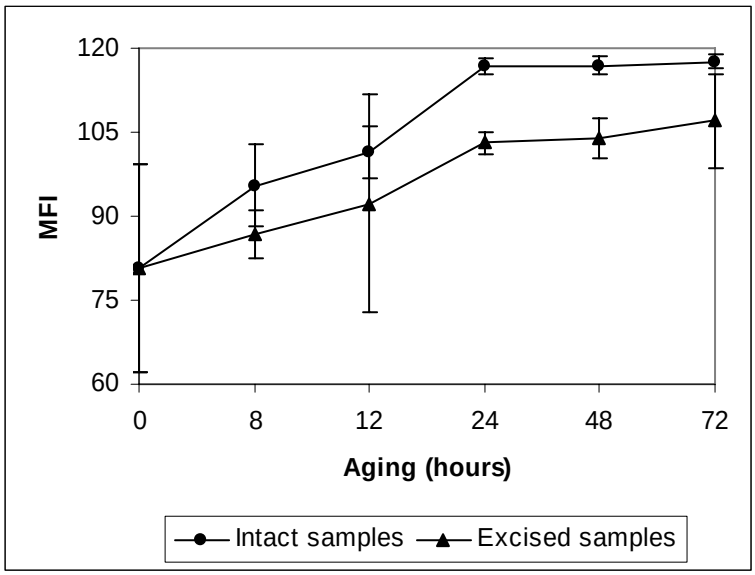

Figure 1. Myofibrillar fragmentation index of broiler breast fillet. A gradual increase of MFI occurred with storage being more pronounced in intact samples in relation to excised samples.

Breast meat tenderness measurement

Figure 2 shows the decrease of shear force value for both samples being more noticeable in samples kept for 24h becoming virtually constant throughout experiment.

Again the tenderness was higher in intact in comparison to excised samples ($p \leq 0.05$). A negative significant correlation (R=-0.93) was observed between MFI and shear force values indicating higher the proteases activity lower was the breast meat texture. Calpains enzymes digested the sarcomere structure particularly Z-lines improving the meat tenderness and synergistically samples attached to bones were protected against muscles restrain avoiding further the rigor shortening and the intact fillets became more tender.

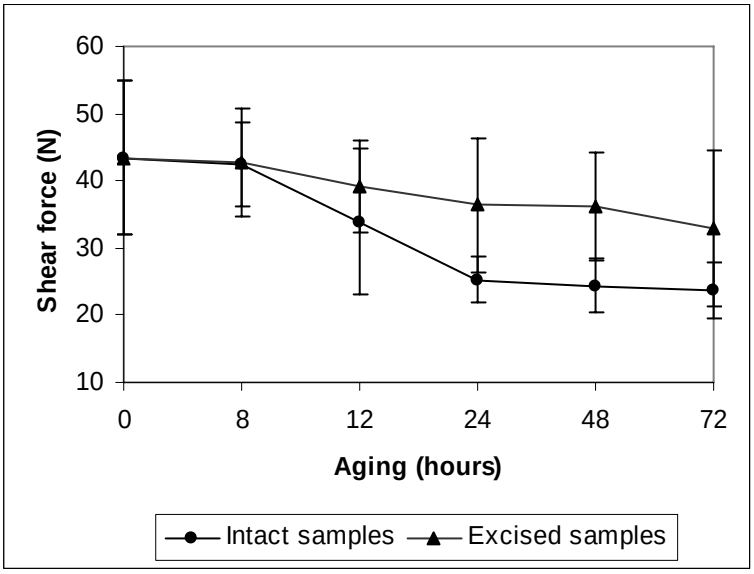

Figure 2. Shear force values of broiler breast fillet. A gradual decrease during storage occurred for shear force being more pronounced in intact samples in relation to excised samples.

Sensory analysis

Table 1 presents the results of acceptance test for both samples. The best scores were attributed to intact samples kept refrigerated for 24h and 72h and the acceptance index were 75.0 and 77.0%, respectively. These results of panelists acceptance were in accordance to the results of MFI and shear force analysis.

Table 1 –Average and acceptance index applying structured hedonic scale of 9 points, 1= dislike very much to 9= like very much, intact and excised samples of broiler breast meat refrigerated at 2°C in different periods of storage.

Refrigerated samples stored at different period of time	Score	Acceptance index (%)
Breast fillet 0h	$4.18^{b} \pm 1.85$	46.4
Intact breast fillet 24h	$6.75^{a} \pm 1.97$	75.0
Excised breast fillet 24h	$5.36^{b} \pm 1.93$	59.6
Intact breast fillet 72h	$6.93^{a} \pm 1.41$	77.0
Excised breast fillet 72h	$5.32^{b} \pm 2.25$	59.1

Means followed by different letters differed significantly by Tukey test of 5% of probability (n=28).

Electron Microscopy

Figure 3 shows a picture of longitudinal muscle section from excised samples stored for 72h and was characterized by a normal miofilaments structure and showed a regular transverse striation with evident bands of I and A, zone H and lines Z and M. The sarcomeres were of equal length and width but the faint Z-lines indicated that there were some protease activities within the muscle.

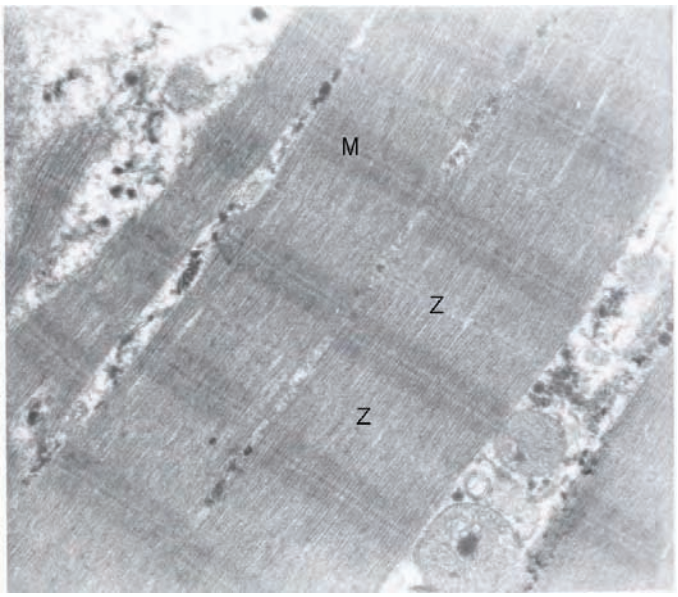

Figure 3. Electron micrograph of *Pectoralis major m*. stored for 72h at 2°C ± 2. Note a faint Z-disk digested by calpain (Z- Z-line, M-M-line). Magnification 23 000 x.

Conclusions

Our results of myofibrillar fragmentation index, shear force measurement, taste panel analysis and ultrastructural evaluation demonstrated that the technology of storing intact broiler breast fillet refrigerated at 2°C ± 2 for a minimum of 24h was an excellent procedure to obtain a very tender meat.

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