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Biochemical and sensorial evaluation of intact and boned broiler breast meat tenderness during ageing

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Abstract

Meat tenderness is the main characteristic demanded by consumers and is affected by *rigor mortis* development and proteolysis activities, both of which occur during carcass refrigeration. In this work, we demonstrate that broiler breast fillet tenderness can be further increased and its extension depends on whether or not meat is excised from the carcass. Post-harvest samples taken from 0 to 72 h after slaughtering and kept refrigerated at 2 ± 2 °C were evaluated for tenderness by myofibrillar fragmentation index determination, shear force analysis and sensorial testing. The 24 h post-harvested intact samples were 30.6% more tender than excised samples and 41.7% more tender than control samples ($p \leqslant 0.05$). The myofibrillar fragments index was 13.2% higher in intact samples than in deboned fillet ($p \leqslant 0.05$) and a sensory test showed that the 24 h intact samples were of major acceptability. Our results demonstrated that tenderness was best achieved with intact breast fillet samples stored at 2 ± 2 °C for 24 h.

Keywords: Myofibrillar fragmentation index; Shear force values; Acceptance test; Calpain system; Meat aging

1. Introduction

Consumer satisfaction with meat tenderness will determine whether 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 achieve consistency in tenderness it is necessary to standardize the procedures of *ante-* and *post-mortem* handling of carcasses. Several factors explain this variation in meat tenderness, including the amount of intramuscular fat, water-holding capacity and actomyosin complex (Avery, Sims, Warkup, & Bailey, 1996). Collagen and its crosslinking are involved as the broilers advance in age (Coro, Youssef, & Shimokomaki, 2002) and other factors are the changes that occur during *post-mortem* 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, provided that the breast meat is not prematurely excised or otherwise altered (Papinaho & Fletcher, 1996). Papinaho and Fletcher (1996) described temperature-induced shortening in broiler breast muscle sampled as intact and excised muscle. *Post-mortem* tenderization by proteolysis has been extensively studied and the calpain system has been known to initiate the myofibrillar framework enzymatic digestion (Goll, Boehm, Geesink, & Thompson, 1997). Koohmaraie (1996) pointed out that breakdown of the key proteins that maintain the sarcomere structure causes its weakening. Hence alterations in meat

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tenderness and the Z-line region degradation are among the main changes occurring during *post-mortem* tenderization (Taylor, Gessink, Thompson, Koohmaraie, & Goll, 1995). Earlier work has shown that early boning of breast fillet can yield a tough meat (Sams & Janky, 1986; Smith, Fletcher, & Papa, 1992) and tenderness can be improved by prolonging the time between slaughter and deboning (Notthcutt, Buhr, Young, Lyon, & Ware, 2001). Sams and co-workers have reported the relationship between proteolysis activity and shear force values during cold storage (McKee, Hirschler, & Sams, 1997; Sams, 1999).

The objective of this work was to investigate the tenderness of broiler breast meat through myofibrillar fragmentation index, shear force measurement and sensory acceptance of intact and excised samples during refrigeration at an industrial processing plant.

2. Materials and methods

2.1. Sample preparation

Sixty six chickens, of Cobb lineage of 42 days, were slaughtered according to the standard industrial plant practice. This consists essentially of a sequence of electrical stunning, bleeding, defeathering, evisceration, carcass water cooling, deboning and refrigeration (Guarnieri et al., 2004; Northcutt, 2001).

2.2. Refrigeration techniques

Meat samples were divided into two experimental groups as follows: intact breast ($n = 6$) and excised breast ($n = 6$) meat (*Pectoralis major m.*) were stored in plastic boxes at 2 ± 2 °C for 0, 8, 12, 24, 48 and 72 h *post-mortem*. *Post-mortem* samples ($n = 6$), taken immediately after slaughter (0 h), were treated as controls, irrespective of being deboned or not. For temperature decline rate, measurement samples were taken at 0, 1, 2, 3, 4, 5, 6, 7, 8 and 24 h of storage time. Samples were taken for myofibrillar fragmentation index (MFI) determination and shear force measurement at 0, 8, 12, 24, 48 and 72 h *post-mortem*.

2.3. Myofibrillar fragmentation index (MFI)

MFI was determined as an indirect measurement of calpain activity according to Culler, Parrish, Smith, and Cross (1978). Four grams muscle samples, free of external fat and visible connective tissue, were homogenized for 30 s in 20 ml of MFI buffer (100 mM KCl, 20 mM potassium phosphate, 1 mM EDTA, 1 mM $MgCl_2$ and 1 mM NaN_3 at pH 7.0). The homogenate was centrifuged at 10×10^3 rpm for 15 min at 2 °C, the supernatant discarded and pellet resuspended in 20 ml of the MFI buffer and centrifuged at 10×10^3 rpm for 15 min at 2 °C. The supernatant was discarded and the pellet suspended in 10 ml of the same MFI buffer. The myofibril suspension was poured through a strainer to remove connective tissue, and then assayed for protein concentration using the Biuret method. Aliquots of the suspensions were diluted in the MFI buffer to a final protein concentration of 0.5 mg/ml. The diluted protein suspension was poured into a cuvette and the absorbance at 540 nm was immediately measured with a spectrophotometer. The MFI was expressed as $A_{540\text{nm}} \times 200$.

2.4. Shear force measurement

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

2.5. Sensory analysis

Six intact and six excised breast samples, taken at 0, 24 and 72 h *post-mortem* refrigerated at 2 ± 2 °C, were submitted for sensory analysis. Broiler breast fillet was vacuum-packed and submitted to the cooking process in an oven at 80 °C until the internal temperature reached the value of 75 °C. After cooling to 28 °C, samples were randomly presented to 28 subjects of a sensorial group in order to evaluate their acceptance. A structure hedonic scale of 9 points (1 = dislike very much to 9 = like very much) was used (Meilgaard, Civille, & Carr, 1999).

2.6. Statistical analysis

The experiment was entirely randomised and experimental treatments were intact and excised meat samples, evaluated at the refrigeration periods of 0, 8, 12, 24, 48 and 72 h *post-mortem*. Statistical analysis was carried out using the Statistica Program version 5.0 (Oklahoma, 1995). The Student test t was also applied to compare both treatments, intact and excised samples, in each period in relation to MFI and meat tenderness. The sensorial experiment was of a randomised blocks design with variance analysis. The Tukey test was used for comparisons of acceptance after experimental treatments.

3. Results and discussion

3.1. Myofibrillar fragmentation index

Fig. 1 shows the MFI of intact and excised broiler breast meat. As can be seen, the MFI increased from its initiation up to a 24 h duration of refrigeration. It became virtually constant after 72 h of storage for both samples. These results indicated that the endogenous muscle proteases system reached its maximum activity under conditions of 2 ± 2 °C after approximately 24 h of refrigeration. However, entire breast presented MFIs higher ($p \leqslant 0.05$) than deboned samples throughout treatment. This difference was 13.2% from 24 h onwards.