Microscopic changes in poultry breast muscle treated with high hydrostatic pressure

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INTRODUCTION

Poultry and poultry-derived products generally present elevated microbiological load, which makes them highly perishable (6, 7). For this reason, a number of methods to delay their microbial spoilage are being tested (15, 16).

High hydrostatic pressure processing is an interesting food preservation method, especially for foods which can be substantially modified if subjected to a thermal treatment. It causes microbial inactivation and, therefore, can be used to improve the quality of some foods and food ingredients (2, 13). But high pressure has a very large effect on the myofibrillar structure and causes important changes in sarcomeres (9, 10, 14); thus, pressurization can greatly modify texture and palatability of meat, poultry and derived products. Some work on the tenderizing effect of high pressure processing on meat has been done, obtaining different results.

OBJECTIVES

The aim of this study was to evaluate the magnitude of changes in the microscopic structure of poultry breast muscle caused by high hydrostatic pressure processing.

MATERIALS AND METHODS

Poultry carcasses were provided by an industrial abattoir. Each breast was divided into three longitudinally-cut pieces, which were vacuum packaged. High pressure treatments were carried out as Yuste *et al.* (16) described. Poultry samples were pressurized at 500 MPa for 10 or 30 min at 2°C.

For light microscopy, samples were fixed with 10% buffered formaldehyde for 48 h, embedded in paraffin, sliced into 4-μm-sections by means of a microtome and hematoxylin-eosin (H/E) stained. Sections were examined with a light microscope (Olympus BH-2). A camera (Olympus C-35AD-4-Winding) and an exposure controller (Olympus Unit AD System) were used to take the photographs. For measurements of muscular fibre area, perimeter and maximum and minimum diameters, an image digital processor and analyser (IMCO 10, Kontron Bildanalyse GMBH -hardware-; Microm IP, Microm España, S. A. -software-) at × 200 was used.

RESULTS AND DISCUSSION

The reference sample showed a slight degeneration in isolated muscular fibres (Fig. 1a), which is a normal *post-mortem* change because of the handling and autolysis. Cross section was also normal, with thin fisures due to the H/E staining. There was small distance among fibres; it contained delicate connective tissue. Fibres had polygonal shape (Fig. 1b).

The sample pressurized for 10 min presented greater degeneration in muscle fibres than the reference sample (Fig. 1c). Cross section was more homogeneous. Distance among fibres was large and contained connective tissue strips and liquid. Elgasim and Kennick (4) also observe an increase in the interfibrillar space in pressure-treated bovine muscle. Fibres had rounded shape (Fig. 1d). All these changes were more pronounced in the sample treated for 30 min, which showed a high number of broken muscular fibres and a great structural disorganization (Figs. 1e and 1f).

The reference sample presented the significantly highest values of muscular fibre area, perimeter and maximum and minimum diameters. Moreover, the perimeter of fibres of the sample pressurized for 10 min were significantly greater than that of the 30-min-treated muscle fibres (Table 1).

High pressure processing has been reported to have tenderizing effect on meat (1, 3, 8, 11, 12, 14). Macfarlane *et al.* (9) conclude that pressure treatment achieves its effect mainly by irreversible disaggregation of myosin filaments. But in this study the non-pressurized sample proved to be more tender than pressurized ones (data not shown). It must be emphasized that high pressure does not affect connective tissue or, therefore, the toughness often given by this tissue to meat (5, 12, 14); so, pressurization just affects the toughness attributed to the myofibrillar proteins. As can be seen in light-microscopy images (Fig.1), pressure considerably modifies the structure of muscle fibres. Correlation among these modifications, ultrastructural changes and meat tenderness and, likewise, the optimal treatment conditions have to be in-depth investigated to assess the tenderizing effect of high pressure processing.

CONCLUSIONS

High pressure processing induces important and irreversible changes in the structure of muscular fibres.

These modifications should give a more tender meat but, in fact, the opposite effect is likely to happen due to the large release of intracellular fluids into the extracellular spaces caused by pressurization.

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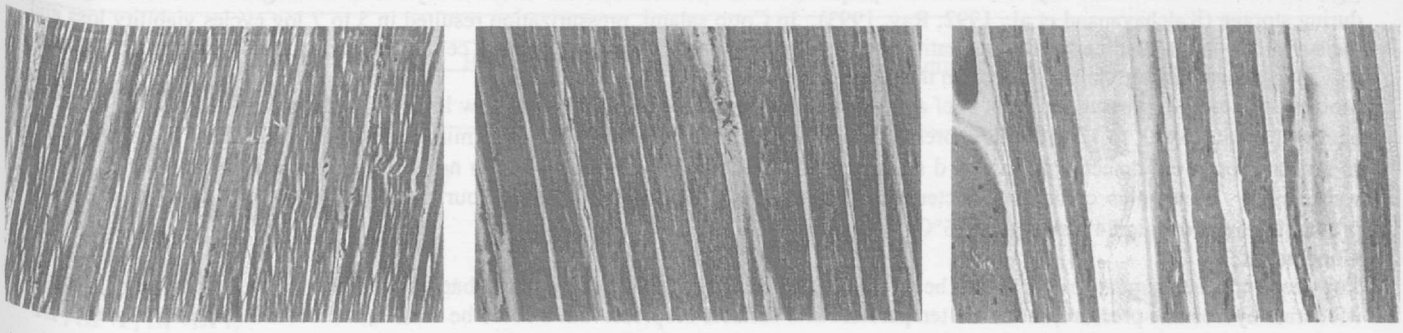
Table 1. Measurements of muscular fibres of poultry breast pressurized at 500 MPa for 10 or 30 min at 2°C.

	Area (μm^2)		**Perimeter** (μm)		**Max. Ø** (μm)		**Min. Ø** (μm)	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Reference sample	$1793{,}73^{a}$	799,172	$254{,}08^{a}$	129,072	$61{,}87^{a}$	13,880	$40{,}54^{a}$	10,529
10 min	$1329{,}12^{b}$	668,567	$218{,}17^{b}$	110,410	$52{,}62^{b}$	15,599	$34{,}30^{b}$	9,873
30 min	$1399{,}65^{b}$	761,515	$147{,}80^{c}$	52,701	$50{,}39^{b}$	17,175	$34{,}21^{b}$	12,851

Means within a column lacking a common superscript differ significantly ($P < 0{,}05$). SD: standard deviation.

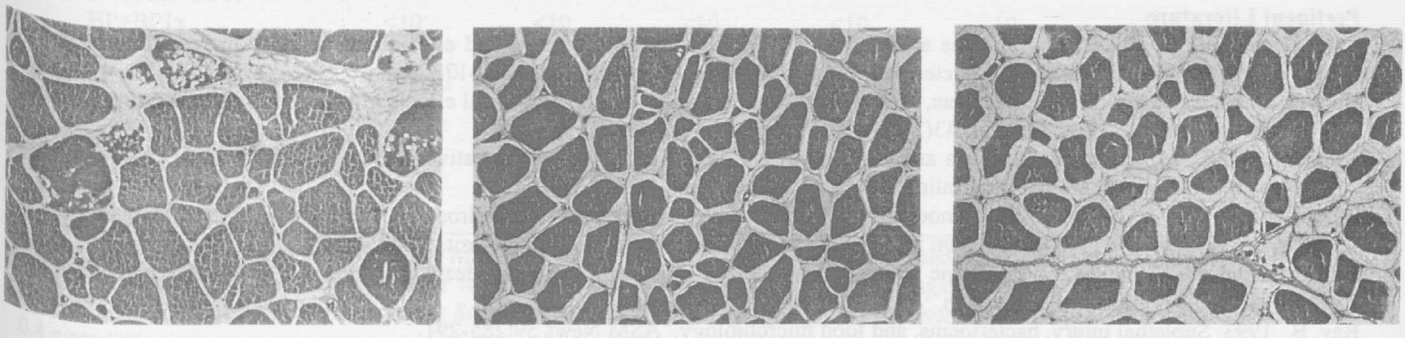
Figure 1. Longitudinal (LS) and cross (CS) sections of poultry breast muscular fibres (light microscope, × 66, H/E).



(a) LS, reference sample

(b) LS, 500 MPa / 10 min / 2°C

(c) LS, 500 MPa / 30 min / 2°C



(d) CS, reference sample

(e) CS, 500 MPa / 10 min / 2°C

(f) CS, 500 MPa / 30 min / 2°C