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Influence of cooking conditions on cooking loss and tenderness of raw and marinated chicken breast meat

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Abstract

The influence of different cooking treatments on tenderness and cooking loss, as main quality characteristics of chicken breast meat, was investigated. Industrial skinless chicken breast meat samples were designated as raw and marinated and cooked in the oven by hot air and hot air-steam mixture at 130, 150 and 170 °C, for 4, 8 and 12 min. Cooking losses were evaluated by weight changes before and after cooking, and tenderness changes were determined on cooked samples by measuring shear force using instrumental texture analysis. Results showed that marination, followed by air-steam cooking is the best combination to obtain the most tender chicken breast slices. The time and temperature of cooking showed similar effects on cooking loss and tenderness: short cooking time (4 min) and temperatures of 130–150 °C resulted in lower cooking losses and best meat tenderness, in both not marinated and marinated meat. Statistically significant correlations between tenderness and cooking loss indicated that the cooking loss correlated better with cooking time than with cooking temperature. An opposite phenomenon was observed for meat tenderness.

Keywords: Chicken breast; Cooking loss; Texture analysis; Tenderness

1. Introduction

Tenderness of meat products, together with juiciness, flavour and colour are the main eating quality characteristics that do influence the consumers' overall judgement of quality (Wood, Nute, Fursey, & Cuthbertson, 1995). They can be influenced by several production factors (genetics, feeding systems, etc.) and processing techniques (chilling, marinating, cooking). Therefore, to be able to enhance product quality, meticulous measurements of processing steps need to be conducted and optimized (Warkup, 1993).

Marinating is a traditional culinary technique that is used to tenderize and to improve flavour and juiciness of poultry meats (Lemos, Nunes, & Viana, 1999). Sodium chloride, polyphosphates and sugars are considered important ingredients of marinades, as they improve meat tenderness and flavour. Marinating also increases water binding capacity of meats, thus reducing cooking losses and improving meat juiciness (Brotsky, 1976; Babdji, Froning, & Ngoka, 1982; Froning & Sackett, 1985).

Oven cooking is widely used in commercially processed poultry meats, particularly in the foodservice systems. The air forced convection method is the most representative cooking system, and it results in desirable foods quality traits.

Air convection is often coupled with steam injection in the oven chamber to improve meat tenderness and to reduce cooking losses (Murphy et al., 2001). However, this combined cooking technique is quite complex and difficult to understand because it leads to unpredictable

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results, due to not well-understood effects of steam on meat products. As a consequence, one must consider that the key eating quality characteristics of meats (for example, cooking loss, tenderness and crust formation), are mainly affected by both the cooking technique and by the time-temperature profiles (Murphy & Marks, 2000).

The measurement of changes occurring during meat cooking may be carried out by a wide range of analytical methods, including textural and microstructural evaluations (Yoon, 2002), soluble protein identification, protein fragmentation, cooking loss or colour evaluation (Murphy et al., 2001; Quiao, Fletcher, Smith, & Northcutt, 2002; Garcia-Esteban, Ansorena, Gimeno, & Astiasaran, 2003). In particular, it is widely recognized that meat tenderness is the most significant factor affecting consumers' satisfaction (Savell et al., 1987, 1989; Obuz, Dikeman, & Loughin, 2003). The improvement of tenderness in meats is mainly caused by changes in the structure of connective tissues solubilized by heat, while at the same time heat-denaturation of myofibrillar proteins generally causes meats toughening (Palka & Daun, 1999).

The purpose of this research was to evaluate the influence of different cooking treatments on main quality characteristics of chicken breast meat that may influence the consumers' acceptance: tenderness and cooking loss. To achieve this objective, industrial skinless chicken breast samples were selected as raw and marinated, cooked in the oven in two different ways (air and air-steam) at three temperatures (130, 150 and 170 °C), and three different time periods (4, 8 and 12 min). The weight changes occurred in chicken breast samples due to experimental processing were quantitatively evaluated as cooking losses. Tenderness variation was measured by instrumental texture analysis.

2. Materials and methods

2.1. Materials

Fresh and skinless chicken breast slices were obtained from a local continuous processing plant about one our after slaughter. The samples ($n = 120$, average weight 38.72 g ± 5.60) were divided into two groups: raw (R), and marinated (M).

2.2. Industrial marinating procedure

About 60 chicken breast slices were put in a refrigerated horizontal tumbler with the marinade. The product/marinade weight ratio was 80:20. The marinade, previously prepared and kept at 3 °C, was composed of water (80 g/100 g), sodium chloride (3 g/100 g), sugar mixture (dextrose, lactose and saccharose, 9.5 g/100 g), wheat flour (4 g/100 g) and milk proteins (3.5 g/100 g). Tumbling was performed at 0 °C under vacuum (25 kPa) for a total time of 2.5 h (6 tumbling cycles of 20 min each plus 6 still marinating cycles, 5 min each).

Raw and marinated samples were then enclosed in sealed plastic pouches, placed into a cooled container with ice and transported to the laboratory for the cooking trials.

2.3. Proximate sample analysis

Uncooked raw (R), uncooked marinated (M), and some cooked chicken breast slices (Table 1), were analysed in triplicate for the proximate composition, following AOAC procedures (AOAC, 1995), and as reported by Murphy and Marks (2000). Total water content was determined on uncooked R and M samples by the oven drying method at 110 °C for 24 h (AOAC,

Table 1
proximate composition (± standard error) of raw and marinated uncooked samples (g/100 g). Each value is the mean of three readings

Chicken breast slices	Total water (g/100 g)	Total proteins (g/100 g)	Total lipids (g/100 g)	Total ashes (g/100 g)
Raw uncooked (R)	$76.60^{a} \pm 0.83$	$21.47^{a} \pm 1.02$	$0.64^{a} \pm 0.21$	$1.29^{a} \pm 0.20$
Marinated uncooked (M)	$80.78^{b} \pm 1.17$	$16.22^{b} \pm 1.72$	$1.01^{a} \pm 0.74$	$1.99^{b} \pm 0.24$
RA (130 °C, 4 min)	70.33*	$27.24^{c} \pm 0.33$	$1.04^{b} \pm 0.02$	$1.37^{c} \pm 0.06$
RS (130 °C, 4 min)	65.57*	$32.08^{d} \pm 0.87$	$0.93^{b} \pm 0.04$	$1.41^{c} \pm 0.04$
RA (170 °C, 12 min)	47.32*	$47.46^{e} \pm 0.68$	$3.04^{c} \pm 0.03$	$2.18^{d} \pm 0.09$
RS (170 °C, 12 min)	56.52*	$38.93^{f} \pm 0.11$	$2.11^{d} \pm 0.05$	$2.43^{e} \pm 0.06$
MA (130 °C, 4 min)	75.28*	$21.38^{g} \pm 0.98$	$1.01^{e} \pm 0.09$	$2.32^{f} \pm 0.05$
MS (130 °C, 4 min)	67.66*	$28.29^{h} \pm 0.02$	$1.20^{e} \pm 0.03$	$2.84^{g} \pm 0.09$
MA (170 °C, 12 min)	66.77*	$29.46^{i} \pm 0.42$	$0.69^{e} \pm 0.03$	$3.08^{f} \pm 0.19$
MS (170 °C, 12 min)	43.93*	$50.41^{j} \pm 1.70$	$1.08^{e} \pm 0.09$	$4.59^{h} \pm 0.08$

RA = raw sample, cooked by dry air; RS = raw sample cooked by air-steam; MA = marinated sample cooked by dry air; MS = marinated sample, cooked by air-steam.
*Calculated water content as [100−(proteins + ashes + lipids)].
Student's t-test for independent samples: different superscript letters within a column mean significant difference ($P \leqslant 0.05$).