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Poultry breasts with white striping meat x impacts on technological properties

Frangos com white striping x impacto nas propriedades tecnológicas da carne

Pollos con white striping x impacto en las propiedades tecnológicas de la carne

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Abstract

This work aimed to characterize the physicochemical parameters and technological properties of breasts from poultry with WS and compare them with normal breasts to evaluate breast quality. Poultry breast fillets (10 normal and 10 carcasses with WS) were White Striping (WS) is a major problem that compromise the quality of the meat. Occurrence of WS on the surface of chicken breasts impairs the visual appearance and consequently decreases consumer acceptance causing damage to the industrial sector. obtained from a slaughterhouse. Then they were weighed, packaged and stored in the freezer at -20°C until analysis of: pH, moisture, protein, lipids, lipid oxidation, warmed-over flavor (WOF), water holding capacity (WHC), cooking loss (CL), exudate protein content (EP) and myofibrillar fragmentation index (MFI) of proteins. The physicochemical characteristics and technological parameters of poultry breasts with WS compromised the quality of the product when compared to the normal breast showing heavier breasts, increasing moisture, lipid content, lipid oxidation and WOF, reduction in total protein content and WHC and an increase in CL, EP content and MFI of proteins. Therefore, this myopathy showed changes in the physical and chemical parameters that can compromise the technological and sensory aspects of meat products, affecting their quality.

Keywords: Warmed over flavor; Protein quality; Oxidative stability; Poultry meat.

Resumo

A produção e exportação de frangos de corte no Brasil continua crescendo e os frigoríficos devem continuar mantendo a qualidade da carne associada com a garantia do rendimento dos frangos pesados. No entanto, surgiram algumas anomalias não patológicas nos peitos de frango com miopatia denominada de White Stripping (WS). Estas anomalias têm sido consideradas como defeitos de qualidade da carne e tem ocasionado prejuízos para o setor industrial. O objetivo deste trabalho foi caracterizar os parâmetros físico-químicos e as propriedades tecnológicas de peitos de frangos de corte com miopatia WS e compará-los com os peitos normal visando a avaliação da qualidade dos peitos. Os filés de peito de frango (10 carcaças normal e 10 carcaças com anomalias de WS) foram obtidos no frigorifico. Os peitos

de frango foram pesados, acondicionados e armazenados no freezer a -20C. Após descongelamento, os peitos de frango foram analisados quanto as medidas de pH, umidade, proteínas, lipídios, oxidação lipídica, aroma de requentado (WOF), capacidade de retenção de água (CRA), perda por cozimento (CL), teor de proteínas do exudato (PE) e índice de fragmentação miofibrilar (IFM) das proteínas. As características físico quimica e parâmetros tecnológicos das carnes de peito de frango com miopatia WS comprometeram a qualidade do produto em relação ao peito normal. Os peitos de frango normal quando comaparado com peitos de frango com WS, apresentaram peito com maior peso, aumento no teor de umidade e lipídios, na oxidação lipídica e no WOF; redução no teor de proteínas e na CRA; aumento no CL, no teor de PE e no IFM das proteinas.

Palavras-chave: Aroma de requentado; Qualidade da proteína; Estabilidade oxidativa; Carne de frango.

Resumen

La producción y exportación de pollos de engorde en Brasil sigue creciendo y los mataderos deben continuar manteniendo la calidad de la carne asociada a garantizar el desempeño de los pollos pesados. Sin embargo, han aparecido algunas anomalías no patológicas en las pechugas de pollo con miopatía llamadas White Stripping (WS). Estas anomalías han sido consideradas defectos en la calidad de la carne y han provocado pérdidas al sector industrial. El objetivo de este trabajo fue caracterizar los parámetros físico-químicos y las propiedades tecnológicas de las mamas de pollos de engorde con miopatía por SW y compararlas con las mamas normales para evaluar la calidad de las pechugas. Los filetes de pechuga de pollo (10 normales y 10 con anomalías de WS) se obtuvieron en el frigorífico. Las pechugas de pollo se pesaron, acondicionaron y almacenaron en el congelador a -20ºC. Después de descongelarlas, se analizaron las pechugas de pollo para determinar el pH, la humedad, las proteínas, los lípidos, la oxidación de lípidos, el aroma recalentado (WOF), la capacidad de retención de agua (CRA), la pérdida por cocción (CL), el contenido de proteínas exudado (PE) e índice de fragmentación miofibrilar (MFI) de proteínas. Las características físico-químicas y los parámetros tecnológicos de las pechugas de pollo con miopatía WS comprometieron la calidad del producto en relación con la pechuga normal. Las pechugas de pollo normales, en comparación con las pechugas de pollo WS, presentaron pechugas más pesadas, mayor contenido de humedad y lípidos, oxidación de lípidos y WOF; reducción del contenido de proteínas y CRA; aumento del contenido de CL, PE e IFM de proteínas.

Palabras clave: Aroma recalentado; Calidad proteica; Estabilidad oxidativa; Carne de pollo.

1. Introduction

White Striping (WS) myopathy in poultry breasts produce negative visual characteristics due to the presence of white striae in the breasts (Petracci et al. 2014), changes in chemical composition and consumer rejection of purchase (Kuttappan et al. 2012; Kuttappan et al. 2013). Furthermore, it was observed by Petracci and Cavani (2012) that fast-growing poultry was more susceptible to heat stress due to the reduction in their thermoregulatory capacity, which influenced the quality of poultry meat due to increasing production of free radicals in the muscle.

Today, the incidence of poultry breasts with WS in industry has been high, with a detected incidence of 12% to 40% in countries such as Italy and Brazil (Petracci et al. 2013) which cause economic losses caused by myopathies in chicken breasts like: WS and Wooden Breast estimated at up to US$ 70.632/day (Zanetti et al. 2018). These losses are related to the non-utilization of this raw material due to the rejection and the impossibility of commercialization of carcasses as whole poultry (Corazza et al. 2017).

In poultry breasts with WS, there are also changes in the various parameters of meat quality, such as water holding capacity (WHC) and therefore, the importance and necessity to reduce this myopathy with WS have been highlighted (Alnahhas et al. 2016). Therefore, the objective of this study was to characterize the physicochemical parameters and technological properties of poultry breast muscle (*Pectoralis major*) with WS myopathy and compare them with normal poultry breasts to evaluate the quality of this meat.

2. Methodology

Sampling

The carcasses were obtained from a poultry slaughterhouse located in the south of Brazil with a federal inspection service in site. Poultry with anomalies were removed from the line with the consent of the Federal Inspection Department. The strain used was Ross without sex selection at 48 days of age. After the hanging, electrical stunning, bleeding, scalding, plucking, eviscerating and chiller/cooling steps, 10 carcasses of normal and 10 carcasses with WS myopathy were collected. The number of carcasses collected is similar to that found in the works conducted by Lee et al. (2008), Mudalal et al. (2014), Soglia et al. (2016).

After collecting the carcasses, poultry breasts classified as WS myopathy and normal were weighed in a semi-analytical scale, labeled and sealed and forwarded, under refrigeration, to the Meat Science Laboratory of the Federal Technological University of Paraná, Campus Londrina, Brazil, where samples were properly packaged with plastic wrap to prevent dryness and stored in a freezer at -20ºC. According to work conducted by Kuttappan et al. (2012), there was no classification regarding the severity of WS anomaly, as moderate or severe. For physicochemical characterization and evaluation of technological parameters, poultry breasts were analyzed in triplicate.

Physicochemical and technological properties of poultry breasts

The pH measurements were performed 24 h postmortem using insertion pH meter (Testo Brand, Model 205). Moisture, lipid and protein content were determined according to the methods described in AOAC (2016). Only moisture content was determined in samples that were collected 24h postmortem. To determine the PE, 1.0 gram of the liquid from the cooking loss (CL) was collected and adequately homogenized. Lipid oxidation was determined by the quantification of thiobarbituric acid reactive substances (TBARS) (Crackel; Gray; Pearson et al. 1988). Warmed-over flavor (WOF) was measured according to the quantification of TBARS. The samples were collected after the CL, placed in plastic bags and kept for 24 h under refrigeration until the WOF was determined.

The WHC was performed after 24 h post mortem (Hamm 1960); CL (Petracci and Baéza 2011); myofibrillar fragmentation index (MFI) (Culler et al. 1978) with modifications by Hopkins et al. (2000) using three different centrifuge speeds (5000, 10,000 or 15,000 rpm).

Statistical analysis

Results were subjected to analysis of variance (ANOVA) followed by the t-test (LSD) at a significance level of 5% ($p \leq 0.005$) using the BioEstat 5.0 statistical program.

3. Results and Discussion

Physical Chemical Characteristics of Poultry Breasts with WS

In Table 1 we can observe the values obtained for the analyses of physicochemical characteristics comparing normal and WS myopathy breasts.

The weight of breasts of poultry with WS myopathies was approximately 30% higher than normal breasts (Table 1). The higher weight of WS poultry was also observed by Kijowski and Konstanazoc (2009). According to Petracci and Cavani (2012), this poultry quality may also be associated with their genome due to the molecular responses of proteins and metabolic pathways that may help in identifying the mechanisms underlying muscle conversion. In larger poultry breasts, there is a predominance of rapid glycolytic metabolism that may also result in modifications of proteolytic enzymes that influence the functionality and denatures of muscle proteins.

Table 1 – Physicochemical characteristics of normal and WS myopathy chicken breasts.

Analysis	Normal	WS
weight (g)	800.80 ± 104.56^{b}	1155.12 ± 108.37^{a}
Moisture (%)	65.84 ± 3.4^{b}	76.38 ± 1.4^{a}
pH	5.73 ± 0.13^{b}	6.09 ± 0.21^{a}
Protein	19.71 ± 3.8^{a}	15.30 ± 3.19^{b}
Lipid (%)	1.28 ± 0.76^{b}	2.87 ± 0.91^{a}

*Average values followed by different letters in the same row (lower case letters) and different letters in the same column (upper case letters) differ by a t-test (LSD) at the 5% significance level.

The moisture content of poultry breasts with WS was higher than normal breasts (Table 1), whose characteristic was similar to Sihvo et al. (2014); Petracci et al. (2014) and Kuttappan et al. (2012). The high water content of WS poultry breasts may be due to the occurrence of moderate to severe edema in the musculature and from the inflammatory process that has settled in the muscle tissue. Poultry breasts with WS showed higher pH values than normal ones (Table 1). It was reported by Alnahhas et al. (2016), who observed that the occurrence of white striae in poultry breasts was negatively correlated with glycogen reserve in the muscle that compromised the glycolytic process and made it challenging to reduce post mortem pH.

Protein content in poultry breasts with WS was lower, while lipid content was higher than normal poultry breast (Table 1). The effect of white stretch marks on WS poultry breasts on their chemical composition was evaluated by Petracci et al. (2014) and Kuttappan et al. (2013) showing that the higher the severity of striae marks in poultry breasts, the lower the protein content and higher lipid content. These results were similar to Lonergan et al. (2003); Kuttappan et al. (2013); Petracci et al. (2014); Soglia et al. (2015) and Baldi et al. (2018). It

was noted by Lonergan et al. (2003) that the increase in fat content in poultry breasts with WS was due to increased liver lipogenesis and lipoprotein lipase (LPL) activity, which resulted in increased fatty acid absorption, in adipose tissues. According to Alnahhas et al. (2016), the higher the severity of poultry breast with WS, the higher the intramuscular fat content due to possible cell regeneration from striae damage.

Lipid oxidation and WOF in poultry breasts with WS

The lipid oxidation measurements for normal and WS poultry breasts showed no differences (Table 2). Similar results were obtained by Alnahhas et al. (2016). The same behavior was also observed by Golzar Adabi and Soncu (2019), whose TBA values for in fresh poultry meat, refrigerated for 3 days, showed no significant differences and the lipid profile for normal and WS poultry meat showed differences in the content of saturated fatty acids (SFA) and polyunsaturated fatty acids (PUFA). In contrast, the meat with WS had higher PUFA content. According to Salles et al. (2019), lipid oxidation of normal breasts differed only from the breasts classified as severe and showed no differences in the ones classified as moderate. They also observed that free radical formation and protein oxidation were more expressive in poultry breasts with moderate and severe myopathy, consequently increasing TBARS in fresh meat.

The susceptibility to lipid oxidation after cooking poultry breasts with WS, quantified by WOF, was higher than normal breast (Table 2). This susceptibility may be associated with the higher PUFA content for WS poultry meat, as observed by

Golzar Adabi and Soncu (2019). Lipid oxidation of breasts with WS may compromise its quality, since after cooking, the consumer can detect, in the product, a possible negative sensory perception. Besides, breasts with WS presented higher fat content than normal ones (Table 1), possibly due to the loss of moisture during cooking, which compromised the quality of the product and also negatively influenced the acceptance of the product by the consumer (Sanches Brambila et al. 2016).

Table 2 – Lipid oxidation and warmer-over flavor (WOF) measurements in normal and WS poultry breasts.

Analysis	*Normal*	*WS*
TBA (mg/kg)	2.86 ± 0.81[a]	3.18 ± 1.09[a]
WOF (mg/kg)	2.86 ± 0.79[b]	3.85 ± 0.96[a]

*Average values followed by different letters in the same row (lower case letters) and different letters in the same column (upper case letters) differ by a t-test (LSD) at the 5% significance level.

Evaluation of the technological properties of poultry breasts

In Table 3 we can observe the differences between normal and WS myopathy poultry breasts for the technological characteristics suggested for different authors referenced in this present work. The WHC in breasts with WS was lower compared to normal (Table 3). The same was observed in Petracci et al. (2013) and Mudalal et al. (2015). This parameter, according to Petracci and Cavani (2012) is influenced by the general proteomics that allows a better understanding of cellular mechanisms. This decrease in WHC may be associated with glycosaminiglican deposition due to a type of inflammation that occurs in the muscles of poultry with WS myopathy since this deposition generates an increase in the negative charge of the covalent bonds of proteoglycan nuclei that ionically interact with water (Soglia et al. 2016). The reduction in WHC with loss of exudate in poultry breasts with WS can have several adverse effects on the poultry chain with impacts on meat quality, processing capacity and nutritional value, as well as on purchase satisfaction by (Hafid et al. 2016). Processed products from WS myopathy meat showed a reduction in emulsion stability due to the compromise of raw material WHC (Zanetti et al. 2018).

Table 3 – Technological characteristics for normal and WS broiler breasts;

Analysis	*Normal*	*WS*
WRC (%)	76.58 ± 4.4[a]	70.95 ± 5.8[b]
Cooking Loss (CL)	2.50 ± 0.96[b]	3.04 ± 1.00[a]
Proteins in exudate (PE)	0.55 ± 0.17[b]	0.82 ± 0.26[a]
MFI	25.46±2.31[b]	32.24±3.54[a]

*Average values followed by different letters in the same row (lower case letters) and different letters in the same column (upper case letters) differ by a t-test (LSD) at the 5% significance level.

Regarding CL, it was observed that poultry breasts with WS lost more water during cooking time (Table 3) and the same was also observed by Tijare et al. (2016) and Baldi et al. (2018). It was found that the water in the exudate showed higher (PE) (Table 3). The increase in CL and PE in poultry breasts with WS compared to normal breasts may be primarily due to the change in quality and type of proteins found in this meat with WS myopathy. Mudalal et al. (2014) observed that breasts with WS and classified as severe presented lower solubility and concentration of sarcoplasmic and myofibrillar proteins.

The white striae in poultry breasts with WS have been attributed to be responsible for the decrease in the total protein content of meat. However, there was a higher content of collagenous material in the muscle. During the determination of CL in breasts with WS, it was observed (Table 2) that there was gelatinization of collagen with the migration of collagenous material and myofibrillar protein residues to the exudate and may result in potential technological problems due to the formation of gelatinous material during heat treatment, which results in an undesirable increase in viscosity, it may also result in a reduction in the total protein content of meat with a consequent reduction in the nutritional value of the product.

Poultry meat with WS, due to its high connective tissue content, must require new processing technologies due to the possible occurrence of technological failures that compromise the texture of the products (Sanches Brambila et al. 2016). Thus, it was observed that the occurrence of poultry breasts with WS might compromise the nutritional value and some technological aspects of the product.

The MFI indicates the degree of proteolysis extension that may be associated with changes in tissue degenerative processes due to an intense tissue inflammation that potentiates the loss of WHC with increased spacing between the myofibrillar spaces (Mudalal et al. 2015). It was observed in the present study that the MFI of poultry breasts with WS were higher than normal breasts (Table 3) and these results were similar to those described by Soglia et al. (2016).

The technological aspects of meat products are essential to maintain the parameters of physicochemical, sensory and economic quality since the protein interactions and the ability of water to interact with food are necessary conditions to maintain these parameters (Hafid et al. 2016).

4. Conclusion

The physicochemical characteristics and technological parameters of WS myopathy poultry breasts compromised the quality of the product compared to normal poultry breast. Normal poultry breasts, when compared to the ones with WS, showed higher breast weight, increased moisture and lipid content, in the lipid oxidation and WOF and reduced the protein content. There was also a decrease in WHC and an increase in CL, in the protein exudate and protein MFI.

We can also point out the need for future studies that consider different strains and their associated genetics as well as nutrition and intestinal microbiota may be associated with these myopathies.

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