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SHORT COMMUNICATION

Chemical composition and pH of the meat of broilers submitted to pre-slaughter heat stress

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Abstract In order to evaluate the chemical composition and pH of chicken meat subjected to heat stress during the pre-slaughter rest time, an experiment was conducted in a slaughterhouse. Twenty-five birds were randomly selected and housed in rooms without air conditioning for a 3-hour period, with an average temperature of 33°C and relative humidity of 83%. After slaughter, the carcasses were deboned and prime cuts were chilled (between 0 and 4 °C) for 24 hours for analysis of moisture levels, protein, fat, ash, and pH. The humidity values were 72.80, 71.47, and 70.30%, protein values were 16.81, 14.90, and 15.10%, lipid values were 0.78, 3.30, and 5.80%, ash values were 0.81, 0.88, and 0.89%, and pH values were 5.30, 6.10, and 6.54 for breast, thigh, and drumstick, respectively. Heat stress for 3 hours before slaughter led to changes in the chemical composition and pH of the chicken, which establishes an anomaly in the flesh of the PSE type (pale, soft, and exudative). It is evident that pre-slaughter management is important to ensure animal welfare and consequently high meat quality.

Keywords: animal welfare, poultry, relative humidity, temperature

Introduction

The poultry production industry has sought progress through research in genetics, facilities, nutrition, management, health, and environmental comfort. All these advances are intended to better understand the factors that influence the development and performance of broiler chickens. Therefore, it is possible to get the maximum production of meat with lower production costs by considering both the welfare of birds and providing suitable conditions to express their best productive characteristics (Nazareth et al 2009; Carvalho-Curi and Moura 2014).

Among the various factors that influence the production of broilers, environmental factors, such as temperature, relative humidity, wind, illuminance, radiation, etc., are crucial in the process of breeding, as they aid in the most important vital function of birds, homeothermy (Amaral et al 2011; Carvalho-Curi and Moura 2014).

In this context, pre-slaughter management (including harvesting, fast, transport, time, hanging, immobilization, and animal stunning) exerts great influence on muscle glycogen stores, the temperature, and relative humidity, the factors that most directly affect the birds (Amaral et al 2011).

According to regulations of the Brazilian Animal Protein Association (ABPA, 2015), it is recommended that the rest time for birds to be as short as possible and not exceed 3 hours with a maximum temperature and relative humidity of 23°C and 65%, respectively.

Knowing that broiler chickens are exposed to acute heat stress over the short-term immediately prior to slaughter and that these conditions change the quality of the meat (Sandercock et al 2001), we aimed to evaluate the chemical composition and pH of meat chicken subjected to heat stress prior to slaughter during the rest time.

Materials and Methods

The experiment was conducted at the slaughterhouse Só Aves (Vasconcelos and Santos Ltda – ME, 5° 14' S, 37° 35" W; altitude: 24 m). We randomly selected 25 birds, Cobb 55 lyne, that were unsexed and roughly 45 days of age; the birds had an average weight of 2.530 kg and had undergone controlled fasting for 6 hours. The birds were subjected to thermal pre-slaughter stress, consisting of housing in rooms that were not air conditioned for 3 hours, with an average temperature of 33°C (max/min: 34.5, 32.3°C) and an average relative humidity of 83% (max/min:

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85%, 81%), measured via a digital thermo-hygrometer (Incoterm TH50).

The birds were slaughtered in one day, following a commercial slaughter protocol with electric stunning (55 volts for 10 seconds) and bleeding via a unilateral cut through the jugular vein and carotid artery. We conducted boning, apparent skin and fat removal of the prime poultry cuts (i.e., the drumsticks, thigh and chest).

After slaughter, the sections were then packed, one by one, in plastic bags and refrigerated at 4°C for 24 hours to carry out the proximate composition and pH analysis.

The muscle tissue homogenate for each prime cut was analyzed in triplicate for chemical composition (moisture, lipids, protein and ash) following the laboratory techniques described by Silva and Queiroz (2005). The pH measurements were performed in triplicate using a digital pH meter (HANNA©) coupled to a penetration electrode. The pH was measured in prime cuts at two times: immediately after slaughter and 24 hours after the post-mortem period required for establishment of rigor mortis, which occurs due to the consumption of glycogen and the consequent decline in pH.

The data were submitted to homoscedasticity analysis and normality of errors, and we removed the identified outliers (outliers and influential). We then calculated the mean and standard deviation using the statistical software R-Development Core Team (2011).

Results and Discussion

The results of the parameters observed in the quality of chicken meat subjected to pre-slaughter heat stress can be seen in Table 1. The observed values of the chemical composition of prime cuts were lower than those reported by Taco (2011) for moisture (74.8% for breast, 76.4% to 72.7% for thigh and drumstick), protein (21.5% for breast, 17.8% and 17.6% for thigh and drumstick), lipids (3.0% for breast, 4.9% for thigh and 9.6% drumstick) and ash (1.0% to breast, 0.9% and 0.9% for thigh and drumstick). According to Olivo (2006), the chemical composition of the meat vary depending on the species, sex, age of the animal, origin of muscle, fat, pre and post-slaughter handling and cutting commercial type.

According to Le Bihan-Duval et al (2008), pH values for chicken meat, specifically the breast meat, should present have a final pH 24 hours post mortem between 5.7 and 5.9. Therefore, the observed values for this prime cut can be considered to be non-standard, resulting in pale, soft and exudative (PSE) meat. Fernandes et al (2016) evaluated the pH of frozen and chilled chicken prime cuts and noted average values of 5.90 and 5.96 for frozen and chilled breast, respectively, average of 6.42 and 6.46 for frozen and chilled thigh, respectively, and average of 6.38 and 6.56 for frozen and chilled drumsticks, respectively. These authors used the observed values for the breast to state that the observed samples, frozen or chilled, had no kinds of PSE or dark, hard and dry (DFD) anomalies.

Given a lack of oxygen (as during the post-mortem period), degradation of glycogen through anaerobic glycolysis occurs and leads to the formation of lactic acid from pyruvate, reducing muscle pH. This reduction is required for correct maturation of meat in the process called muscle meat conversion (Brossi et al 2009). This drop in pH in the flesh occurs generally for initial pH values of about 7.2 up to final values around 5.8. However, Brossi et al (2009) stressed that birds quickly use up their glycogen stores, which may result in their in vivo depletion, preventing a decrease in pH post-mortem. Birds may also suffer an acceleration of glycolysis after slaughter, generating lactic acid accumulation in the muscle, with subsequent rapid lowering of the pH (McKee and Sams, 1998).

In living birds, the whole body works physiologically in harmony, maintaining homeostatic balance. During pre-slaughter handling, biochemical changes are initiated that establish rigor mortis and the decrease in muscle pH. These changes dictate the quality of the final meat such as its composition, water-retention capacity and coloring.

Table 1 Chemical composition and pH of broilers prime cuts subjected to pre-slaughter heat stress.

Parameters (% Wet basis)	Breast	Thigh	Drumstick
Moisture	72,80 ± 1,99	71,47 ± 1,86	70,30 ± 1,76
Protein	16,81 ± 2,03	14,90 ± 1,79	15,10 ± 2,10
Lipids	0,78 ± 0,14	3,30 ± 0,20	5,80 ± 1,68
Ash	0,81 ± 0,12	0,88 ± 0,16	0,89 ± 0,15
pH	5,30 ± 0,30	6,10 ± 0,28	6,54 ± 0,32

±Standard deviation

Conclusions

Heat stress, characterized by a temperature of 33°C and a relative humidity of 83% for 3 hours prior to slaughter, led to changes in the chemical composition and pH of chicken meat, establishing an anomaly in the flesh of the PSE type. The importance of pre-slaughter management to ensure animal welfare and consequently the quality of the meat is accordingly revealed.

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