COLOUR, LIPID AND PROTEIN OXIDATION IN BREAST AND THIGH MEAT OF BROILERS RAISED IN FOUR PRODUCTION SYSTEMS IN BELGIUM

Zeshan Ali*, Eline Kowalski and Stefaan De Smet

Laboratory for Animal Nutrition and Animal Product Quality, Department of Animal Sciences and Aquatic Ecology, Ghent University, Belgium

*Corresponding author email: Zeshan.Ali@ugent.be

I. INTRODUCTION

Worldwide, broilers are raised in different production systems from extensive to intensive, covering a range of genetics and management practices. Influence of the production system on the oxidative stability of meat has not been widely studied [1]. Oxidation of myoglobin, lipids and protein are major causes of quality deterioration in meat [2]. Differences in *in vivo* and *postmortem* muscle metabolism may affect the endogenous antioxidant defense system and the release of pro-oxidants and reactive oxygen species, resulting in potential differences in resistance against oxidation. The main objective of the present study was to compare oxidation in breast and thigh meat from broilers produced in four divergent production systems in Belgium.

II. MATERIALS AND METHODS

In this study, 4 broiler production systems with distinctive characteristics (Intensive, Better Chicken Commitment (BCC), Slow growth with outdoor access and Organic) were selected (Table 1). From each production system, 5 farms randomly distributed in the country were chosen, and 15 broilers (mixed sex; 3 broilers per farm) were slaughtered and sampled. On day 2 after slaughter, the meat from the thigh and breast muscles (skinless) was minced and approximately 40 g was placed in petri dishes. These petri dishes were covered with a foil to limit dehydration and exposed to light (1600-2200 lux) for 7 days in the fridge at 2-4 °C. Colour lightness (L^*), redness (a^*), and yellowness (b^*) were measured daily in duplicate with a Hunterlab Miniscan colour meter (D65 light source, 10° standard observer, 45°/0° geometry, 1-inch light surface, white standard) to estimate colour stability. The difference (day1 – day7) in colour lightness (ΔL), redness (Δa), yellowness (Δb) and total colour difference ΔE ($\Delta E = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}$) was calculated for this purpose. On day 7, the samples were vacuum packed and frozen at -80°C for analysis of lipid and protein oxidation. Lipid oxidation was assessed in duplicate, spectrophotometrically by the thiobarbituric acid reactive substances (TBARS) method based on Tarladgis *et al*. [3] and expressed as malondialdehyde (MDA) in µg per g meat. Protein oxidation was measured in duplicate through the formation of protein carbonyls compounds (PCC), according to the method of Oliver *et al*. [4] with some modifications by Ganhao *et al*. [5]. PCC were determined spectrophotometrically, following their covalent reaction with 2,4-dinitrophenylhydrazine (2,4-DNPH), and expressed in nmol carbonyls per mg protein.

Table 1 Summary of production characteristics

	Intensive	BCC	Slow growth	Organic
Breed	Ross 308	RedBroM	Ja 757	Ruby XL (SASSO)
Age at slaughter (days)	39-42	42-45	56	73-76
Live weight at slaughter (kg)	2.6-2.8	2.4-2.6	2.1-2.3	2.3-2.5
Stocking density (kg/m^2)	42	30	27-33	21
Outdoor access	No	No	Yes (limited)*	Yes*

This data was summarized from 18 farms sampled so far (Intensive, Slow growth and Organic n=5 each, and BCC n=3)
*Outdoor access was temporarily not possible due to avian flu.

The data were analyzed by one-way ANOVA with production system as a fixed factor and storage time as random factor, in R studio.

III. RESULTS AND DISCUSSION

Colour (day 0). In breast, the *L** values were higher for Intensive and BCC chickens compared to Slow growth and Organic chickens, whereas in thigh the *L** values were higher for Intensive chickens compared to chickens from the other systems ($P < 0.001$). In both breast and thigh, the *a** and *b** values were lower for meat from Intensive and BCC chickens compared to Slow growth and Organic chickens ($P < 0.001$).
Colour stability. In breast, production system did not affect Δa and Δb. ΔL and ΔE differed ($P < 0.05$) among production systems, with breast of Slow growth chickens having higher ΔL and ΔE compared to breast from Intensive system ($P < 0.05$), and intermediate values for the BCC and Organic systems. In thigh, production system influenced the ΔL, Δb and ΔE values ($P < 0.05$) but not Δa values. ΔL was higher in thigh of Slow growth chickens compared to BCC chickens ($P < 0.05$), with intermediate values for the other two systems. Δb values were higher in thigh from Organic and Intensive system compared to BCC ($P < 0.05$). ΔE was higher ($P < 0.01$) in thigh from Slow growth and Organic compared to Intensive and BCC system.
Lipid oxidation. TBARS differed among production systems in both muscles ($P < 0.05$). In breast, higher lipid oxidation was found in Organic compared to Intensive and BCC chickens ($P < 0.05$). In thigh, lipid oxidation was higher in Organic and BCC than in Intensive and Slow growth chickens ($P < 0.05$). It must be mentioned that TBARS values after 7 days of simulated retail display were still low (average values < 0.2 µg/g meat), denoting no risk of rancidity [6].
Protein oxidation. No significant effect of the production system was observed on PCC values.

IV. CONCLUSION

This study revealed significant meat colour differences according to broiler production system, with meat from Intensive and BCC systems being paler, less red, and less yellow compared to meat from Slow growth and Organic systems. This was accompanied by slightly better colour stability based on lower ΔE values. The growth rate of the chickens seems to be the major factor involved. Small differences in lipid oxidation among production systems were also observed, whereas protein oxidation was not affected.

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