

SURVEY OF CARCASS PIGMENTATION VARIABILITY OF YELLOW-SKINNED BROILER CHICKENS

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Abstract

The appearance of whole carcass and skin-on cut-up products is an important attribute that deeply affects the consumers choice. Skin pigmentation is affected mainly by genetics, concentration and dietary source of pigments, health status of the birds, and scalding/plucking conditions during slaughtering, although other factors might play an important role. Retailers request batches of broiler chicken carcasses characterized by uniform skin pigmentation to be sold as whole carcass or parts. The aim of this study was to evaluate the variability of skin colour of yellow skinned broilers reared under intensive conditions. For the study, a total of 2,300 medium size broiler chickens (2,300-2,500 g of live weight) from 23 flocks (100 birds/flock; n=12 flocks of males and n=11 flocks of females) were randomly selected in a single slaughterhouse. The colour measurements were carried out on both breast and thigh pterylae as well as on shanks skin adopting the L* a* b* system and using a Minolta colorimeter CR 300. The overall range in measured yellowness (b*) was fairly large for all skin colour measurement positions. For breast it was observed a mean value of 22.77 (SD=5.12) with values ranging from 7.45 to 39.12. Average values of thigh and shank were 20.23 (SD=5.02; range 1.99-37.82) and 53.99 (SD=8.13; range 24.22-78.65), respectively. Comparing male and female birds, a higher skin yellowness in females in all body parts, was observed. Yellowness values of breast and thigh were significantly correlated ($r=0.85$; $P<0.01$) suggesting that the colour evaluation may be carried out only on one measurement position of the skin.

Keywords: Chicken, Skin, Pigmentation, Colour, Yellowness.

Introduction

Appearance is one of the most important factors affecting the consumers choice and sensory evaluation of the products. The consumer preferences for the skin colour of broiler chickens varies in the different part of the world, and are generally based on historical and regional supplies (Fletcher 1999). In North Italy, where maize, rich in yellow pigments, is cultivated, deeply yellow skin broiler are preferred, whereas in South Italy, where wheat, lacking in pigments, is cultivated, white or pale skinned broiler are preferred. The main world-wide reared modern broiler strains exhibit the ability to deposit pigments in the skin, however skin pigmentation is affected by genetics as well as by the amount and type of dietary pigments, health status of birds, sex and processing (Bilgili *et al.*, 1998; Fletcher, 2002; Petracci and Fletcher, 2002). Several researches have been carried out to study the biological availability and the skin colouring ability of several natural or synthetic pigments (Ouart *et al.*, 1988; Perez-Vendrell *et al.*, 2001; Castaneda *et al.*, 2005). The feed industry commonly adds pigments to the ingredients used for the production of yellow skinned broiler to meet the consumer demand. Due to the different factors affecting skin colour, the broiler carcasses are characterized by wide variations in colour but, on the other hand, consumers tend to evaluate in a positive way uniform products and negatively, or as a defect, non homogeneous products. For this reason retailers request batches of birds with a uniform skin pigmentation. Indeed, even though an increasing amount of broilers is sold as skinless raw products or further processed products, a large amount of birds is still sold as whole carcass or skin-on parts with main regard to thighs and drumsticks. Recently, Bianchi *et al.* (2007) also evidenced that the more yellow the colour of the skin, the more yellow the colour of raw breast meat.

Direct instrumental measurement has been proposed to evaluate skin colour broiler by several years (Fry *et al.*, 1969; Yacowitz *et al.*, 1978; Janky, 1986), however visual scoring systems are even today commonly used in poultry industries for evaluating broiler pigmentation.

The aim of this study was to evaluate the skin colour variation of yellow-skinned broiler chickens under commercial conditions.

Materials and Methods

A total of 2,300 medium size (2,300-2,500 g of live weight) broiler chickens Ross 308 and 508 from 23 flocks (100 birds/flock; n=12 flocks of males and n=11 flocks of females) were randomly selected in a single slaughterhouse.

The CIE (1978) system colour profile of lightness (L^*), redness (a^*), and yellowness (b^*) was measured by a reflectance colorimeter Minolta colorimeter CR 300 using illuminant source C. The colour measurements were carried out on both breast and thigh pteryllae as well as on shanks skin of carcasses collected after chilling. Males and females received the same multiphase corn-soybean diets formulated according to the Italian regional market needs for yellow skinned chickens with a total xanthophyll content ranging from 12 to 15 mg/kg feed. The data were analysed by descriptive statistics (mean, standard deviation, minimum and maximum values, skewness and kurtosis) for each colour coordinate (L^* a^* b^*) measured in the three measurement positions. Data were analysed by ANOVA of the GLM procedures of SAS software (SAS Institute, 1988) to test the effect of gender of the birds on skin colour. Pearson's correlation coefficients (r), regression model (R^2), and probabilities were calculated to evaluate the relationships between the colour parameters of breast, thigh and shank skin.

Results and Discussion

In Table 1 the descriptive statistics of skin colour coordinates of breast, thigh and shank are reported.

The average of lightness (L^*) in the different body parts increased from 75.40 (SD=2.05) to 77.21 (SD=1.87) and 79.96 (SD=1.68) respectively for breast, thigh and shank. The differences between the maximum and the minimum values for all body parts were 15-17 lightness points. The lightness of skin breast showed a not normal distribution due to the positive kurtosis (10.77) whereas thigh and shank exhibited a normal distribution. Values of redness, decreasing from breast to thigh and shank, were quite variable particularly in breast and thigh (SD=1.47 and 1.40, respectively).

The overall range in measured yellowness (b^*) was fairly large for all skin colour measurement positions. For breast it was observed a mean value of 22.77 (SD=5.12) with values ranging from 7.45 to 39.12. Average values of thigh and shank were 20.23 (SD=5.02; range 1.99-37.82) and 53.99 (SD=8.13; range 24.22-78.65), respectively.

Overall results evidenced a high variability of skin colour especially for yellowness (b^*) even if total xanthophyll content was rather homogeneous (from 12 to 15 mg/kg feed) among flocks. This result indicates that beside the pigment concentrations other factors can play an important role in determining the final skin colour of the birds.

The mean values found in this study are quite similar to those previously found by Bilgili *et al.* (1998) and Petracci and Fletcher (2002) in yellow-skinned broiler carcasses, whereas yellowness values were considerably lower than the findings by Pérez-Vendrell *et al.* (2001) which used birds fed diet with higher xanthophyll content.

Regarding the effect of gender, females showed a significantly higher values of lightness in breast and lower L^* values in thigh and shank than males (Figure 1). As for redness, females exhibited significantly lower values in all body parts (Figure 2). Although the differences were statistically different they were numerically small. The parameter that better describes the visual differences observed in skin colour is yellowness which was higher in females than males in either breast (24.9 vs. 20.4), thigh (22.2 vs. 18.1) or shank (56.5 vs. 51.3) skin (Figure 3). The higher level of yellowness observed in females broilers can be due to their higher subcutaneous fat indeed broilers deposit a portion of adsorbed dietary pigments into the fat other than in the skin (Fletcher, 1992).

Yellowness values of breast and thigh were significantly correlated ($r=0.85$; $P<0.01$; Figure 4) suggesting that the skin colour evaluation may be carried out effectively regardless of the measurement position.

This study indicated that a high degree of skin colour variability exists under commercial conditions with potential detrimental effects on the consistency of skin-on products' appearance. The gender of the birds is one important factor for this variability. Finally, in order to control the skin colour consistency among different flocks, measurements of skin colour can be easily carried out in one of the three locations purposed in this study.

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Table 1. Descriptive statistics of skin colour of breast, thigh and shank (n= 2,300).

	Mean	Minimum	Maximum	SD	Skewness	Kurtosis
<i>Breast</i>						
Lightness, L*	75.40	65.87	81.67	2.05	0.48	10.77
Redness, a*	1.16	-3.53	7.52	1.47	-0.10	-0.21
Yellowness, b*	22.77	7.45	39.12	5.12	0.01	-0.19
<i>Thigh</i>						
Lightness, L*	77.21	68.50	83.44	1.87	-0.22	0.36
Redness, a*	-0.04	-4.21	4.79	1.40	0.20	-0.19
Yellowness, b*	20.23	1.99	37.82	5.02	0.03	-0.07
<i>Shank</i>						
Lightness, L*	79.96	71.20	88.70	1.68	-0.44	1.45
Redness, a*	-3.47	-7.24	2.57	1.33	0.62	0.75
Yellowness, b*	53.99	24.22	78.65	8.13	-0.39	0.17

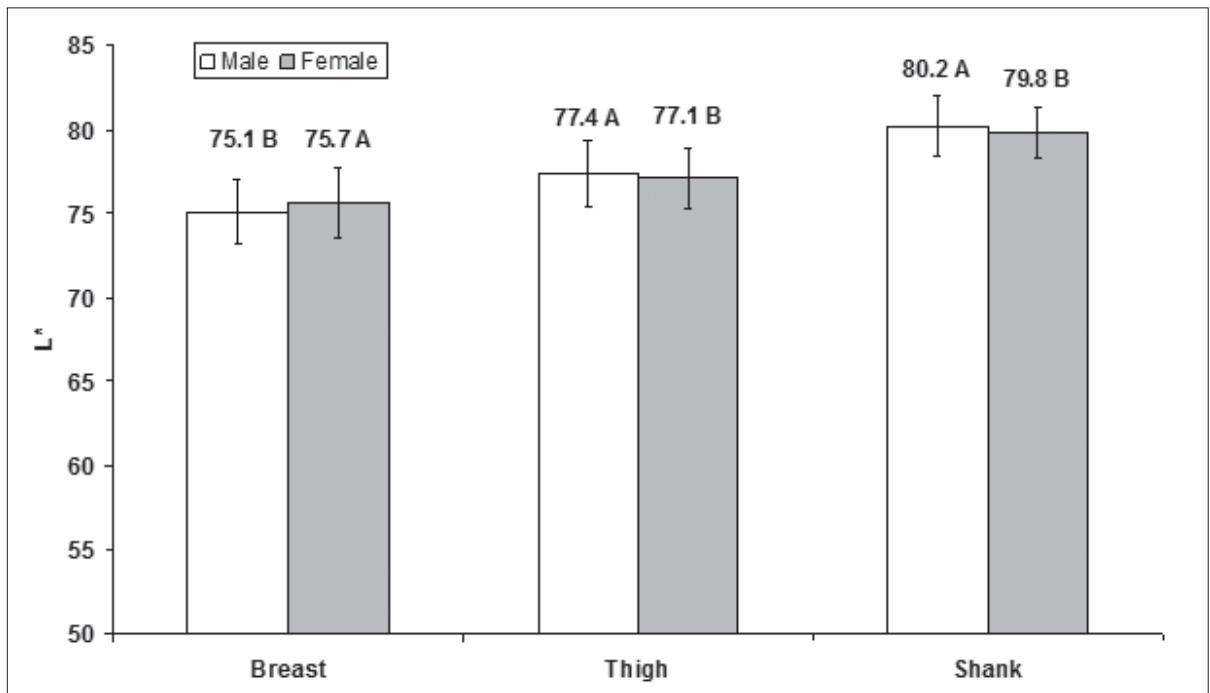


Figure 1. Effect of the gender on lightness (L^*) values (mean \pm SD) on the skin of breast, thigh and shank (A, B = $P \leq 0.01$).

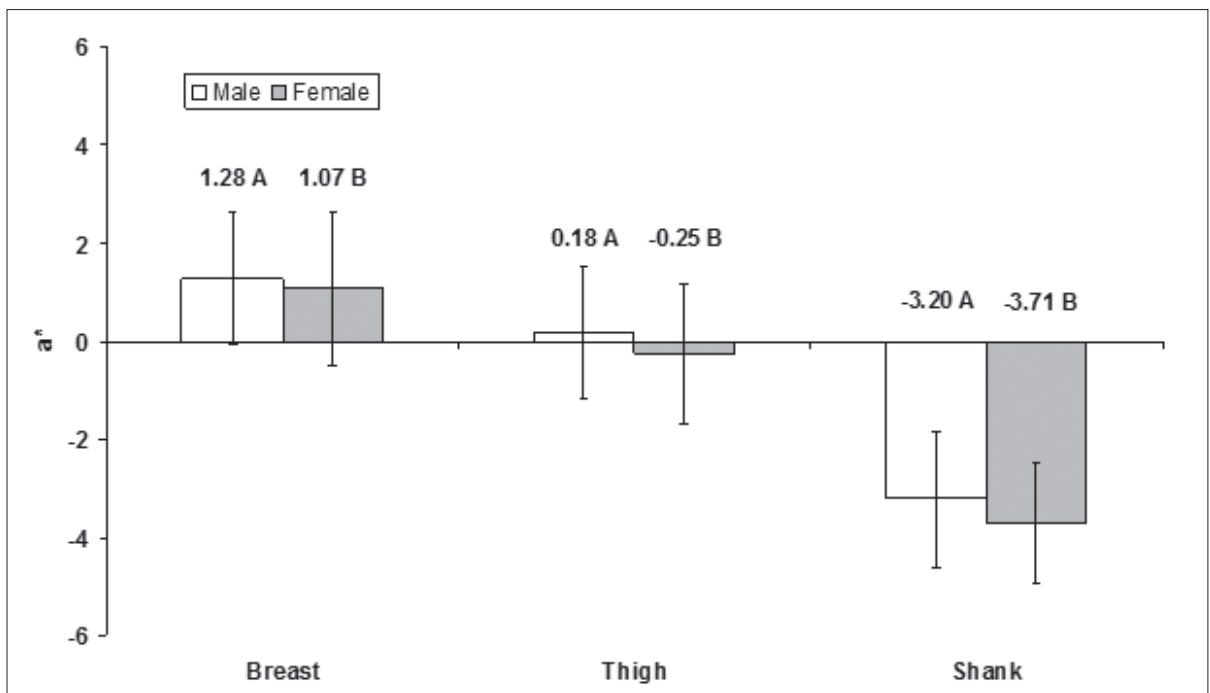


Figure 2. Effect of the gender on redness (a^*) values (mean \pm SD) on the skin of breast, thigh and shank (A, B = $P \leq 0.01$).

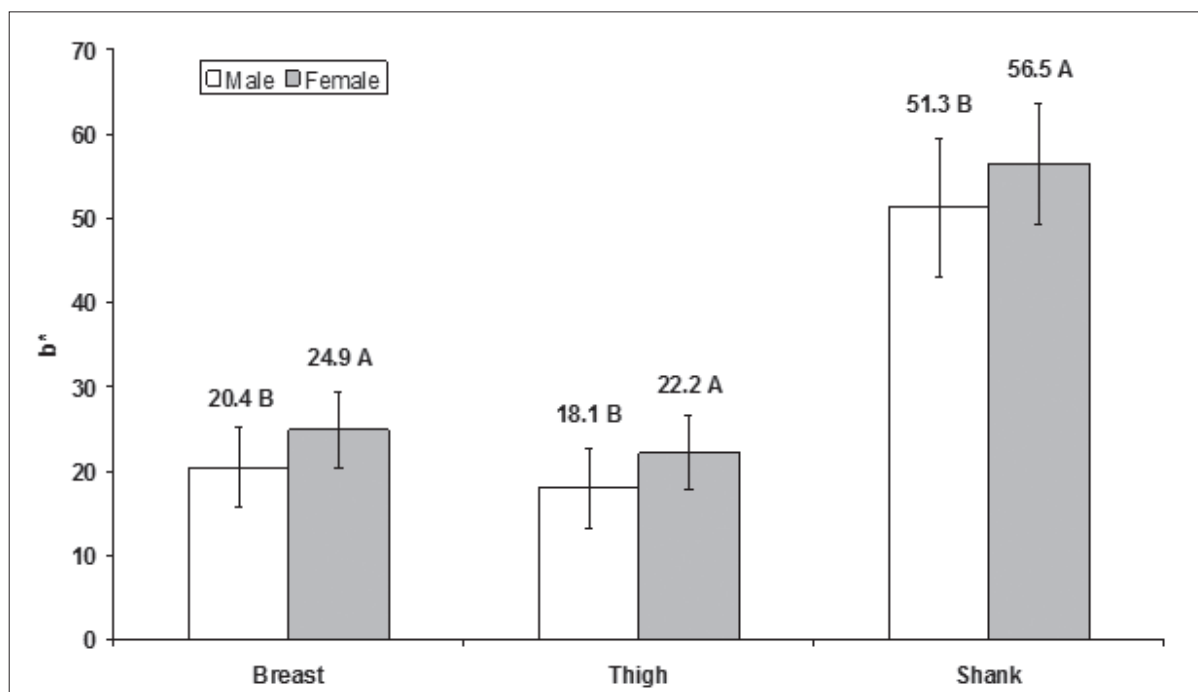


Figure 3. Effect of the gender on yellowness (b*) values (mean±SD) on the skin of breast, thigh and shank (A,B = P<0.01).

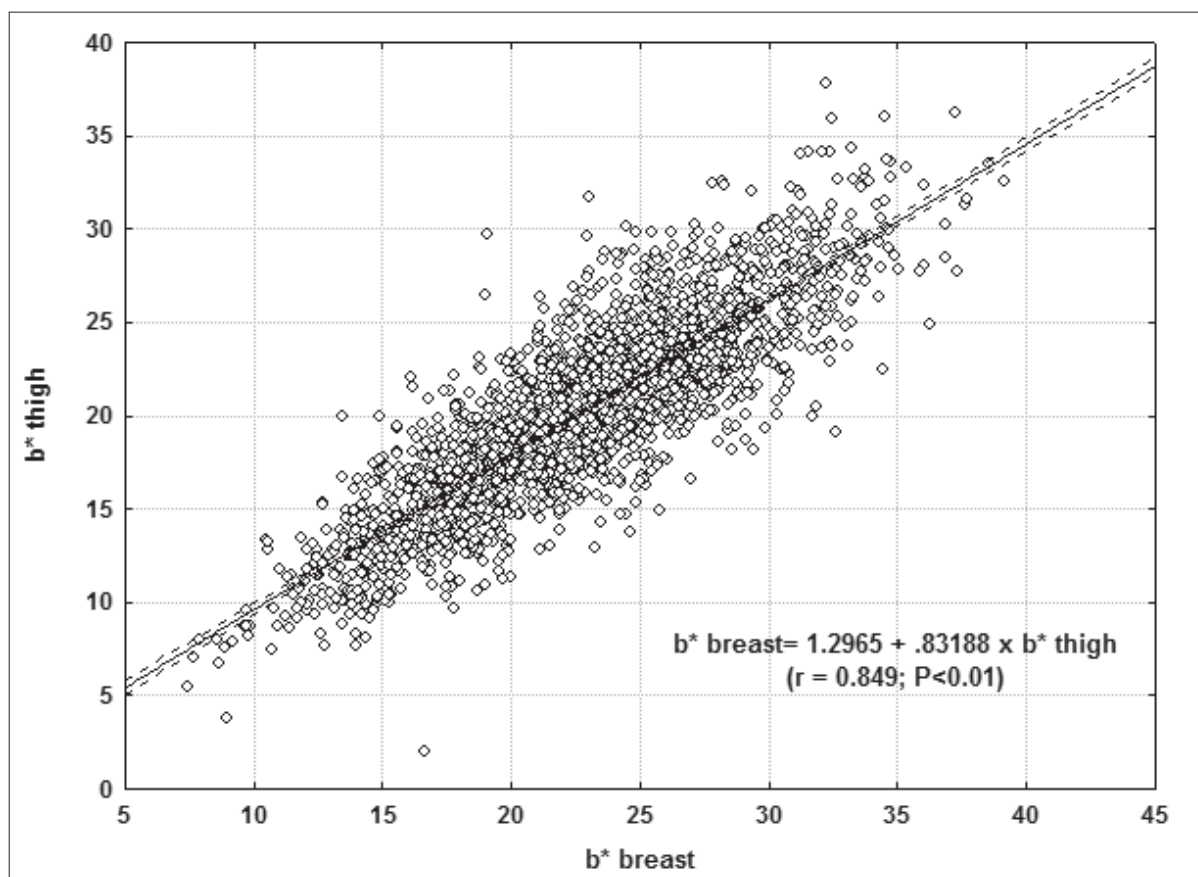


Figure 4 – Correlation between yellowness (b*) values of breast and thigh skin (n= 2,300).