Colour variation and stability in poultry meat

C. Werner, S. Janisch & M. Wicke
Institute of Animal Breeding and Genetics, Georg-August-University Goettingen, Albrecht-Thaer-Weg 3, D-37075 Goettingen.
*E-mail: carsten.werner@agr.uni-goettingen.de.

Abstract

The trend to self-service trays with several meat pieces makes colour differences within the same package or in comparison to neighboring trays more obvious. The consumers are unsettled and complaints in retail increase. Therefore in the presented study the variability of the colour values (L*a*b*) and the colour development during storage of poultry meat was analysed. The L*a*b values on the surface of the *M. pectoralis superficialis* (*MPS*) of 160 broilers and 120 turkeys were determined at different times up to 72 h post mortem. The data show that the variation of the L* was low in the broiler and turkey *MPS* at all times whereas the variation of a* and b* was rather high. During meat storage L* and b* values increase in both poultry species. However, a* decreases in broiler and increases in turkey meat. The correlation between early and late post mortal colour values is rather low. The data indicate that early sorting might reduce the colour differences in the trays but can not fully prevent them due to the imprecise prediction of the late colour development. Further research is necessary to generally reduce the colour variation and to find indicators that improve early colour prediction.

Introduction

The shift in the poultry market from whole birds to further processed meat products increases the incidence of physical appearance changes of meat in the poultry processing industry and retail (Guidi et al., 2006). Especially the trend to self-service trays with several pieces of meat makes colour differences within the same package or in comparison to neighboring trays more striking. This irritates the consumer and increases complaints in retail. However, the variation of the meat color is up to a certain grade physiological, but the differentiation to pathological alterations like pale, soft and exudative (PSE)-like meat is important because the latter is characterized by a paler color, a heterogeneous appearance, a poorer texture and cohesiveness as well as a higher drip loss (Berri et al., 2007). Early information about the development of meat quality is important for the poultry industry to reduce the color differences before subsequent packaging and to exclude meat with less acceptable appearance. The aim of the present study was the analysis of the colour variation and the stability during storage of poultry meat with special focus on the main species broiler and turkey.

Material and methods

One hundred sixty broiler (mixed sex, mean age: 32 d) of the genetic Ross 308 (Ross, Aviagen Ltd., Midlothian, UK) were slaughtered at four different slaughter dates (N = 40/ slaughter) and 120 turkey toms (mean age: 147 d) of the genetic strain B.U.T. Big 6 (Big 6, Aviagen Turkeys Ltd., Tattenhall, UK) were slaughtered at three different slaughter dates (N = 40/ slaughter) in a commercial broiler or turkey abattoir. Before entering the chilling room the broiler and turkey carcasses were removed from the slaughter chain and the left *M. pectoralis superficialis* (*MPS*) were carefully excised from the carcasses.

The color values lightness (L*), redness (a*) and yellowness (b*) of the *MPS* were evaluated with a colorimeter (Minolta CR 400, Minolta GmbH, Langenhagen, Germany) 20 min, 90 min, 180 min, 24 h, 48 h and 72 h after slaughter on the medial surface (bone side). The surface was exposed to air for 15 min at room temperature before determining the color at the intersection area of the muscle. Between the analyses the muscle samples were stored at 4°C in a box equipped with a lid. Each value was an average of at least four measurements.

The (statistical) analysis of the data was performed with the software package STATISTICA 7.1. Results for the individual birds were subjected to the GLM. Statistical significance was calculated with the TUKEY post-hoc test considering a probability error P of 0˙05.

Results and discussion

The colour analysis of the *MPS* showed that the lightness values in both poultry species had a low variation whereas the standard deviations of the redness and yellowness values were rather high. Comparing the colour values between the poultry species the study showed that the turkey breast muscles were significantly ($P<0.05$) darker than those of the broiler, whereas the latter species had significantly ($P<0.05$)

lower redness and higher yellowness values (Table 1).

Table 1. Least square means (LSM) and standard deviation (SD) of the colour values of the investigated broiler (Ross 308) and turkey (B.U.T. Big 6) *MPS*

	Broiler (N = 160)		Turkey (N = 120)	
	LSM	SD	LSM	SD
$L^*_{24\ h\ p.m.}$	52.51[b]	2.43	50.96[a]	2.43
$a^*_{24\ h\ p.m.}$	2.98[a]	0.93	3.68[b]	0.90
$b^*_{24\ h\ p.m.}$	6.65[b]	1.26	3.89[a]	1.09

[1]Lightness (L*), redness (a*) and yellowness (b*) were determined on the medial surface (bone side) of the *MPS* 24 h post mortem; [ab]LSM with different superscripts in a line differ significantly (P<0.05).

A comparison of the presented data with recently published results is difficult because factors like the diet, slaughter age or the preparation of the breasts weighing differ, but the presented data are "within the range" of results presented in publications that used muscle samples from broiler (Van Laack et al., 2000; Woelfel et al., 2002; Debut et al., 2003; Young et al., 2004; Mehaffey et al., 2006; Nissen and Young, 2006; Berri et al., 2007, 2008) and turkey (Fernandez et al., 2001; Hahn et al., 2001; Le Bihan-Duval et al., 2003; El Rammouz et al., 2004; Grashorn and Bessei, 2004; Molette et al., 2005; Updike et al., 2005; Fraqueza et al., 2006; Guidi et al., 2006).

During storage of the MPS an increase of the lightness and yellowness values on the surface of the muscle could be determined not only in the broiler, but also in the turkeys. The progression of the L* and b* is parallelly with generally higher values of the broiler breast muscle. In contrast to this, the redness of the MPS increased in turkey, whereas in the broiler the a* values slightly decrease. It is interesting to note, that in both poultry species the L* and a* values initially decrease shortly after slaughter up to 180 min before a clear increase could be determined (Figure 1). The increase in the lightness and redness values in both poultry species was already presented by other authors (Ristic 1978; Le Bihan-Duval et al., 1999; Owens et al., 2000; Berri et al., 2001; Fernandez et al., 2001; Qiao et al., 2001; El Rammouz et al., 2004; Molette et al., 2005).

The regression analysis of the L* values determined 20 min, 90 min and 180 min, 24 h and 48 h in relation to the $L^*_{72\ h\ p.m.}$ showed an increase of the correlation coefficients from 0.39 ($L^*_{20\ min\ p.m.}$) to 0.81 ($L^*_{48\ h\ p.m.}$) in broiler whereas in the turkeys the r-values increase more irregular from 0.58 ($L^*_{20\ min\ p.m.}$) to 0.70 ($L^*_{48\ h\ p.m.}$) with a drop 180 min p.m. (r = 0.39). The data indicate that in broiler and turkey meat prevision of the colour at an early period after slaughter is less

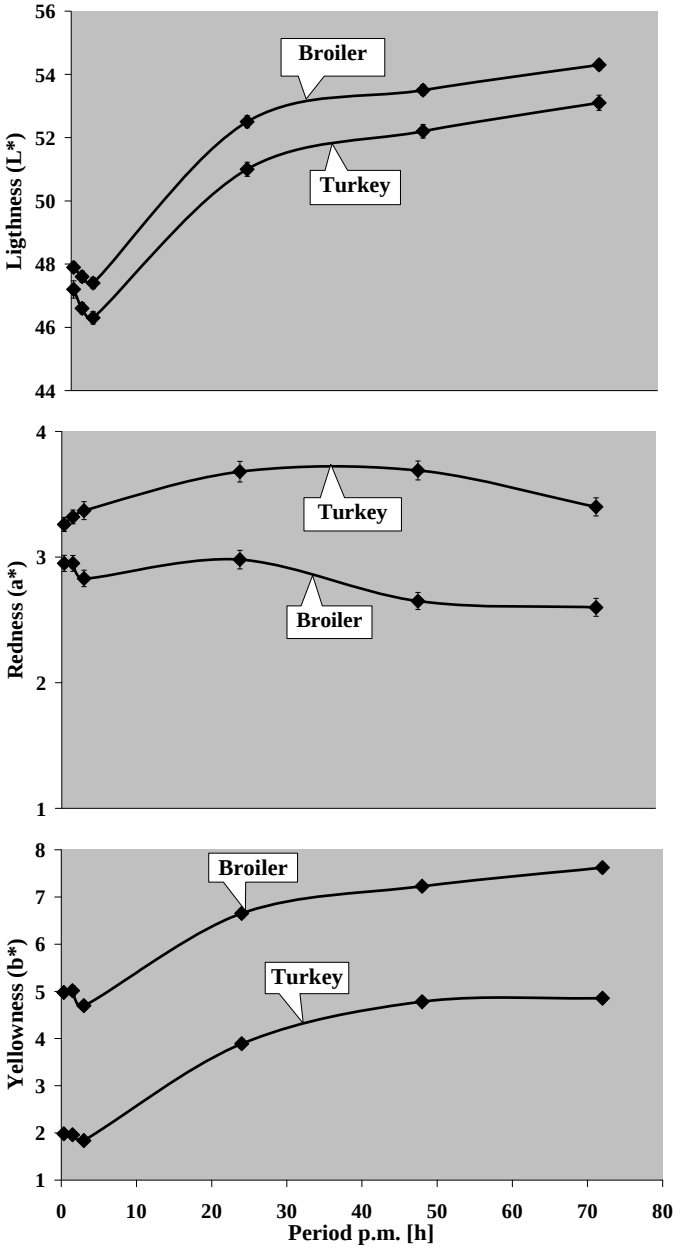

Figure 1. LSM and standard error of means (SEM) of the lightness (L*), redness (a*) and yellowness (b*) values during cold storage of the MPS (at 4°C) of the investigated broiler (Ross 308, N = 160) and turkey (B.U.T. Big 6, N = 120) *MPS*. The L*a*b* values were determined on the medial surface (bone side) of the breast muscle samples.

imprecise than at a later point of time.

Considering the presented results it can be concluded that the poultry meat industry should sort the *MPS* before packing them to self-service trays otherwise colour differences within the same package could not be reduced. The presented data also indicate that sorting of the *MPS* shortly after slaughter is less useful. However, as the poultry industry is interested to deliver the self-service trays to the retail as quick as possible colour variation in the package could not be fully prevented by sorting. Therefore it is necessary to generally minimize the colour variation in the *MPS* on the one hand by optimizing the exogenic factors that influence the post mortal colour development like feeding, transport, lairage, stunning and scalding, on the other hand by selection of poultry genotypes with a reduced colour variation.

Table 2. Pearson correlation coefficients of the lightness (L*) values determined 20 min, 90 min, 180 min, 24 h and 48 h after slaughter (p.m.) in relation to $L^*_{72\ h\ p.m.}$

	Broiler (N = 160)	Turkey (N = 120)
	$L^*_{72\ h\ p.m.}$	$L^*_{72\ h\ p.m.}$
$L^*_{20\ min\ p.m.}$	0.39*	0.58*
$L^*_{90\ min\ p.m.}$	0.52*	0.53*
$L^*_{180\ min\ p.m.}$	0.68*	0.39*
$L^*_{24\ h\ p.m.}$	0.78*	0.68*
$L^*_{48\ h\ p.m.}$	0.81*	0.70*

* Significant correlation between the parameters ($P<0.05$)

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