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Quality indicators of broiler breast meat in relation to colour

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The aim of the study was to investigate the relationship between colour, final pH and drip loss and to determine the incidence of PSE and DFD meat in Cobb 500 and Hubbard Classic broiler chickens. The carcass weight, breast meat weight and its share (%) of broiler carcass, pH_u, breast meat colour (CIE-L*a*b*) and drip loss (%) were measured. On the basis of paleness (L*) breast meat was classified into DFD (L*<44), "normal" (L*=44-53) and PSE (L*>53). Seventy five per cent of breast meat from Cobb 500 and seventy from Hubbard Classic were classified as "normal". Breast meat classified as PSE had higher L*, lower pH_u and higher drip loss (%) that than of normal characteristics. The opposite was found for DFD meat. Negative correlation between CIE-L and pH_u and positive correlations between L* and b* values as well as between L* and drip loss (%) in both hybrid lines were determined.

KEY WORDS: chicken / DFD / meat quality / PSE

The success in broiler production is mainly dependent on the selection of a proper hybrid. This has motivated breeding companies to produce highly productive broiler strains with fast weight gain, high feed conversion and meat with satisfactory nutritive and technological quality.

However, in chicken meat, like in pigs', due to accumulation of lactate in *post mortem* muscle, incidence of meat quality deterioration in form of PSE (pale, soft, exudative) and DFD (dark, firm, dry) meat can occur. A number of factors can lead

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to development of PSE and DFD meat. These include *ante mortem* handling of the chicken [Guarnieri *et al.* 2004], feed [Olivo *et al.* 2001], genetic background [Lara *et al.* 2003] and lipid oxidation [Soares *et al.* 2009]. Quiao *et al.* [2001] have classified chicken breast muscle into three groups according to the colour: "lighter than normal" (L*>53), "normal" (48<L*>53) and "darker than normal" (L*<48). Based on their earlier investigations of relationship between ultimate pH and broiler breast fillet colour, Soares *et al.* [2009] have proposed the following criteria for classification of breast meat into quality categories: L*≥53 for PSE, L≤44 for DFD like and 44<L*<53 for normal meat. Medić *et al.* [2009] reported that PSE chicken is often characterised with lower ultimate pH values (<5.6). Several authors have found a negative correlation between colour and pH of chicken breast meat [Barbut 1993, Fletcher 1995, Allen *et al.* 1998]. Chicken meat with lower ultimate pH values has lower water holding capacity which influences cooking loss and drip loss, while meat with higher ultimate pH is often characterised by increased tenderness [Froning *et al.* 1978, Barbut 1993] and improved shelf life [Allen *et al.* 1997]. Meat colour is associated with pH in a way that lighter muscles (L*>50) have higher pH values than darker (L*<45) ones [Allen *et al.* 1998]. Fletcher *et al.* [2000] have established a significant correlation between pH and extreme colour variations, while Salakova *et al.* [2009] have determined a negative correlation between pH, L* and b* and positive between pH and a* values.

The aim of this research was to investigate relationship between colour and pH values, as well as with drip loss in breast meat of Cobb 500 and Hubbard Classic broiler chickens and to determine incidence of PSE and DFD meat in these two strains.

Material and methods

The study was conducted on 85 Cobb 500 and 81 Hubbard Classic broiler chickens of mixed sex. Both hybrids were fed same feed and were raised under same conditions. Birds were fed starter diet containing 23% CP and 12.64 MJ/kg ME from day 1 to 21, and from day 22 until slaughter they were fed diet containing 19% CP and 13.50 MJ/kg ME. After day 42 broilers were slaughtered and carcasses were processed according to Croatian regulations N.N. 78/11 and N.N. 67/12. After 24 h of cooling the carcasses their weight and technological meat quality traits were measured. Ultimate pH values (pH_u) were determined on *Pectoralis major* muscle 24h *post mortem* with Mettler MP 120-B digital pH-meter. The colour of breast meat was determined after 24 h of cooling the carcass with Minolta CR-300 colorimeter (MINOLTA CAMERA Co. Ltd., Osaka, Japan) calibrated against white plate (L*=93.30; a*=0.32 and 1.8; b*=0.33) with 8 mm optical probe diameter, D65 illuminant and 2° observer. The meat colour is presented as CIE-L*a*b* (Commission Internationale de l'Eclairage, 1976). Drip loss was determined by bag method according to Honikel [1987]. Depending on the colour breast meat samples were classified into following groups: DFD (L*<44), "normal" (44<L*<53) and PSE meat (L*>44) – Soares *et al.* [2002, 2009].

The obtained data were subjected to one-way ANOVA (Statistica for Windows v. 8.0). The differences between hybrids were tested using Fisher LSD test, where $P<0.05$ was classified as significant. The relationship between investigated technological meat quality traits is described by linear regression and correlation (r). In cases where $P<0.05$, correlation coefficient *(r)* was classified as significant.

Results and discussion

Table 1 presents differences between investigated hybrid strains in slaughter and meat quality traits. There were no significant differences between broilers in carcass weight, L* and b* values. A significant difference between two hybrids was found for a* values, which indicates that Hubbard Classic broilers had more pronounced redness in their breast muscle than did Cobb 500 strain.

Table 1. Slaughter and meat quality traits (mean±SD) of investigated hybrids

Trait	Cobb 500 strain (n=85)	Hubbard Classic strain (n=81)	P
Carcass weight (g)	1483.60±253.42	1472.10±242.79	0.632
Breast meat weight (g)	542.02±114.90	502.96±103.85	**0.023**
Share of breast meat (%)	37.08±2.98	34.02±2.52	**<0.001**
pH_u	5.99±0.16	5.90±0.20	**0.001**
L*	49.93±4.87	51.11±2.62	0.080
a*	1.73±1.21	2.57±1.32	**<0.001**
b*	10.17±2.11	10.50±2.19	0.326
Drip loss (%)	2.30±0.75	2.72±0.78	**0.041**

It can be noticed that breast meat with higher L* values had lower pH_u, which is in accordance with investigations of Qiao *et al.* [2001] and Medić *et al.* [2009]. Salakova *et al.* [2009] have determined a negative correlation between pH and L* values ($r = -0.41$, $P<0.001$). This was also in accordance with Fletcher [2000]. Janisch *et al.* [2011] have determined only small differences in meat quality traits (pH, electric conductivity, a*, b*) between hybrid broilers aged 28 and 42 days, where L* values were higher in older chicken, while higher a* and b* values were found in breast meat of younger chicken. Similarly, Muthukumar *et al.* [2011] have found that birds with slaughter weight higher than 2000 g had higher a* and b* and lower L* values than birds with lower slaughter weights. Petracci and Fletcher [2002] reported a significant alteration of chicken meat and skin colour during first 6h *post mortem*, afterwards these changes were minimal. Allen *et al.* [1998] have grouped breast meat samples into "light" (L*>50) and "dark" group (L*<45) and reported that "light" breast muscles had higher b* and a* values, as well as considerably lower pH than "dark" muscles. Ristić and Klaus [2010] have determined significant differences between chicken sexes and genotypes in pH values measured 15 minutes *post mortem*. They assumed that meat quality (PSE and DFD) can be predicted by initial pH and proposed

following critical values: ≤5.8 (PSE), 5.9-6.2 ("normal"), ≥6.3 (DFD). Opposite to this, Le Bihan-Duval *et al.* [2008] proposed ultimate pH as a criterion for meat quality prediction, because this trait is significantly associated with colour, water holding capacity and tenderness.

Table 2 presents pH, colour and drip loss values when breast muscles were classified into PSE, "normal" and DFD meat. It can be noticed that 20% of Cobb 500 and 27.12% of Hubbard Classic broiler chicken breasts were classified as PSE meat, while 75.29% of breast samples from Cobb 500 and 70.3% of breast samples from Hubbard Classic broilers exhibited L* values from 44 to 53 which classified them to "normal" quality group. As expected, breast muscles classified as PSE meat exhibited lower pH_u and higher L* values than breasts classified as "normal". Furthermore, drip loss was higher in PSE group and lower in DFD group, comparing to the "normal" breast meat classified in both broiler lines. This is in accordance with investigations of Froming *et al.* [1978] and Barbut [1993].

Table 2. pH, colour and drip loss values for PSE, "normal" and DFD meat

Category	n	%	pH_u	L*	a*	b*	Drip loss (%)
			Cobb 500 strain (n = 85)				
PSE	17	20.00	5.88	56.76	1.14	12.76	3.45
"normal"	64	75.29	6.02	48.53	1.87	9.63	2.11
DFD	4	4.71	6.35	43.35	2.03	7.89	1.50
			Hubbard Classic strain (n=81)				
PSE	22	27.12	5.84	55.55	2.15	12.59	3.24
"normal"	57	70.37	5.91	49.68	2.29	9.80	2.44
DFD	2	2.47	6.40	42.88	2.69	7.58	1.55

Tables 3 and 4 contain correlation coefficients between L* value, *i.e.* level of paleness and technological meat quality, breast meat weight and share of breast meat in investigated broiler lines. In both hybrids a negative correlation coefficient (*r*) between L* and a*, pH_u and breast meat weight was determined. Opposite to this, with the increase of L* value, an increase of b* and drip loss (%) in chicken breast meat

Table 3. Correlation coefficients (*r*) between L* and investigated meat quality traits and regression equations for prediction of L* value in Cobb 500 hybrid line

Trait	Correlation (*r*)	P (*r*)	Regression equation
a*	-0.309	**0.004**	52.078 - 1.241x
b*	0.650	**<0.001**	34.653 + 1.502x
pH_u	-0.285	**0.008**	102.072 - 8.705x
Drip loss (%)	0.353	**0.009**	45.363 + 2.010x
Breast meat weight (g)	-0.107	0.331	52.383 - 0.004x
Share of breast meat of carcass (%)	0.130	0.237	42.085 + 0.212x

Table 4. Correlation (*r*) between L* and investigated meat quality traits and regression equations for prediction of L* value in Hubbard Classic hybrid line

Trait	Correlation (*r*)	P (*r*)	Regression equation
a*	-0.011	0.919	51.190-0.031x
b*	0.428	**<0.001**	43.680+0.707x
pH_u	-0.438	**<0.001**	97.367-7.842x
Drip loss (%)	0.476	**0.002**	46.182+0.924x
Breast meat weight (g)	-0.322	**0.003**	56.751-0.011x
Share of breast meat of carcass (%)	-0.300	0.107	65.757-0.431x

can be observed. The correlation between L* value and share of breast meat in Cobb 500 was positive ($r = 0.130$) and in Hubbard Classic negative ($r = -0.300$). However, these correlations were not significant in both investigated hybrids. Moreover, the correlation between L* value and body weight (Hubbard Classic), as well as with L* and a* value (Cobb 500) was also not significant (P=0.331 and P=0.919). However, a significant correlation between L* and b* values was found. The *r* coefficient of correlation was between 0.428 for Hubbard Classic and 0.650 for Cobb 500. With the drop of pH_u an increase of L* values could be observed in both Cobb 500 ($r = -0.285$; y=102.072-8.750x) and Hubbard Classic ($r = -0.438$; y=97.367-7.842x) hybrid lines. The correlation between L* values and drip loss (%) was positive and medium high in Hubbard Classic ($r = 0.476$), while in Cobb 500 it was also positive, although with lower *r* coefficient (0.353).

Summarizing, the results presented here show that meat from Hubbard Classic broilers had different quality traits as compared to Cobb 500 hybrid line. A significant negative correlation between L* and pH_u and between L* and drip loss was established, while the regression equations show a linear relationship between investigated slaughter and meat quality traits. In conclusion, these results can help processing plants to make important decisions on further processing of chicken breast meat into different products.

REFERENCES

1. ALLEN C.D., RUSSEL S.M., FLETCHER D.L., 1997 – The relationship of broiler breast meat color and pH to shelf-life and odour development. ***Poultry Science*** 76, 1042-1046.
2. ALLEN C.D., FLETCHER D.L, NORTHCUTT J.K., RUSSELL S.M., 1998 – The relationship of broiler breast color to meat quality and shelf-life. ***Poultry Science*** 77, 361-366.
3. BARBUT S., 1993 – Colour measurements for evaluating the pale, soft, exudative [PSE] occurrence in turkey meat. ***Food Research International*** 26, 39-43.
4. FLETCHER D.L., 1995 – Relationship of breast meat colour variation to muscle pH and texture. ***Poultry Science*** 74S, 120.
5. FLETCHER D.L, QIAO M, SMITH D.P., 2000 – The relationship of raw broiler breast meat color and pH to cooked meat color and pH. ***Poultry Science*** 79, 784-788.
6. FRONING G.W., BABJI A.S., MATHER F.B., 1978 – The effect of preslaughter temperatures, stress, struggle and anesthetization on color and textural characteristic of turkey muscle. ***Poultry Science*** 57, 630-633.

7. GUARNIERI P.D., SOARES A.L., SCHNEIDE J.P., MACEDO R.M., IDA I.E., SHIMOKOMAKI M., 2004 – Preslaughter handling with water shower spray inhibits PSE (Pale, Soft, Exudative) broiler breast meat in a commercial plant. Biochemical and ultrastructural observations. ***Journal of Food Biochemistry*** 28, 269-277.
8. JANISCH S., KRISCHEK C., WICKE M., 2011 – Color values and other meat quality characteristics of breast muscles collected from 3 broiler genetic lines slaughtered at 2 ages. ***Poultry Science*** 90, 1774-1781.
9. LARA J.A.F., NEPOMUCENO A.L., LEDUR M.C., IDA E.I., SHIMOKOMAKI, M., 2003 – Mutations in the ryanodine receptor gene. Proceedings of 49th International Congress of Meat Science and Technology, Brazil, p79-80.
10. LE BIHAN-DUVAL E., DEBUT M., BERRI C.M., SELLIER N., SANTE-LHOUTELLIER V., JEGO Y., BEAUMONT, C., 2008 – Chicken meat quality: genetic variability and relationship with growth and muscle characteristics. ***BMC Genetics*** 9, 53.
11. MEDIĆ H., VIDAČEK S., SEDLAR K., ŠATOVIC V., PETRAK T., 2009 – Utjecaj vrste i spola peradi te tehnološkog procesa hlađenja na kvalitetu mesa. ***Meso*** 11(4), 223.-231.
12. MUTHUKUMAR M., SEN A.R., NAVEENA B.M., VAITHIYANATHAN S., GIRISH PATIL S., 2011 – Carcass traits and meat quality attributes of broilers grown to different body weights. ***Indian Journal of Animal Sciences*** 81(6), 615-620.
13. QIAO M., FLETCHER D.L., SMITH D.P., NORTHCUTT J.K., 2001 – The Effect of Broiler Breast Meat Color on pH, Moisture, Water-Holding Capacity, and Emulsification Capacity. ***Poultry Science*** 80, 676-680.
14. OLIVO R., SOARES A.L., IDA E.I., SHIMOKOMAKI M., 2001 – Dietary vitamin E inhibits poultry PSE and improves meat functional properties. ***Journal of Food Biochemistry*** 25, 271-283.
15. PETRACCI M., FLETCHER D.L., 2002 – Broiler skin and meat color changes during storage. ***Poultry Science*** 81, 1589-1597.
16. PRAVILNIK O TRŽIŠNIM STANDARDIMA ZA MESO PERADI. 2011 – ***Narodne novine*** br. 78.
17. PRAVILNIK O IZMJENAMA I DOPUNAMA PRAVILNIKA O TRŽIŠNIM STANDARDIMA ZA MESO PERADI. 2012 – ***Narodne novine*** br. 67.
18. RISTIĆ M., KLAUS D., 2010 – The meaning of pH-value for the meat quality of broilers – Influence of breed lines. ***Tehnologija mesa*** 51 (2), 115-119.
19. SALÁKOVÁ A., STRAKOVÁ E., VÁLKOVÁ V., BUCHTOVÁ H., STEINHAUSEROVÁ I., 2009 – Quality Indicators of Chicken Broiler Raw and Cooked Meat Depending on Their Sex. ***Acta Veterinaria Brno*** 78, 497-504.
20. SOARES A.L., LARA J.A., IDA E.I., GUARNIERI P.D., OLIVO R., SHIMOKOMAKI M., 2002 – Variation in the Color of Brazilian Broiler Breast Fillet. Proceedings of 48th International Congress of Meat Science and Technolology**,** Rome, Italy, P 540-41.
21. SOARES A.L., MARCHI D.F., MATSUSHITA M., GUARNIERI P.D., DROVAL A.A., IDA E.I., SHIMOKOMAKI M., 2009 – Lipid oxidation and fatty acid profile related to broiler breast meat color abnormalities. ***Brazilian Archives of Biology and Technology*** 52(6), 1513-1518.
22. STATSOFT, INC. 2007 – STATISTICA [data analysis software system], version 8. www.statsoft.com