



International 58th Meat Industry Conference “Meat Safety and Quality: Where it goes?”

The effect of breed line and age on measurements of pH-value as meat quality parameter in breast muscles (*m. pectoralis major*) of broiler chickens

Natasa Glamoclija^{a,*}, Marija Starcevic^a, Jelena Janjic^a, Jelena Ivanovic^a, Marija Boskovic^a, Jasna Djordjevic^a, Radmila Markovic^a, Milan Z. Baltic^a

^aFaculty of Veterinary Medicine, Bulevar Oslobođenja 18, 11000 Belgrade, Serbia

Abstract

The objective of this study was to determine the effect of breed line and age on pH in broiler chicken breast muscles. pH values of *m. pectoralis major* muscle were compared within 6 groups - each line (Cobb, Ross, Hubbard) was divided into two groups aged 42 and 50 days. pH values were recorded 15 minutes, 24 and 48 hours after slaughtering. Older broilers showed significantly lower pH than younger ones. Interactions between breed line and age were found, except for pH after 24 hours. Meat quality of broilers can be estimated quickly by determining the pH-value of breast meat.

© 2015 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Peer-review under responsibility of scientific committee of The 58th International Meat Industry Conference (MeatCon2015)

Keywords: Cobb; Ross; Hubbard; meat quality; pH-value

1. Introduction

Nowadays, poultry meat is one of the most important foods in many cultures around the world, due to its nutritional characteristics. Apart from the quantities of meat that must be produced, the quality of the products must

* Corresponding author. Tel.: +381-64-166-166-5.
E-mail address: glamonata@gmail.com

be maintained in order to satisfy the demand under quality and health conditions¹. The major attributes which define the quality of the poultry and other types of meats as well are appearance, texture, juiciness, flavor, and functionality. A critical attribute for successful product formulation and process control is pH value as a functional property². Because of that, the meat industry has developed several methods to assess meat quality, such as pH. Some authors^{3,4} reported significant correlations between muscle pH value and poultry meat quality. The pH (a measure how acidic or basic a solution is) of meat can range from about 5.2 to 7.0. The pH value of meat is influenced by various factors such as genetics - breed lines, gender, the manner of holding animals, transport, lairage conditions and time - pre-slaughter stress, method of slaughter, technological parameters and post-mortem handling, storage time of meat, etc.⁵. Also, the pH value of the meat depends on the muscle type of the same animal; therefore, it is necessary to standardize the region of the muscle wherein the pH value will be measured. For measuring the pH of the broiler meat it is the best to use the *m. pectoralis major*^{6,7,8}. Generally, ultimate pH value is measured in broiler breast 24 hours after slaughter, but also similar value can be measured after 6 to 8 hours⁶. According to many researchers, the highest quality products of broiler breast meat usually tend to fall within ultimate pH range of 5.7 to 6.0^{5,9,10,11,12,13}. Many authors agree that pH value 15 to 30 minutes after slaughter can be a reliable indicator of broiler meat quality^{14,15,16,17,18}. Today, the main problem connected with pH value is PSE (pale, soft and exudative) broiler meat, and its typical characteristics have been reported by a number of authors^{4,13,16,19,20,21}. The aim of this study was the determination of pH value as a meat quality parameter of broilers shortly after slaughtering depending on breeding and age.

2. Materials and methods

The study was conducted on 300 commercial market broilers (100 Cobb 500, 100 Ross 308 and 100 Hubbard Classic) which were divided into six groups - each line was divided into two groups of broilers. The first group were 42 and the second 50 days old. Broilers were between 2000 and 2600 grams of live weight. The groups were fed according to a breeder feeding program based on recommended nutrient levels. Broilers were slaughtered in a registered slaughterhouse.

Meat quality measurements were carried out on *m. pectoralis major*. pH values at 15 minutes, 24 and 48 hours (pH_{15min} , pH_{24h} , pH_{48h}) were measured on fifty carcasses from each group (total 300 carcasses). pH values were measured using a pH Measuring Instrument (Germany, Testo 205) by penetration in breast muscle.

Statistical analysis of the results was conducted using the software GraphPad Prism Version 5.00 for Windows (GraphPad Software, San Diego, California USA, www.graphpad.com). Mean values were calculated and the groups were compared with one-way ANOVA with Tukey's multiple comparison statistical test and two-way ANOVA with Bonferroni post test. Bonferroni post test was performed to test the effect of broilers line (Cobb, Ross and Hubbard) and age (42 and 50 days) as main effects, and their interaction on pH values. Values of $p < 0.05$ were considered significant.

3. Results and discussion

pH values (30 minutes, 24 and 48 hours after slaughter) of the 42 and 50 days old Cobb, Ross and Hubbard broilers breasts are presented in Table 1. Also, the effect of breed line and age, as well as their interaction on pH are presented in the same table. Average pH values after 15 minutes, 24 and 48 hours were not different regardless of breed line, but significant differences ($p < 0.001$) were determined between broiler ages. Lower pH values were found in older broilers. Interactions between breed line and age were detected for all pH values, except for pH after 24 hours.

Table 1. The effect of breed line and age on measurements of meat quality parameters in breast muscles (*m. pectoralis major*) of broiler chickens.

Parameters	42 days old			50 days old			L	A	L x A
	Cobb (n = 50)	Ross (n = 50)	Hubbard (n = 50)	Cobb (n = 50)	Ross (n = 50)	Hubbard (n = 50)			
pH _{15min}	6.44±0.19 ^A	6.29±0.19 ^{A,B}	6.48±0.22 ^B	6.15±0.16 ^{D,a}	6.29±0.20 ^{D,C}	6.05±0.29 ^{C,a}	ns	***	***
pH _{24h}	6.03±0.16 ^a	6.19±0.30 ^a	6.09±0.25	5.90±0.21	5.85±0.18	5.82±0.16	ns	***	ns
pH _{48h}	6.04±0.17 ^a	6.20±0.27 ^a	6.06±0.23	5.93±0.20	5.85±0.20	5.84±0.15	ns	***	*

Within a row, means with a common superscript letter significantly differ: ^{a-} ($p < 0.05$) and ^{A, B, C, D-} ($p < 0.01$); ns - no significance ($p > 0.05$); * - $p < 0.05$; ** - $p < 0.01$; *** - $p < 0.001$; L - line factor; A - Age factor; L x A - Interaction between line and age factor; pH_{15min}, pH_{24h} and pH_{48h} - pH values measured 15 minutes, 24 hours and 48 hours postmortem; t_{15min} - meat temperature measured 15 minutes postmortem.

According to Table 2, there are different reports about pH values of the *m. pectoralis major* of broilers (15 minutes after slaughter). The strictest were Ristic and Schön, Taylor and Jones, and Ristic and Dame, with limits of pH 5.8 and under for PSE meat^{14,18,22}. For DFD meat, the strictest were Fletcher, and Petracci et al., with limits of 5.81 and 6.04^{3,15}. Our results, which are presented in Table 1, show that pH values of the *m. pectoralis major* (15 minutes after slaughter) of the different broiler origins are from 6.05 (Hubbard 50 days old) to 6.44 (Cobb 42 days old). A similar situation was found for pH 24 and 48 hours after slaughter. According to Ristic and Dame, pH values 24 hours after slaughter of different broiler origins were 5.84 for Cobb and 5.71 for Ross⁵. In our results, these pH values for both breed lines were higher (Cobb 6.03 and Ross 6.19 – 42 days old; Cobb 5.90 and Ross 5.85 – 50 days old; Table 1). Age of broilers had an impact on the meat quality parameter, pH value.

Table 2. Limits of different authors for the determination of broiler meat quality using pH-measurement of broiler breasts.

Testing time breast meat (min p.m.)	Meat quality-pH values			Author
	PSE	Normal	DFD	
15	<5.8	>6.0	>6.2	Ristic and Schön, 1977 ²²
15	<5.7	5.8-6.3	>6.4	Niewiarowicz and Pikol, 1979 ²³
15	5.63	5.7	5.81	Fletcher, 1999 ³
15	5.77	5.89	6.04	Petracci et al., 2004 ¹⁵
15	<5.8	5.8-6.5	>6.5	Taylor and Jones, 2004 ¹⁴
15	5.54	5.91	6.23	Zhang and Barbut, 2005 ¹⁶
180	<5.7	5.7-6.1	>6.1	Lesiow et al., 2009 ¹⁷
15	<5.8	5.9-6.2	>6.3	Ristic and Dame, 2010 ¹⁸

min p.m. - minutes postmortem, PSE – Pale, Soft, Exudative meat, DFD - Dark, Firm and Dry meat.

4. Conclusion

Broiler chicken breed line and age affects measurements of the meat quality parameter of pH in breast muscles (*m. pectoralis major*) of broiler chickens. 50 day old broilers had lower pH values than 42 days old broilers. However, in addition to breed line and age, many other factors like breeding, transport, cooling, the storage period, etc. also affect meat quality parameters, including pH, and this should be taken into account.

Acknowledgement

This paper was supported by Ministry of Education and Science, Republic of Serbia, Project “Selected biological hazards to the safety/ quality of food of animal origin and the control measures from farm to consumer” (31034).

References

1. Duran-Melendez LA. Poultry carcass evaluation and cutting. In: Guerrero- Legarreta I. and Y.H. Hui: *Handbook of poultry science and technology, Volume 1: Primary Processing*. Hoboken, New Jersey: John Wiley & Sons, Inc.; 2010. p. 101-106.
2. Bianchi M, Fletcher DL, Smith DP. Physical and functional properties of intact and ground pale broiler breast meat. *Poult Sci* 2005;**84**:803–8.
3. Fletcher DL. Broiler breast meat color variation, pH and texture. *Poult Sci* 1999;**78**:1323–27.
4. Van Laack RLJM, Liu CH, Smith MO, Loveday HD. Characteristics of pale, soft, exudative broiler breast meat. *Poult Sci* 2000;**79**:1057–61.
5. Ristic M, Damme K. Significance of pH-value for meat quality of broilers – influence of breed lines. *Veterinarski glasnik* 2003;**67**:67-73.
6. Petracci M, Baeza E. Harmonization of methodology of assessment of poultry meat quality features. In: *Proceedings XVIII European Symposium on the Quality of Poultry Meat*. Prague, 2009. pp. 175-80.
7. Salakova A, Strakova E, Valkova V, Buchtova H, Steinhauserova I. Quality Indicators of Chicken broiler Raw and Cooked Meat Depending on Their Sex. *Acta Vet Brno* 2009;**78**:497-504.
8. Dzinic N, Okanovic Dj, Jokanovic M, Tasic T, Tomovic V, Ikonic P, Filipovic S. Carcas and breast meat quality og broilers feed with extruder corn. *Biotech Anim Husbandry* 2011;**27**,**4**:1697-1703.
9. Madruga MS, Mottram DS. The effect of pH on the formation of Mailard-derived aroma volatiles using a cooked meat system. *J Sci Food Agric* 2005;**68**:305-10.
10. Bihan-Duval E, Milet N, Remignon H. Broiler Meat Quality: Effect of Selection for Increased Carcass Quality and estimates of Genetic Parameters. *Poult Sci* 1999;**78**:822-26.
11. Silva Cristiane MG, Gloria M, Beatris A. Bioactive amines in chicken breast and thigh after slaughter and during storage at +4°C and in chicken based meat product. *Food Chem* 2002;**78**:241-48.
12. El Rammouz R, Berri C, Le Bihan-Duval E, Babile R, Fernandez X. Breed Differences in the Biochemical Determinism of Ultimate pH in Breast Muscles of Broiler Chickens-A Key Role of AMP Deaminase. *Poult Sci* 2004;**83**:1445-51.
13. Berri C, Le Bihan-Duval E, Debut M, Sante-Lhoutellier V, Baeza E, Giagaud V, Jego Y, Duclos MJ. Consequence of muscle hypertrophy on characteristics of pectoralis major muscle and breast meat quality of broiler chickens. *J Anim Sci* 2007;**85**:2005-11.
14. Taylor RD, Jones GP. The incorporation of whole grain into pelleted broiler chicken diets. *Poult Sci* 2004;**45**:237-46.
15. Petracci M, Bianchi M, Betti M, Cavani C. Colour Variation and Characterisation of Broiler Breast Meat During Processing in Italy. *Poult Sci* 2004;**83**:2086-92.
16. Zhang L, Barbut S. Rheological characteristics of fresh and frozen PSE, normal and DFD chicken breast meat. *Poult Sci* 2005;**46**:687-93.
17. Lesiow T, Sazmanko T, Korzeniowska M, Bobak L, Oziemblowski M. Influence of the season of the year on some technological parameters and ultrastructure of PSE, normal and DFD chicken breast muscles. In: *Proceedings XIX. European Symposium on the Quality of Poultry Meat*, June 2009., Turku, Finland, 2009. pp. 21-25.
18. Ristic M, Damme K. The meaning of pH-value for the meat quality of broilers – Influence of breed lines. *Tehn mesa* 2010;**51**:120-23.
19. Woelfel RL, Owens CM, Hirschler EM, Martinez-Dawson R, Sams AR. The characterisation and incidence of pale, soft, exudative broiler meat in comercial plant. *Poult Sci* 2002;**81**:579-84.
20. Alvarado CZ, Sams AR. Injection marination strategies for remediation of pale, exudative broiler breast meat. *Poult Sci* 2003;**81**:1365-70.
21. Zhang ZY, Jia GQ, Zuo JJ, Zhang Y, Lei J, Ren L, Feng DY. Effects of constant and cyclic heat stress on muscle metabolism and meat quality of broiler breast fillet and thigh meat. *Poult Sci* 2012;**91**:2931-37.
22. Ristic M, Schön L. Verlauf des pH-Niveaus von Broйлern in Abhängigkeit von den Jahresproduktionen. *Archiv für Geflügelkunde* 1977;**41**:253-55.
23. Niewiarowicz A, Pikul J. pH-Wert der Hautoberfläche vor der Schlachtung als Indikator für PSE- und DFD-Fleisch bei Broйлern. *Fleischwirt* 1979;**59**:405-7.