The Influence of Refrigeration Method and Maturation Time in Broiler Meat Quality

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Bulletin UASVM Animal Science and Biotechnologies 71(2) / 2014,
Print ISSN 1843-5262; Electronic ISSN 1843-536X
DOI:10.15835/buasvmcn-asb:10323

Abstract

Consumer acceptability of broiler meat depends on its tenderness and appearance, main cause of incidence hardness broiler meat cutting and boning the carcass before the completion of *rigor mortis*. Thus, to prevent apparition of rough meat literature describes a number of studies that focused on finding the optimum aging time. Prior to cutting and boning, to obtain juicy meat is needed to apply an early maturation period ranging between 4-6 h.

Meat color was expressed by tristim spectral coordinates L^* , a^* , b^* colour space in CIEL* a^* b^* (AMSA). To determine the force to Warner Bratzler was used texture-meter single bladed TA Instruments Liold plus 1 KN.

Descriptive analysis of meat quality parameters showed lower values for carcass chilling in drafts submitted for pH, L^* , a^* , b^* and WBSF significant differences ($P \leq 0.05$) were recorded for pH, brightness and cooking losses. The curing time significantly influenced ($P \leq 0.05$) analyzed parameters. Acidity of meat, coordinate complementary colors red-green (a^*) and yellow-blue (b^*) and meat tenderness was assessed by a inverse relationship with increasing aging time.

The results described a negative correlation of losses by cooking refrigeration and maturation of acidity, coordinate complementary colors yellow-blue and Warner Bratzler shear force. The main negative effects of meat maturation were open colored pectoral muscle and increase losses by boiling.

Keywords: chicken, maturation, refrigeration.

INTRODUCTION

Consumer acceptability of broiler meat depends on its tenderness and appearance, main cause of incidence hardness broiler meat cutting and boning the carcass before the completion of *rigor mortis* (Fletcher, 2002).

Thus, to prevent apparition of rough meat literature describes a number of studies that focused on finding the optimum aging time. Prior to cutting and boning, to obtain juicy meat is needed to apply an early maturation period ranging between 4-6 h (Young, 1997; Northcutt *et al.*, 2001; Liu *et al.*, 2004). Maturation of carcasses is expensive because of the space required for storage and energy costs. Therefore, many processors prefer application immediately after chilling, the cutting and boning meat process that

takes place in 0.5-0.83 h for cooling carcasses by immersing them in water (Veerkamp, 1990) and 1.5-2.5 h for cooling systems in air stream (James *et al.*, 2006). To obtain an optimum maturity processors, stored carcasses at refrigeration temperature (0-4°C) for another 2.5-4.5 h prior to the cutting and boning (Sams, 2002).

Previous studies have shown that high temperatures and slow cooling rates may accelerate *post-mortem* glycolysis and consequently the final texture of the meat, which means that its functional properties (Papinaho and Fletcher, 1996; McKee and Sams, 1998; Skarovsky and Sams, 1999; Alvarado and Sams, 2002).

However there is little information in the literature on comparing functionality broiler carcasses cut fillets, boneless prematurely and cooled

either by immersion or air. From this perspective, the objective of the current study was to evaluate the effect of ripening time and cooling method on pH, cooking losses, resulting meat color and tenderness.

MATERIALS AND METHODS

Prior to refrigeration, 150 carcasses of chickens (Ross 308) were removed from the slaughter line. 50% of the carcasses were subjected withdrawn dry air chilling method (RAU) and 50% were chilled by immersion in water (RIA). After application of the two types of refrigeration and 3 experimental groups formed based on the aging time (0, 2 and 24 hours), at the end of maturation was done boning pectoral muscle that was subjected to analysis.

Determination of meat pH was performed at 0, 2 and 24 hours post-slaughtering, the principle of analysis described by ISO 2917:2007, with digital pH meter with automatic reading of acidity and temperature HANNA HI 8424 subsequent corrections were made a function of temperature.

The color of the meat samples was done with a thickness of 15-50 mm, which were sections perpendicular to the longitudinal axis of the muscle fiber. Meat color was expressed by tristim spectral coordinates L^* , a^* , b^* color space in CIEL* a^* b^* (AMSA), measured by specular component included (SCI), the whole principle of operation of the spectrophotometer applying the specifications given in "CIE colorimeter Second Edition, Publication 15.2 (1986)".

As a method, the measurement itself was done

in three different areas of each sample of meat Minolta CM-2600d portable spectrophotometer. Calibration was performed before each series of chromameter measurement using a calibration device Minolta CM-A32. The values obtained were converted and processed using software Spectra Magic v.3.30.

To determine the force to Warner Bratzler was used texture-meter single bladed TA Instruments Lloyd plus 1 KN, equipped with specific blade ($\alpha=60^\circ$) it is speed of 100 mm/min under conditions of cutting force of 1,000 N. Roll meat samples were sectioned on perpendicular direction of the muscle fibers, the maximum force required sectioning the sample being watched indicator for describing meat tenderness.

Software NEXYGEN Ondio, Ta Plus Series Integrated texture-meter allowed direct calculation of the values of shear forces on the cutting-strain curve, which is expressed in the form of peaks corresponding to the maximum recorded (Honikel, 1998), ensuring operation of the system texture-meter accordance with the requirements of BS EN ISO 7500:1999 set.

The data were processed by one-way analysis of variance in order to determine the effect of refrigeration type and storage time on each variable. Duncan's test was carried out to determine differences between groups. The level of statistical significance was $P \leq 0.05$. Pearson correlation was made to determine the interactions between variables and the influence of treatment on variables, with level of statistical of significance level of $P \leq 0.05$ and $P \leq 0.01$. Statistical analyses were performed using IBM SPSS software, v19

Tab. 1. Descriptive parameters of broiler meat quality (Mean $\pm$ Standard Error of Mean)

	Refrigeration type		Maturation time		
	RDA	RIW	0 h	2 h	24 h
pH	5.98 $\pm$ 0.09	6.28 $\pm$ 0.09 ^a	6.47 $\pm$ 0.05 ^c	6.36 $\pm$ 0.09 ^c	5.55 $\pm$ 0.03
L^*	53.17 $\pm$ 0.80	56.58 $\pm$ 0.77 ^a	52.09 $\pm$ 0.86	54.55 $\pm$ 0.65	57.99 $\pm$ 1.09 ^{ab}
a^*	1.68 $\pm$ 0.20	1.71 $\pm$ 0.20	2.51 $\pm$ 0.25 ^{bc}	1.79 $\pm$ 0.14 ^c	0.77 $\pm$ 0.14
b^*	2.20 $\pm$ 0.23	2.30 $\pm$ 0.24	3.37 $\pm$ 0.26 ^{bc}	2.12 $\pm$ 0.16 ^c	1.25 $\pm$ 0.23
Cooking loss	24.92 $\pm$ 0.78 ^b	21.29 $\pm$ 0.70	21.90 $\pm$ 0.99	22.87 $\pm$ 1.03	24.56 $\pm$ 0.91
WBSF	12.90 $\pm$ 0.79	14.80 $\pm$ 0.94	17.05 $\pm$ 0.75 ^c	15.98 $\pm$ 0.61 ^c	8.52 $\pm$ 0.62

Note: Results are based on two-sided tests assuming equal variances with significance level 0.05. For each significant pair, the key of the smaller category appears under the category with larger mean. For each significant pair, the key of the smaller category appears under the category with larger mean. Tests are adjusted for all pair wise comparisons within a row of each innermost suitable using the Bonferroni correction.

RDA -dry air method; **RIW** -refrigerated by immersion in water; **WBSF** -Warner Bratzler Shear Force

Fig. 1. Meat quality descriptors of broiler breast file in relation with refrigeration type and maturation time

(2010).

RESULTS AND DISCUSSION

Descriptive analysis of meat quality parameters (*Tab. 1, Fig. 1*) showed lower values for carcass chilling in drafts submitted for pH, L*, a*, b* and WBSF significant differences ($P \leq 0.05$) were recorded for pH, brightness and cooking losses. The

curing time significantly influenced ($P \leq 0.05$) analyzed parameters. Acidity of meat, coordinate complementary colors red-green (a*) and yellow-blue (b*) and meat tenderness was assessed by an inverse relationship with increasing aging time.

By analyzing the interaction between qualitative determined parameters, the type of cooling and ripening period (*Tab. 2*) has shown significant effect ($P \leq 0.05$) moderately negative ($r = -0.320$) pH on brightness and cooking losses ($r = -0.307$), where a*, b* and tenderness (BSF) pH with a significant ($P \leq 0.05$) positive (*Tab. 2*).

Statistical analysis flesh color not found any significant correlation ($P > 0.05$) between it and boiling losses, but the latter parameter influencing negatively ($r = -0.343$) significantly ($P \leq 0.05$) tenderness of meat (*Tab. 2*).

Analyzing the influence of treatment was revealed moderate negative effect ($r = -0.413$) significant losses chilling the cooked and ripening time on pH ($r = -0.764$), coordinate complementary colors red-green ($r = -0.671$) and Warner Bratzler shear force ($r = -0.731$) (increased tenderness) (*Tab. 2*).

Tab. 2. Coefficients of simple correlation (**r**) between meat qualitative studied parameters (**a**) and influence of experimental factors on meat quality descriptors (RDA, RIW, maturation time: 0, 2 and 24 h)

Specification	pH	Color			Cooking loss	WBSF
		L*	a*	b*		
STUDIED PARAMETERS						
pH	1					
L*	-0.320*	1				
a*	0.561**	-0.380**	1			
b*	0.568**	-0.331**	0.686**	1		
Cooking loss	-0.307*	0.144	0.015	-0.087	1	
WBSF	0.749**	-0.297*	0.492**	0.422**	-0.343**	1
FACTORS						
		Refrigeration			Maturation	
pH		0.296*			-0.764**	
L*		0.375**			0.529**	
a*		0.014			0.658**	
b*		0.039			-0.671**	
Cooking loss		-0.413**			0.247	
WBSF		0.199			-0.731**	

Note: **WBSF** – Warner Bratzler Shear Force; **RDA** - dry air method; **RIW** - refrigerated by immersion in water;

*Correlation is significant at 0.05 level (2-tailed)

**Correlation is significant at 0.01 level (2-tailed)

CONCLUSION

The results described a negative correlation of losses by cooking refrigeration and maturation of acidity, coordinate complementary colors yellow-blue and Warner Bratzler shear force. The main negative effects of meat maturation were open colored pectoral muscle and increase losses by boiling. After 24 h, Warner Bratzler shear force values for RIW and RDA meat were <4.62 kg and corresponded by sensory categories from soft to very soft. Results showed that refrigeration by air chilling has an effect on acceleration of rigor mortis, so we recommend 24-36 h maturation.

REFERENCES

1. Alvarado CZ and Sams AR (2002). The role of carcass chilling rate in the development of pale, exudative turkey pectoralis. *Poultry Science* 81:1365-1370.
2. Fletcher DL (2002). Poultry meat quality. *World's Poultry Science* 58:131-146.
3. Honikel KO (1998). Reference methods for the assessment of physical characteristics of meat. *Meat Science* 49(4): 447-457.
4. James C, Vincent C, Andrade Lima TI and James SJ (2006). The primary chilling of poultry carcasses - a review. *Int J Refrig*. Vol. 29:847-862.
5. Liu Y, Lyon BG, Windham WR, Lyon CE and Savage EM (2004). Principal component analysis of physical, colour, and sensory characteristics of chicken breasts deboned at two, four, six, and twenty-four hours post-mortem. *Poultry Science* 83:101-108.
6. McKee SR and Sams AR (1998). Rigor mortis development at elevated temperatures induces pale exudative turkey meat characteristics. *Poultry Science* 77:169-174.
7. Northcutt JK, Buhr RJ, Young LL, Lyon CE and Ware GO (2001). Influence of age and postchill carcass aging duration on chicken breast fillet quality. *Poultry Science* 80:808-812.
8. Papinaho PA and Fletcher DL (1996). The influence of temperature on broiler breast muscle shortening and extensibility. *Poultry Science* 75:797-802.
9. Sams A (2002). Post-mortem electrical stimulation of broilers. *World's Poultry Science Journal* 58:147-157.
10. Skarovsky CJ and Sams AR (1999). Tenderness, moisture loss and post-mortem metabolism of broiler pectoralis muscle from electrically stimulated and air chilled carcasses. *Br. Poultry Science* 40:622-625.
11. Veerkamp CH (1990). Chilling of poultry and poultry products 147-158 in *Chilled Foods - The State of Art*, TR Gormley, ed. Elsevier Appl. Sci.
12. Young LL (1997). Effect of post-chill deboning on tenderness of broiler breast fillets, *J. Appl. Poult. Res* 6:174-179.
13. *** Colorimetry, Second Edition, Publication CIE no. 15.2 (1986), cited in: International Commission on Illumination – Technical Report, online at:
14. <https://law.resource.org/pub/us/cfr/ibr/003/cie.15.2004.pdf>
15. *** SR ISO 2917:2007. Carne și produse din carne. Măsurarea pH-ului. Metoda de referință.