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Chicken Meat Quality as a Function of Fasting Period and Water Spray

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Broilers, color, meat, pH.

ABSTRACT

This study aimed at evaluating the effect of different fasting periods and water spray during lairage on the quality of chicken meat. A number of 300 male Ross broilers were reared up to 42 days of age, and submitted to four pre-slaughter fasting periods (4, 8, 12, and 16 hours) and sprayed with water or not during lairage. Deboned breast meat was submitted to the following analysis: pH, color, drip loss, water retention capacity, cooking loss, and shear force. There was a significant effect ($p \leq 0.05$) of fasting period on meat luminosity was significantly different, with the highest value obtained for 4-hour fasting, whereas no difference was found among the other fasting periods. Meat pH values were different among fasting periods when birds received water spray, with birds fasted for 4, 8, and 12 hours of fasting presenting lower meat pH values (5.87, 5.87, and 6.04, respectively). The interaction between fasting period and water spray influenced meat drip loss and cooking loss, with birds fasted for 16h and not receiving water spray presenting higher drip loss (4.88) and higher cooking loss (28.24) as compared to the other birds. Fasting period affects meat quality, and very short periods (4h) impair meat quality.

INTRODUCTION

Pre-slaughter management of broilers routinely adopted in commercial farms in Brazil include six to 12 hours of feed withdrawal, water withdrawal after catching, and lairage time of not less than two hours. The aim of feed withdrawal is to reduce carcass contamination by gastrointestinal content during process, and to replenish glycogen reserves in stressed birds, as the meat quality of these birds is lower.

When feed is withdrawn periods shorter than six to seven hours, the digestive tract is still full of feed, and the intestines are enlarged and round at processing, occupying a large part of the abdominal cavity and increasing the probability of gastrointestinal leaking during evisceration (Northcutt, 2000).

In addition to possible contamination of carcasses during processing, fasting duration is directly related to meat quality. Therefore, the knowledge on optimal pre-slaughter conditions of broilers will allow the production high-quality chicken meat, as these factors, in addition to post-slaughter influences, are involved in final meat quality (Mendes, 2001).

According to Moreira (2005), spraying broilers with water during lairage increases meat cooking loss and causes lower shear and water retention capacity. The same author verified that *ante mortem* stress caused by short fasting periods, no water spray during lairage, and inadequate lairage time, loading and transport are the main factors responsible for PSE meat.



Murray & Rosemberg (1953) reported that glycogen concentration is related to pre-slaughter fasting. Glycogen concentration is lowest when a 16-h fasting period is applied, and increases 33% between 1 and 10 hours, when birds are re-fed with ground corn. Mellor *et al.* (1958) evaluated the relation between glycogen and pH, and found that chicken meat with high glycogen concentration presented pH 6.2. therefore, the highest glycogen level was related to more acid meat, as low pH 24 post mortem is related to PSE meat (pale, soft, exudative). According to Kotula & Wang (1994), glycogen levels decrease as fasting time increases, as they found that zero and 36 hours of fasting resulted in glycogen values at zero hour *post mortem*) of 7 mg. g⁻¹ and 3.5 mg. g⁻¹, respectively.

Romão (2001) found that broilers not submitted to pre-slaughter fasting presented higher incidence of PSE meat (pH <5.7 up to 15 minutes) as compared to those submitted to fasting, with a 24% (12 birds) incidence in Ross broilers and 13.33% (eight birds) in Cobb broilers. Castro (2006) also asserted that higher PSE frequency is related to very short fasting periods, as there is high glycogen availability in the muscle. Therefore, fasting is related to meat pH and influences the incidence of PSE in chicken meat.

One of the aims of lairage and water intake of animals during the pre-slaughter period is to allow the re-synthesis of glycogen to increase energy reserves, and therefore to obtain higher meat acidification *post mortem*. The typical fasting period used in broilers may delay the rate of *rigor mortis*. As in birds there is rapid development of *post mortem* chemical reactions, fasting may cause undesirable changes in final meat quality.

Several authors, such as Castro (2006) and Denadai *et al.* (2002), studied the effect of different fasting periods on carcass yield, offal conditions, live weight loss, and meat quality. However, the relation between the effects of pre-slaughter fasting and water spray on meat quality has not been studied yet. Therefore, the present study aimed at assessing the meat quality of broilers submitted to different pre-slaughter fasting periods, and the use or not of water spray in the lairage.

MATERIAL AND METHODS

The experiment was carried out at the Poultry Sector of School of Veterinary Medicine and Animal Science (FMVZ), UNESP, Botucatu campus, São Paulo, Brazil. A number of 300 one-day-old male Ross broilers was housed in six experimental pens and reared until 42

days of age, and submitted to equal management and feeding. On day 42, birds were placed in plastic transport crates and transported for three km to the experimental processing plant of FMVZ, where birds were processed.

Birds were distributed in a completely randomized experimental design in a 4 x 2 factorial arrangement consisting of fasting periods (4, 8, 12, or 16h) vs. water spray with ventilation during lairage (presence or absence), with ten birds per treatment.

After each fasting period, birds were slaughtered, deboned breasts were collected, and 24h later the following parameters were analyzed: pH, objective color, drip loss, water retention capacity, cooking loss, and shear force.

Meat pH was directly measured in the *pectoralis major* muscle using a pHmetro (Hanna model HI-8314) coupled to a probe electrode (Belden type lanceFAT, model 9239). Readings were carried out 15, 30, and 45 min after deboning, and 1 and 24 h *post mortem* (Table 3).

Breast fillet color was determined using a Minolta colorimeter, model CR-300, and CIELab system, according to the following parameters: L* (luminosity), a* (redness), and b* (yellowness) (Van Laack *et al.*, 2000).

In order to determine water retention capacity, 2-g meat cubes were placed between two circles of filter paper placed on two glass plates. A 10kg weight was placed on the top glass plate for 5 minutes, after which samples were weighed, as the amount of water loss was calculated as the difference between initial and final weights (Hamm, 1960).

Drip loss was determined by keeping breast fillet under conditions that simulate retail sales. Samples were placed on polystyrene trays, covered with permeable plastic film, and stored at 3±1°C for 72h. Drip loss was calculated as the difference between initial and final weights (Northcutt *et al.*, 1994; Dirinck *et al.*, 1996).

Cooking loss was measured by grilling breast fillet samples on a heated metal plate until internal temperature reached 82°C, and calculating the weight difference before and after cooking (Honikel, 1987).

Samples used to determine cooking loss were utilized to measure shear force. Meat fibers were placed perpendicularly to the blades of a Warner-Bratzler apparatus, according to the technique described by Froning *et al.* (1978).

The obtained data were submitted to analysis of variance (ANOVA) using SAS (SAS Institute, 1998)



statistical package. Means were compared by the test of Tukey.

RESULTS AND DISCUSSION

Table 1 shows the results obtained for meat color (L^* , a^* e b^*), pH, water retention capacity (WRC), drip loss (DL), cooking loss (CL), and shear force (SF). There were significant differences ($p \leq 0.05$) among treatments for color (L^* and a^*), pH, CL, SF, and WRC values.

Luminosity (L^*) was significantly ($p < 0.05$) higher in birds submitted to 4h fasting (51.39), but similar in birds fasted for 8, 12, and 16h fasting (46.98, 46.31, and 46.54, respectively). Castro (2006) also observed that L^* values decreased as fasting time increased (6, 12, 15, 18h), and that L^* value was 51.43 for 6h fasting, whereas there was no significant difference in the other fasting periods. Redness (a^*) ($p \leq 0.05$) was significantly different among fasting times, with lower values observed in birds submitted to 4, 8, and 16h fasting (2.51, 3.06, and 3.02, respectively) as compared to 12h fasting (3.30). On the other hand, yellowness (b^*) was not influenced ($p > 0.05$) by fasting periods. The higher L^* value and the lower a^* value in the meat of broilers submitted to 4h fasting shows that this period of fasting affects meat color, as compared to the other fasting periods.

A short fasting period (4h), even in the presence of water spray, is not enough to make birds recover from the stress caused by catching, loading, and transport. Therefore, longer fasting periods – of at least 8 hours – are recommended.

Significant interactions ($p < 0.05$) between fasting period and water spray were observed in terms of pH, drip loss (DL), and cooking loss (CL), and shown in details in Table 2.

There were significant effects of the interaction between fasting period and water spray on pH measured 24h *post mortem*, as shown in Tables 1 e 2.

Meat pH was different among fasting periods only when birds received water spray. Birds fasted for 4, 8 and 12h presented lower meat pH (5.87, 5.87, and 6.04, respectively). In general, meat pH increased with fasting period. According to Bressan & Beraquet (2002), two hours of lairage resulted in higher muscle pH as compared to zero and four hours of lairage, explaining why the establishment of *rigor mortis* was faster in birds that did not rest or rested for 4h than in birds that rested for two hours.

Table 2 - Effects of the interactions between pre-slaughter fasting period and water spray at lairage on meat pH, drip loss (DL), and cooking loss (CL) evaluated in breast meat.

Water spray	Fasting period (hours)				
	4	8	12	16	
pH					
Yes ^{24hs}	5.87 b	5.87 b	6.04 ab	6.10 a	5.97
No	5.89	6.04	6.02	6.00	5.98
Mean	5.88	5.95	6.03	6.05	
Drip loss (DL)					
Yes	5.17 a	5.37 a	5.11 a	2.38 Bb	4.51
No	4.73	3.41	3.45	4.88 A	4.12
Mean	4.95	4.38	4.28	3.63	
Cooking loss (CL)					
Yes	28.45 a	27.38 ab	29.07 a	24.31 Bb	27.30
No	27.60	27.68	30.23	28.24 A	28.44
Mean	28.03	27.53	29.65	26.27	

Means followed by different small letters in the same row and capital letters in the same column are different ($p \leq 0.05$) by the test of Tukey.

Meat pH (Table 3) was significantly influenced ($p \leq 0.05$) by the different fasting period. The lowest values were obtained in the meat samples of birds submitted only to 4h pre-slaughter fasting, and there were no significant differences ($p > 0.05$) in pH (evaluated in different periods) among the remaining pre-slaughter fasting periods (8, 12, and 16 hours). Castro (2006), analyzed meat pH eight hours after slaughter, also did not detect any effect ($p > 0.05$) of the different pre-slaughter fasting periods, with pH values between 5.71 and 5.77.

Tables 1 and 2 show drip loss and cooking loss as a

Table 1 - Meat quality parameters of broilers submitted to different fasting periods and sprayed or not with water during lairage.

Parameters	Quality traits							
	L^*	a^*	b^*	pH	DL	CL	SF	WRC
Fasting (hours)								
4	50.39 a	2.51 b	3.31	5.88 ^{24h}	4.95	28.03	2.28 b	58.65 b
8	46.98 b	3.06 ab	2.96	5.95	4.38	27.53	2.94 a	90.56 a
12	46.31 b	3.30 a	3.35	6.03	4.28	29.65	2.98 a	86.73 ab
16	46.54 b	3.02 ab	3.19	6.05	3.63	26.27	2.96 a	74.55 ab
Water spray								
Yes	47.44	3.06	3.35	5.97	4.51	27.30	2.70	80.48
No	47.63	2.90	3.06	5.98	4.12	28.44	2.87	74.76
CV (%)	5.49	28.67	40.94	2.52	35.55	9.72	47.11	32.62

Means followed by different letters in the same column are different ($p \leq 0.05$) by the test of Tukey. L^* = luminosity, a^* = redness, b^* = yellowness, DL = drip loss, CL = cooking loss, SF = shear force, WRC = water retention capacity.



Table 3 - Meat pH of broilers submitted to different fasting periods and sprayed or not with water during lairage.

Fasting(hours)	pH values					
	pH _i	pH _{15m}	pH _{30m}	pH _{45m}	pH _{1h}	pH _{24hs}
4	6.17 b	5.97 b	5.88 b	5.86 b	5.80 b	5.88 b
8	6.37 a	6.20 a	6.08 a	5.93 ab	5.83 b	5.96 ab
12	6.33 ab	6.14 a	5.93 ab	5.93 ab	5.91 ab	6.03 a
16	6.37 a	6.12 ab	6.07 a	6.01 a	5.98 a	6.05 a
Water spray						
Yes	6.32	6.14	6.02	5.97	5.90	5.97
No	6.30	6.07	5.96	5.90	5.86	5.98
CV (%)	3.15	2.96	3.11	2.87	2.81	2.52

Means followed by different letters in the same column are different ($p \leq 0.05$) by the test of Tukey.

function of pre-slaughter fasting period and water spray at lairage. There was effect of the interaction between fasting period and water spray on drip loss and cooking loss, with birds submitted to 16h of pre-slaughter fasting and no water bath presenting the highest drip loss (4.88) and highest cooking loss (28.24) as compared to the other birds. Water spray had no effect ($p > 0.05$) on drip loss or cooking loss of the meat of broilers submitted to 4, 8, or 12h of pre-slaughter fasting (5.17 and 28.48, 5.37 and 27.38, 5.11 and 29.07, respectively); however, these values were higher as compared to those obtained in birds submitted to 16h pre-slaughter fasting (2.38 and 24.31, respectively). Rasmussen & Mast (1989) studied the effect of feed fasting on broiler meat composition and quality, and did not find significant differences ($p > 0.05$) in cooking loss among fasting periods.

According to Jensen *et al.* (1998), drip loss is one of the main factors that affect meat quality. It is caused by *post mortem* myofibril shrinkage due to pH decrease.

Table 1 shows shear force and water retention capacity values as a function of fasting period and water spray at lairage. These parameters were only influenced ($p \leq 0.05$) by fasting period. Birds that were fasted for 4h presented the lowest shear force value (2.28) and the lowest water retention capacity (58.65), but these were no significant difference ($p > 0.05$) among the other groups (8, 12, and 16h of fasting). Lyon *et al.* (1991) also studied the effect of pre-slaughter fasting period on the texture of chicken breast meat, and observed significant influence on shear force, with no fasting resulting in the highest values, whereas fasting for 8 and 16h promoted similar shear force values ($p > 0.05$). Castro (2006) did not find any significant difference in meat water retention capacity as pre-slaughter fasting period increased.

The results obtained in the present experiment show that shear force increased as a function of fasting

period (after 8h). However, when water retention capacity was evaluated, opposite results were detected, with the lowest value obtained with 4h fasting period. In addition, this parameter presented an improvement, represented by an increase, as fasting length increased. However, the fact that breast meat presented lower shear force with 4h fasting may be related to the stress caused by this short fasting period. When birds are submitted to stress, their body temperature increases, and muscle pH decreases due to lactic acid production in the muscle. This situation of low pH and high temperature in the muscle lead to higher *post mortem* protein breakdown, with consequent higher tissue water loss, and therefore higher meat tenderness cause by protein breakdown.

CONCLUSION

Pre-slaughter fasting period influenced meat quality, and very short fasting periods (up to 4 hours) impair meat quality. The results obtained in the present study showed that L*, pH, and other meat quality parameters were negatively affected when birds were submitted to 4h fasting, and water spray was not able to ameliorate the effects of this short fasting period. Meat pH values were different among the evaluated pre-slaughter fasting periods only when birds received water spray, with birds fasted for shorter periods presenting lower pH values.

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