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Pre-slaughter fasting times for broiler chickens

[*Tempos de jejum pré-abate em frango de corte*]

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ABSTRACT

This study aimed to evaluate the effect of different pre-slaughter fasting times on live weight and meat quality of broiler chickens slaughtered at 35 and 42 days of age. Treatments consisted of four, eight, 12, and 16 hours of total fasting before slaughter. Eight birds of each sex were slaughtered at each time of fasting. Regression analysis indicated that the longer the fasting time, the greater the weight reduction in both males and females (35/42 days). However, analysis of variance highlighted no weight reduction (P>0.05) for four, eight, and 12 hours of fasting in males slaughtered at 35 and 42 days of age and in females at 35 days. However, females slaughtered at 42 days of age showed no differences (P>0.05) for four and eight hours of fasting. After 16 hours of fasting, both males and females slaughtered at 35 and 42 days of age showed higher weight reductions (P<0.05) than after the other fasting times. No live weight reductions (P>0.05) were observed for male and female birds of 35 and 42 days of age, respectively. Regarding meat quality, no changes (P>0.05) were found for CL and WHC in males and females at 35 and 42 days of age, respectively.

Keywords: Animal welfare; shear; cooking loss; meat quality; food restriction.

RESUMO

Avaliaram-se diferentes tempos de jejum pré-abate sobre redução de peso vivo e qualidade cárnea de frangos abatidos aos 35 e 42 dias de idade. Os tratamentos consistiram de quatro, oito, 12 e 16 horas de restrição de ração. Foram abatidas oito aves de cada sexo em cada tempo de jejum. Análise de regressão indicou que quanto maior o tempo de jejum, maior é a redução de peso tanto em machos como em fêmeas (35/42 dias). A análise de variância indicou que não ocorreu redução de peso (P>0,05) entre quatro, oito e 12h de jejum nos machos aos 35 e 42 dias e nas fêmeas aos 35 dias, enquanto nas fêmeas aos 42 dias não houve diferença (P>0,05) entre quatro e oito horas de jejum. Com 16h de jejum, tanto em machos quanto em fêmeas aos 35 e 42 dias, a redução de peso foi maior (P<0,05) em relação aos demais horários. Não ocorreu diferença (P>0,05) na perda de peso na comparação entre 35 e 42 dias em machos e fêmeas nos respectivos horários de abate. Na qualidade cárnea, não houve alteração (P>0,05) na perda de peso por cozimento e na capacidade de retenção de água em machos e fêmeas nas respectivas idades de abate.

Palavras-chave: Bem-estar animal, cisalhamento, perda de cozimento, qualidade da carne, restrição alimentar.

INTRODUCTION

Pre-slaughter feed restriction is a practice used in industrial broiler production and consists of completely removing the feed (May *et al*., 1990). It is one of the most important stages of processing in a slaughterhouse. Such management has a direct influence on carcass yield and meat quality, avoiding cross-contamination of a gastrointestinal tract full of food during evisceration (Duke *et al*., 1997; Savage, 1998).

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Fasting period is variable and must include loading, transport, and pre-slaughter waiting times (Castro *et al*., 2008). Conversely, water intake has a different behavior, as water access restriction is made moments before loading (Northcutt, 2003). Even so, fasting time cannot be too long because, in addition to the stress caused by feed restriction to birds, which goes completely against one of the five freedoms of animals, several physiological changes may occur. In addition, food restriction for longer times can also encourage birds to start feeding on other organic components such as feces, bedding waste, among others.

Meat quality is also related to dietary restrictions. During fasting period, carcasses start dehydrating as muscles lose water to compensate for lack of water intake and, consequently, body weight losses occur. Meat water-holding capacity (WHC) is intimately related product quality, influencing post-cooking tenderness and palatability (Castro *et al.*, 2008). Low WHC and flaccid texture have become chronic problems in slaughtered birds, affecting functional characteristics used in future processing (Droval *et al*., 2012). Overall, these have been major issues in poultry plants (Garcia *et al.*, 2010; Zhu *et al*., 2012).

Stress caused by long restrictions to feed access can also cause changes in meat quality, which is not only common to poultry species (Langer *et al*., 2010). Stress causes depletion of muscle glycogen reserves (Guàrdia *et al*., 2005). Several studies have shown the relationship between the onset of meat quality changes and acute stress, that is, moments before slaughter muscle glycogen stores are consumed (Xing *et al*., 2015). This acute stress causes the muscles to enter anaerobiosis, initiating their metabolism without oxygen, thus accumulating lactic acid as a product, denaturing proteins, and damaging meat quality (Khan and Nakamura, 1970; May *et al*., 1990).

Researchers have defined a fasting time between eight and 12 hours as optimal to decrease the incidence of contamination without affecting carcass yield (Mendes, 2001). However, new genetic parameters have provided important information about adequacy to the needs and demands of the chicken production chain (Gaya *et al*., 2006). In this sense, old concepts must be reviewed, and new studies on current modern broiler strains are important due to the intense genetic selection pressure.

Therefore, this study aimed to evaluate the effect of pre-slaughter fasting times on live weight reduction and meat quality for male and female broilers slaughtered at 35 and 42 days.

MATERIALS AND METHODS

The project was approved by the UDESC Ethics Committee on Animal Experimentation, under protocol No. 6957021219. A total of 64 birds taken randomly from a larger batch were used. They were reared on shavings litter in a conventional positive-pressure aviary. Birds received the same management conditions following the strain guidelines. Water and feed were provided *ad libitum* during all rearing phases, and feed was based on corn and soybean meal, following the recommendations of Rostagno *et al*. (2017).

Treatments consisted of different pre-slaughter fasting times, and the birds were deprived of access to feed and water for four, eight, 12, and 16 hours. The treatments were evaluated differently in males and females slaughtered at 35 and 42 days of age. A completely randomized design was used, with eight replications for each fasting time and sex, with each bird being considered as an experimental unit.

At the beginning and end of fasting periods, the birds were weighed individually, with weight reductions (%) being determined as the ratio between the initial and final weights. After weighing, the birds were euthanized by cervical dislocation in compliance with humane slaughter guidelines of the Federal Brazilian Council of Veterinary Medicine (CFMV). After sacrifice, breast muscle samples were taken for meat quality analysis. The samples were individualized in vacuum packs and cooked at 75±1°C and kept in water at a temperature of 80±0.5°C for 35 minutes. After the cooking process, they were placed in cold water for 20 minutes and weighed again. Cooking loss (CL) was defined as the

percentage (%) of water loss during cooking, which was determined on a precision analytical scale.

Water-holding capacity (WHC) was also ascertained by selecting 2 g of breast muscle samples. These samples were wrapped in absorbent paper to capture moisture and then subjected to a 5-kg pressure for 5 minutes. Afterward, the paper was removed, and the samples were weighed again to analyze moisture losses after application of pressure. The parameter WHC was considered as the ratio (%) between the final and initial weights of meat samples, using a precision analytical scale.

The results were subjected to analysis of variance. A regression analysis was carried out for live weight reductions. Averages of CL and WHC were subjected to analysis of variance and a significant difference was found. Then, the Tukey's test was applied (5%) to averages, using the SAS statistical software (SAS…, 1998).

RESULTS AND DISCUSSION

At the beginning of fasting times, for broilers slaughtered at 35 days of age, males had an average weight of 2.218kg and females of 1.989kg. Yet for birds slaughtered at 42 days, males weighed 2.921kg and females 2.669kg, on average.

By comparing slaughter times for each sex, no differences in live weight reduction were observed among the pre-slaughter fasting times of four, eight, and 12h (Table 1). For broilers slaughtered at 42 days of age, females showed no changes between four and eight hours of fasting but differing from those under 12 and 16 hours of fasting. Only for birds slaughtered at 42 days of age with 16h of fasting, males showed greater live weight losses ($P<0.05$) compared to the other fasting times.

A significant linear equation for weight reductions was observed by regression analysis (Table 1) for both males and females, in which the longer the fasting time, the greater the live weight reduction of birds.

When comparing the slaughter ages of 35 and 42 days, no differences in weight reductions ($P>0.05$) were recorded for both male and female birds. Moreover, no difference ($P>0.05$) was observed between males and females at the respective slaughter times (Table 1).

Other authors have also obtained similar results. Denadai *et al*. (2001) observed that weight reductions were similar between birds subjected to four and eight h of fasting, but higher than animals without a fasting regime. Schettino *et al*. (2006) evaluated four, eight, 12, 14, and 16h of pre-slaughter fasting for birds slaughtered at 44 days of age; they noted that weight reductions increased among fasting times, but no difference was registered between males and females. Castro *et al*. (2008) analyzed weight reduction with time for three, six, nine, 12, 15, and 18h of pre-slaughter fasting in chickens at 46 days of age; they also reported weight reductions over time, which were 2.27% in birds subjected to three hours of fasting and 7.51% in those under 18 hours of fasting. Ramão *et al*. (2011) assessed the effects of three, six, nine, 12, and 15h of pre-slaughter fasting on live weight reductions of birds slaughtered at 45 days of age and, just as in our study, weight losses increased linearly with fasting times.

According to Denadai *et al*. (2001), live weight losses in chickens occur due to lower intestinal contents at the time of slaughter, that is, there is a gradual emptying of the gut as fasting time progresses. Some authors have indicated that weight reductions are also due to muscle dehydration with fasting time. However, Ramão *et al*. (2011) found no difference in carcass water absorption for chickens under 3 and 15h of fasting. Remarkably, unlike what was performed in our study, some authors provided birds with access to water during fasting, which can cause an experimental error since they may try to satisfy their hunger by ingesting more water, filling the digestive tract, thereby masking the weight at the time of slaughter.

Table 1. Live weight reductions (%) among the different fasting times (hours) for male and female broilers slaughtered at 35 and 42 days of age

Sex	Fasting time	Weight reduction 35 days*	Weight reduction 42 days*	Probability 35x42 days	SEM 35x42 days
Male	4	2.00 b	1.81 b	0.2128	0.87
	8	2.82 b	1.98 b	0.2497	1.81
	12	3.35 ab	2.69 b	0.4244	0.84
	16	4.92 a	4.68 a	0.8020	1.52
	Probability	0.0037	0.0012		
	SEM	1.20	1.14		
	Regression	y=0.224x+0.996	y=0.247x+0.328		
Female	4	2.29 b	1.60 c	0.6353	1.04
	8	3.57 ab	2.57 c	0.6126	1.58
	12	3.63 ab	3.04 b	0.8092	1.82
	16	4.78 a	4.46 a	0.1003	1.14
	Probability	0.0270	0.0001		
	SEM	1.53	0.89		
	Regression	y=0.189x+1.679	y=0.226x+0.660		

Weight reduction at 35 days between male and females

	4 h	8 h	12 h	16 h
Male	3.36	3.48	3.11	4.92
Female	2.67	3.38	3.37	3.86
Probability	0.1169	0.8803	0.6253	0.1645
SEM	0.69	1.12	0.79	1.19

Weight reduction at 42 days between male and females

	4 h	8 h	12 h	16 h*
Male	2.69	3.51	3.98	5.16 a
Female	2.79	2.67	2.46	2.75 b
Probability	0.8241	0.1541	0.0649	0.0016
SEM	0.82	1.03	0.77	0.95

*Unequal letters in the columns differ statistically by the Tukey's test (5%)
SEM: Standard error of the mean

In the present study, we observed that the age at which birds are slaughtered (35 and 42 days) does not interfere with their weight reductions (Table 1), regardless of the fasting times. No study was found in the literature that could confirm such an outcome. Moreover, there was no difference between males and females, regardless of the slaughter time, except for birds slaughtered at 42 days of age, among which males had greater weight losses than females (Table 1). In this context, Chen *et al*. (1983) pointed out that weight reductions as pre-slaughter fasting increases may vary with bird sizes. In addition, Duke *et al*. (1997) stated that weight reductions also occur due to muscle dehydration and a decreased WHC in tissues with age. In this sense, male broilers have greater muscle development compared to females, which have earlier fat deposition (Carolino *et al*., 2014).

Regarding meat quality, the parameters CL (Table 2) and WHC (Table 3) are used to define meat tenderness. Such an ability to retain water in tissues means that processing, such as cooking for example, does not affect meat to the point of dehydrating and making it more rigid. Thus, WHC is an important characteristic related to the appearance before cooking, behavior during cooking, and palatability of the product after cooking (Mendes, 2001). In this context, prolonged fasting or other pre-slaughter stress are associated with ATP losses, glycogen depletions, and lactic acid accumulations within muscles, affecting the meat quality (Abdalla *et al*., 1999).

Table 2. Cooking losses (CL, %) of breast meat samples from male and female broilers under different pre-slaughter fasting times (hours) and slaughtered at 35 and 42 days of age

Sex	Fasting time	CL 35 days	CL 42 days	Probability 35x42 days	SEM 35x42 days
Male	4	24.9	25.1	0.9517	4.21
	8	26.8	25.4	0.9801	3.40
	12	27.6	24.5	0.9620	2.42
	16	29.7	25.3	0.4162	3.72
	Probability	0.3464	0.9914		
	SEM	3.56	4.44		
Female	4	27.4	24.8	0.2515	3.10
	8	25.2	21.9	0.1083	3.60
	12	23.8	22.3	0.3416	2.76
	16	23.4	24.8	0.1186	1.17
	Probability	0.1543	0.1000		
	SEM	3.07	2.65		

	CL at 35 days between male and females			
	4 h	8 h	12 h	16 h
Male	24.9	25.4	24.6	25.7
Female	27.4	25.3	23.8	23.7
Probability	0.1784	0.9398	0.7021	0.0801
SEM	3.18	3.80	2.90	0.70

	CL at 42 days between male and females			
	4 h	8 h	12 h	16 h
Male	25.1	25.9	24.5	26.9
Female	25.5	21.9	22.3	24.8
Probability	0.8645	0.071	0.2259	0.3118
SEM	3.970	3.20	2.49	3.10

There was no difference in any of the evaluations (P>0.05)
SEM: Standard error of the mean

The CL results showed no significant differences (P>0.05) among pre-slaughter fasting times for each sex, between slaughter ages at each fasting time, and between males and females at the time of slaughter (Tab. 02). Unlike our findings, Mendes and Komiyama (2011) observed that age at slaughter affects CL results and highlighted a reduction by 32.95% between 35 and 49 days of age. However, Castro *et al*. (2008) also did not find differences in the CL of breast meat in chickens subjected to three, six, nine, 12, 15 and 18h of fasting, but with water available up to three hours before slaughter.

We found no differences (P>0.05) in WHC among the fasting times for each sex, between slaughter ages in each fasting time, and between males and females at the time of slaughter (Table 3).

The parameter WHC is crucial in meat since it is related to its appearance before cooking, its behavior during cooking, and its palatability. Broiler rearing conditions and stress are reported to affect this variable (Bressan and Beraquet, 2002); therefore, fasting times can be considered a stressful event (Langer *et al*., 2010).

Table 3. Water-holding capacity (WHC, %) of breast meat samples from male and female broilers under different pre-slaughter fasting times (hours) and slaughtered at 35 and 42 days of age

Sex	Fasting time	WHC 35 days	WHC 42 days	Probability 35 x 42 days	SEM 35x42 days
Male	4	23.4	28.3	0.3002	3.08
	8	25.8	26.7	0.5186	2.45
	12	22.3	23.7	0.7362	3.48
	16	24.4	22.9	0.4714	3.51
	Probability	0.2488	0.1139		
	SEM	3.18	3.95		
Female	4	24.3	27.1	0.4471	2.94
	8	25.3	27.2	0.3925	3.45
	12	21.7	25.4	0.0510	2.93
	16	24.3	27.2	0.0696	3.63
	Probability	0.1170	0.5289		
	SEM	3.09	3.78		

WHC at 35 days between male and females				
	4 h	8 h	12 h	16 h
Male	23.4	25.8	22.3	24.4
Female	24.8	25.3	21.7	23.8
Probability	0.3185	0.7602	0.7459	0.6883
SEM	2.68	3.08	3.86	2.80

WHC at 42 days between male and females				
	4 h	8 h	12 h	16 h
Male	26.4	26.7	23.7	22.9
Female	27.0	26.8	25.09	26.5
Probability	0.7736	0.9075	0.3391	0.0904
SEM	3.79	2.94	2.31	3.61

There was no difference in any of the evaluations (P>0.05)
SEM: Standard error of the mean

Schettino *et al*. (2006) evaluated the effects of five pre-slaughter fasting times (four, eight, 12, 14, and 16h) and concluded that females absorbed more water than males. Likewise, Castro *et al*. (2008) evaluated WHC in the meat of chickens subjected to three, six, nine, 12, 15, and 18h of fasting and also found no differences for males slaughtered at 46 days of age. Garcia *et al*. (2008) also reported no meat WHC differences for griller-type female broilers (slaughtered at 35 days) under four, eight, 13, and 17h of pre-slaughter fasting.

CONCLUSION

Male broilers slaughtered at 35 and 42 days of age and females slaughtered at 35 days of age have no live weight reductions for pre-slaughter fasting times up to 12h. Female broilers slaughtered at 42 days of age show no live weight reductions up to eight h of fasting. The meat quality assessed by cooking losses and water-holding capacity is not affected by pre-slaughter fasting times both in male and female broilers slaughtered at 35 and 42 days of age.

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