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Physiological responses of broiler chickens to pre-slaughter heat stress

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Pre-slaughter heat stress is frequently encountered in the broiler industry in Brazil. To cope with heat stress the birds develop physiological responses, which may finally affect meat quality. An experiment was conducted to simulate the actual heat stress situation, under controlled conditions of a climatic chamber, and evaluate the effects on broilers at slaughter weight. Chickens of a commercial strain were raised in a normal production system and, at 42 days of age, were submitted to high heat stress. Thirty broilers in transportation crates (10 birds per crate) were placed in a climatic chamber at high stress condition (temperature 30 C, relative humidity 85%). Two birds per crate were evaluated at each time (0, 30, 50, 90 and 120 min) for body weight, rectal temperature, respiratory frequency and blood samples taken for hematocrit. After each sampling the chickens were sacrificed and the parts (breast, leg quarters, wings, back) were weighed, as well as the viscera. Proc GLM of SAS was used for statistical analyses, using Tukey's test ($p<0.05$) for comparison of means. The physiological responses rectal temperature and respiratory frequency increased gradually from 40.3 to 45.0 C and from 30.7 to >51.0 movements per minute, respectively. Hematocrit decreased from 33.0 to 29.6% with the increased duration of heat stress. Weight loss increased with time, reaching 110 g of body weight after 120 min of heat stress. This was accompanied by a weight loss of legs, wings and backs, whereas breast and viscera were not affected. It was concluded that the physiological adjustments the birds experience during acute heat stress also include changes in the proportion of parts in the carcass.

Keywords: broiler, heat stress, physiology, carcass quality

Introduction

There are some welfare problems in broiler chicken production related especially to pre-slaughter management and transport, such as carcass bruising, physiological stress and elevated mortality (Nicol and Scott, 1990). During transport, in addition to the effects of external environmental conditions and the conditions inside the transportation crates, the waiting time before slaughter will increase the exposition to stress. Therefore, the environment in which the transportation trucks stay during this waiting period may be important in the control of the adverse conditions, relative to needs of the chickens (Bayliss and Hinton, 1990).

Studying the level of thermal well-being during transportation and the pre-slaughter waiting time, Silva et al. (1997) reported that bird density in the transportation crates and the age of the chickens significantly affected mortality. In addition the adequate location of the transportation truck during the waiting time may reduce the thermal load and, therefore, minimize the stress of the birds (Nääs et al., 1998).

When the chickens are exposed to hot environmental conditions, the physiologic responses include an increase in respiratory frequency, a mechanism aimed to maintain the equilibrium of body temperature through the evaporative heat loss, and when this mechanism is disrupted the consequence is an increase in body temperature (Silva et al., 2001). This situation can be frequently encountered during the transport of the chickens from the farm to the slaughtering plant.

This study was conducted to simulate the actual heat stress situation, under controlled conditions of a climatic chamber, and evaluate the responses of the duration of exposure to heat on physiologic traits and carcass composition of broilers at slaughter weight.

Materials and methods

Two hundred straight run chickens of a commercial line were housed in an experimental house located at the ESALQ *Campus*, in Piracicaba, SP, Brazil. The birds were raised to 42 days of age under the usual conditions which include an open sided building, concrete floor covered with rice hulls as litter material, and bird density of 12 chickens.m^{-2}. The chickens had *ad libitum* access to a corn-soybean meal nutritionally adequate feed and water, with a 24-hour light schedule. At 42 days, 36 male broiler chickens were randomly taken in the morning for the experiment. Initially, six chickens were evaluated under the normal raising environment, determining body weight, and the physiologic variables rectal temperature, respiratory frequency and hematocrit, before being sacrificed. The 30 additional broilers were weighed and place in common plastic transportation crates (10 birds per crate, totaling three crates). The crates were then placed in a climatic chamber and the chickens subjected to conditions of elevated stress (35^{o}C and 85% relative humidity), as classified by Kampen (1984). The chickens were kept under stress conditions in the climatic chamber for up to two hours.

At 30 minutes intervals (30, 60, 90, and 120 minutes) two chickens were randomly taken from each crate (six chickens at each time) and the same variables previously measured in the chickens in thermo neutral conditions were recorded; the broilers were then slaughtered and the carcasses processed as described below. Upon removal of the birds from the crates, additional chickens were placed in the crates in order to maintain 10 birds per crate during the entire experimental period. The determinations of rectal temperature, respiratory frequency, and blood collection were performed inside the climatic chamber in order to avoid the effects of the external environment on the physiological condition of the birds.

Rectal temperature and respiratory frequency were obtained as described previously (Barbosa Filho, 2004). Hematocrit was evaluated using the micro-hematocrit technique as described by Rosario et al. (2000) and expressed as percentage. Liveweight was recorded in scale with a precision of 20 g, and was used to calculate weight loss after stress.

The chickens were sacrificed in an experimental slaughter facility, according to the standard practices determined by specific legislation. The following measurements were taken: weight of the eviscerated carcass (without viscera, head, neck, feet and abdominal fat), breast, leg quarters (leg and thigh), wings, back and viscera weight.

The completely randomized experimental design was used in the statistical analyses, with six replicates and the individual bird as the experimental unit. Eviscerated carcass weight was used as a covariate in the analyses of the carcass variables. Analysis of variance was performed using the GLM procedure of SAS (2005) and the effects of treatments (time of exposure to stress) were evaluated by Turkey's test ($P < 0.05$).

Results and discussion

The results obtained for rectal temperature, respiratory frequency, and hematocrit of the birds at each stress period are presented in Table 1.

The duration of the high temperature stress significantly affected the variables. There was a clear tendency for increasing the body temperature and respiratory frequency with the duration of stress. The hematocrit value did show a defined trend across the times of stress, and was not associated with the treatments. It was not possible to record visually the respiratory frequency at the times 90 and 120 minutes, because this rate increased rapidly as the chickens attempted to maintain the body temperature.

Table 1. Average values of rectal temperature, respiratory frequency, and hematocrit of chickens subjected to different stress periods.

Stress time (min)	Rectal temperature (°C)	Respiratory frequency (min^{-1})	Hematocrit (%)
0	40.3^{a}	30.7^{a}	33.0^{d}
30	42.4^{b}	40.0^{b}	29.1^{a}
60	43.9^{c}	51.0^{c}	31.0^{c}
90	44.5^{d}	nd[1]	30.3^{b}
120	45.0^{d}	nd	29.6^{a}

[a,b,c,d] Means in the columns with no common superscripts differ by Tukey´s test ($P < 0.05$).
[1] Not determined.

The longer the time of exposure to heat stress, the greater the influence on the physiological characteristics evaluated; this has been also reported by Nicol and Scott(1990) who related the pre slaughter management and transportation to physiological stress.

Increasing the duration of the heat stress significantly affected the magnitude of body weight loss. This weight loss was accompanied by losses in leg quarters, wings, and backs. However, breast and viscera weights were not affected by the condition of heat stress to which the chickens were subjected (Table 2).

Table 2. Average values of body weight loss and weights of breast, legs, wings, backs, and viscera of chickens submitted to different stress periods.

Stress time (min)	Weight loss (g)	Breast (g)	Leg quarter (g)	Wing (g)	Back (g)	Viscera (g)
0	0.0^{a}	734.2	633.3^{a}	235.1^{a}	427.1^{a}	299.0
30	16.7^{b}	719.4	622.5^{ab}	228.6^{ab}	425.7^{a}	306.4
60	90.0^{c}	700.6	611.1^{ab}	227.3^{ab}	420.7^{ab}	284.0
90	111.7^{d}	726.6	593.8^{b}	216.7^{b}	407.0^{b}	277.1
120	106.7^{d}	701.6	609.3^{ab}	222.7^{ab}	416.1^{ab}	285.1

[a,b,c,d] Means in the columns with no common superscripts differ by Tukey´s test ($P < 0.05$).

In a recent study, Takahashi et al. (2005) observed a significant effect of the duration of the transportation time, as a function of the distance from the farm to the slaughtering house, on the characteristics of carcass quality.

According to Kettlewell et al. (2001), subjecting broilers to high temperature values during transportation is the major responsible for loss of meat quality and losses due to arrival death, and these problems tend to aggravate with the duration of the transport.

It was concluded that the physiological adjustments the birds experience during acute heat stress also include changes in the proportion of parts in the carcass.

References

BARBOSA FILHO, J. A. D. 2004. *Avaliação do bem-estar de aves poedeiras em diferentes sistemas de produção e condições ambientais, utilizando análises de imagens.* MS Dissertation. University of São Paulo, Piracicaba, SP, Brazil.

BAYLISS, P. A. and HINTON, M. H. 1990. Transportation of broilers with special reference to mortality rates. *Applied Animal Behavior Science* **28**:93-118.

KAMPEN, M. V. 1984. Pysiological responses of poultry to ambient temperature. *Archiv fur Experimentelle Veterinar Medizin* **38**:384-391.

KETTLEWELL, P. J., HOXEY, R. P. AND HAMPSON, C. J. 2001. design and operation of a prototype mechanical ventilation system for livestock transport vehicles. *Journal of Agricultural Engeneering Research* **79**:429-439.

NICOL, C. J. and SCOTT, G. B. 1990. Pre-slaughter handling and transport of broiler chickens. *Applied Animal Behavior Science* **28**:57-73.

ROSARIO, M. F., SILVA, M. A. N., MARTINS, E., SAVINO, V. J. M. and COELHO, A. A. D. 2000. Influência da genética e do sexo sobre o valor hematócrito em galinhas reprodutoras pesadas. *Revista Brasileira de Ciência Avícola* **2**:281-286.

NÄÄS, I. A., SILVA, I. J. O. and GOUVEIA, R. P. 1998. Avaliação de sistemas de resfriamento no ambiente de espera em caixas transportadoras de frango de corte utilizando a ventilação e a nebulização. *Revista de EngenhariaRural* **9**:50-55.

SILVA, I. J. O., LAGATA, D., PEDROSO, D. S., VENERO, J. T. R., PIEDADE, S. M. S. and NÄÄS, I. A. 1997. Análise das condições de conforto em caminhões em abatedouro. *Conferência Apinco 1997 de Ciência e Tecnologia Avícolas* (Abstract):1.

SILVA, M. A., N., SILVA, I. J. O., PIEDADE, S. M. S., MARTINS, E., SAVINO, V. J. M. and COELHO, A. A. D. 2001. Resistência ao estresse calórico em frangos de corte de pescoço pelado. *Revista Brasileira de Ciência Avícola* **3**:27-33.

TAKAHASHI, S. E., MENDES, A. A., KOMIYAMA, C. M. and MOREIRA, J. 2005. Efeito do tempo de transporte sobre a ocorrência de carne PSE. *Revista Brasileira de Ciência Avícola(Supl.)*:27.