

## Environmental temperature and serum cortisol levels In growing-finishing pigs

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### Abstract

Thirty-six castrated males and females Landrace x Large-White pigs (74 to 149 days of age) were randomly allotted to two environmental conditions: high temperature in a climatic chamber (HT; 22.2 to 32.8 °C) and comfort temperature in a conventional shed (CT; 17.6 to 26.6 °C), with night-and-day variations. Blood samples were weekly collected from animals of both HT and CT conditions for determination of serum cortisol levels. Cortisol levels of both sexes were not different, and there was no interaction with environmental temperature. Pigs of HT showed significantly higher average cortisol level ( $P < 0.01$ ) than the CT ones (7.06 and 4.82 mg/dL, respectively). Increasing in serum cortisol was continuous and linear ( $P < 0.05$ ) during the experimental period, suggesting the cortisol as a possible indicator of the heat stress in growing-finishing pigs.

### Key words:

Swine.  
Cortisol concentration.  
Heat stress.

### Introduction

Environmental temperature is an important factor of welfare condition for the swine specie. Growing-finishing phase pigs are particularly sensitive to high temperatures, since genetic improvement, breeding intensity, and low thermolytic ability affect the reactions to heat stress. As consequence, cortisol levels increasing the amino acids content in the blood, inducing to a lower intracellular glucose utilisation and increasing liver neoglucogenesis. These events, besides body fat mobilization, are physiological mechanisms to supply energy for the brain and other tissues. In fact, all stressful situations compromise animal welfare, resulting in circulating cortisol increase of pigs.<sup>1,2</sup>

Published data are not in agreement about duration and magnitude of increases of basal glucocorticoids. Alvarez and Johnson<sup>3</sup> observed 28% and 62% of

increase in cortisol after 1 and 2 hours of exposure to heat stress, respectively, with a peak of 102% after 4 hours. Normal values were reached after 48 hours, remaining until the end of the stress condition. Other researches verified great decrease<sup>4</sup> or no effect of heat stress on the corticoid levels<sup>5</sup> regardless duration or intensity. This can be an indication of individual inability to regulate cortisol secretion when stress condition is applied. At present, is acceptable to admit that there is an increase in serum concentrations during the acute phase, inducing neoglucogenesis and higher glucose utilization. The response in the chronic phase is the decrease of cortisol level to prevent metabolic heat production.<sup>6</sup> Becker et al.<sup>7</sup> observed higher serum cortisol levels during three successive days of heat exposure in growing pigs. Increasing the temperature from 20 to 38°C, serum cortisol raised about 25.2 ng/mL. Mean levels dropped from 29.7 ng/mL in the first day to 26.0 ng/mL

in the third day of exposure. Exposure of sows to 30°C suppressed serum cortisol concentrations and cortisol-induced releasing compared to 22°C.<sup>8</sup>

Serum cortisol increases at different stress duration and conditions. Yoshioka et al.<sup>9</sup> verified that both normal pigs and heterozygous pigs with Halothane gene showed an increase in cortisol levels after transportation, indicating a stress condition with clinical signs as increase of rectal temperature and respiratory rate. Different responses of plasma cortisol were observed in Duroc and Pietrain pigs submitted to restraint immobilization from 5 to 60 minutes, with significant interaction between strain of animal and time to exposure to stress.<sup>10</sup>

Several studies indicate that cortisol is susceptible to changes in serum concentrations when temperature is above the thermoneutral range and that can be likely used as an indicator of loss of welfare. The present study was designed to investigate the influence of chronic exposition to high temperature on serum cortisol level and if this measure can be used as an indicator of heat stress for growing-finishing pigs.

## Material and Method

The experiment was conducted during 75 days at the Faculdade de Medicina Veterinária e Zootecnia da Universidade de São Paulo, Campus de Pirassununga, using a brick made climatic chamber (total area of 50 m<sup>2</sup>; 2.5 m right foot, concrete floor, central heating system and incandescent illumination) and an open shed (concrete floor and ceramic roof). Suspended cages had concrete floor and iron fences, containing automatic feeder and nipple drinkers.

Thirty six castrated males and females Landrace x Large-White growing-finishing phase pigs (74 to 149 days age) were randomly allotted to two treatments: heat stress temperature in the climatic chamber (HT group; 22.2 to 32.8°C), and comfort temperature in the stall (CT group; 17.6 to

26.6°C). Diet was formulated based on corn and soybean meal to satisfy the requirements of the category according to the National Research Council.<sup>11</sup> Pigs were individually caged and ration and water were supplied *ad libitum*. Animals were maintained under adaptation period (days 1 to 6) under temperatures of experimental conditions prior to the start of the experiment with no important differences in behavior or clinical signs between both groups. From days 7 to 75 blood serum samples were weekly collected from half of each group, and cortisol determination was performed by Stratus<sup>®</sup> Fluorometric Enzyme Immunoassay.

Experiment was analyzed as a completely randomized design with 2 treatments (HT and CT) and 18 pigs per treatment. Analysis of variance was done using the General Linear Model procedure (SAS<sup>®</sup>, SAS Institute, USA). GrafPad Prism<sup>®</sup> (GrafPad Software, USA) was used to make linear regression of the concentrations per age into the groups.

## Results and Discussion

It is well known that comfort temperature of pigs in growing-finishing phase is 18-20°C, with lower critical temperature of 12-15°C, and upper critical temperature of 26.0°C<sup>12</sup>. In response to exposure to the temperature used in this trial, hormone level difference in both treatments indicated a heat stress condition. Mean values of serum cortisol for both HT (7.1 mg/dL) and TC (4.8 mg/dL) were significantly different ( $P < 0.01$ ), as shown at Figure 1. Punctual differences ( $P < 0.05$ ) were observed at days 114, 121, and 136 days of age (Table 1).

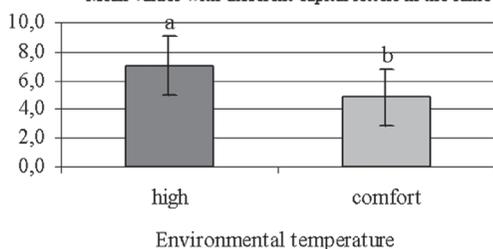
Increase of serum cortisol was occurred during the studied period for both treatments, but HT group showed higher increasing level in each every point, but the 107<sup>th</sup> day o the experimental period (Figure 2). At the day 136 serum cortisol levels of both HT and CT treatments showed a significant decrease ( $P < 0.05$ ), as compared to the previous measure (day 45,

**Table 1** - Differences of serum cortisol levels (mg/dL) of growing-finishing pigs exposed to heat stress temperature (high, HT) and comfort temperature (room, CT) at different ages<sup>1,2</sup>

Day of treatment / age (days)	Environmental temperature range (°C)		
	22.2-32.8 (HT)	15.6-26.6 (CT)	Average
7 / 83	5.9 a	4.4 a	5.3 BC
11 / 94	4.4 a	3.7 a	4.0 C
17 / 100	4.3 a	3.9 a	4.1 C
24 / 107	5.4 a	6.5 a	6.0 BC
31 / 114	5.9 a	2.8 b	4.6 C
38 / 121	7.8 a	5.1 b	6.2 BC
45 / 128	11.8 a	9.4 a	10.9 A
52 / 136	4.7 a	2.9 b	3.6 C
59 / 142	11.6 a	6.2 a	9.7 AB

<sup>1</sup>Mean values with different low case letters in the same row are significantly different (P<0.05)

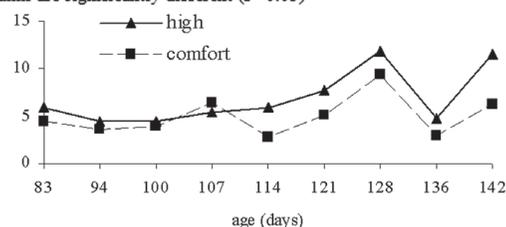
<sup>2</sup>Mean values with different capital letters in the same column are significantly different (P<0.05)



**Figure 1** - Mean serum cortisol levels (mg/dL) of growing-finishing pigs exposed to heat stress temperature (high, HT) and comfort temperature (room, CT) from 74 to 149 days of age (different letters indicate significantly difference between means; P<0.01)

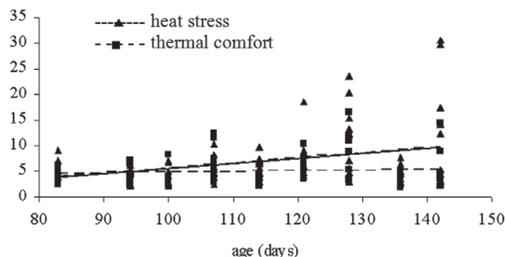
128 days of age). Similar results were also obtained by Cook et al.<sup>13</sup>, De Jong et al.<sup>14</sup> and Rosochacki et al.<sup>10</sup>, who observed the variation in the blood cortisol in response to several stressors related to modern swine production. It is important to have in mind that some variation occurs even in normal situations, as in the comfort temperature range, and the establishment of precise data is necessary to recognize the differences between normal periodical variation and physiological responses to stressors. In this trial, age did not influence the effect of environmental temperature on serum cortisol meaning that there is an independent action of both variables on that hormone release.

Analysis of regression showed that serum cortisol increased linearly in response to duration of heat exposure



**Figure 2** - Serum cortisol levels at different ages of growing-finishing pigs (n = 18) exposed to heat stress temperature (high, HT) and comfort temperature (room, CT)

(P<0.05), while at CT conditions hormone level was constant (Figure 3). Slopes of the HT and CT were significantly different (P<0.05), and evidence of constant increasing of serum cortisol for the entire experimental period was evident in the CT group. F values for HT and CT were 12.51 and 0.82, respectively. Thus, our data substantiate the use of cortisol as indicator of stress, in agreement with previous researches.<sup>10</sup>



**Figure 3** - Linear regression of serum cortisol levels in growing-finishing pigs exposed to heat stress temperature (high, HT) and comfort temperature (room, CT)

## Conclusion

Serum cortisol level of growing-finishing pigs is affected by environmental

temperature range of 22.2 - 32.8°C, increasing about 12% at the long term exposition, indicating chronic heat stress condition.

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## Temperatura ambiente e concentrações séricas de cortisol em suínos em crescimento-terminação

### Resumo

Trinta e seis suínos Landrace x Large-White machos castrados e fêmeas (74 a 149 dias de idade) foram distribuídos em duas condições de temperatura ambiente: temperatura alta em câmara climática (HT; 22,2-32,8 °C) e temperatura de conforto em galpão convencional (CT; 17,6-26,6 °C), em variação diuturna. Semanalmente foram obtidas amostras de sangue dos animais de ambos os tratamentos para determinação das concentrações séricas de cortisol. Os níveis de cortisol não foram significativamente diferentes entre os sexos, assim como não se observou interação entre sexo e temperatura ambiente. Os suínos do grupo HT apresentaram concentrações médias de cortisol significativamente mais altos ( $P < 0,01$ ) que os do grupo CT (7,06 e 4,82 mg/dL, respectivamente). Este aumento foi contínuo e linear ( $P < 0,05$ ) durante o período experimental, sugerindo que, para suínos em crescimento-terminação, o cortisol pode ser um indicador da condição de estresse calórico.

### Palavras-chave:

Suínos.  
Concentrações de cortisol.  
Estresse térmico.

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