RESUMO.- [Hemogasometria venosa de equinos finalistas de provas de enduro de 90 km.] Diante do exercício, os sistemas orgânicos podem sofrer desequilíbrios hidroeletrolíticos e ácido-base, especialmente em se tratando dos gases sanguíneos, demonstrando variações decorrentes de diferentes causas, sejam elas respiratórias ou metabólicas. O entendimento das adaptações fisiológicas que ocorrem em resposta ao exercício é de fundamental importância na busca do ótimo desempenho. Desta forma buscou-se mensurar os gases sanguíneos venosos (pO2, pCO2), bem como, a saturação de oxigênio (SatO2) em equinos saudáveis, Puro Sangue Árabe finalistas de 90km endurance races. A total of fourteen Arabian horses were evaluated, nine males and five females, between six and 12 years old, finalists in 90km endurance races. There was a significant reduction in pO2, pCO2, and SatO2 after the exercise, however, the values remained within the normality range, and did not change the athletic performance of the animals, indicating a temporary alteration, assuming thus a character of physiological response to the exercise performed. The equines, finalists in 90 Km endurance races, demonstrated efficient ventilatory process, without any alterations in the athletic performance, being adapted to the type of exercise imposed.

INDEX TERMS: Arabian horse, blood gas, endurance.

INTRODUCTION

Front of exercise, the organic systems may suffer water-electrolyte and acid-base imbalances, particularly in the case of blood gases, demonstrating variations from different causes, whether respiratory and/or metabolic. Understanding the physiological adaptations to exercise is essential in the search for the optimum performance. In this way, this study measured the venous blood gases (pO2, pCO2), as well as the oxygen saturation (SatO2) in healthy equines, Arabian horses finalists in 90km endurance races. A total of fourteen Arabian horses were evaluated, nine males and five females, between six and 12 years old, finalists in 90km endurance races. There was a significant reduction in pO2, pCO2, and SatO2 after the exercise, however, the values remained within the normality range, and did not change the athletic performance of the animals, indicating a temporary alteration, assuming thus a character of physiological response to the exercise performed. The equines, finalists in 90 Km endurance races, demonstrated efficient ventilatory process, without any alterations in the athletic performance, being adapted to the type of exercise imposed.
dering the partial oxygen pressure (pO2) as evaluation parameter of pulmonary oxygenation, as well as the partial pressure of carbon dioxide (pCO2) for the pulmonary ventilation, being these last two inversely proportional. Therefore, it was considered that the increase or decrease in these parameters may indicate hypoventilation and hyperventilation. In this context, occurs hypoxemia induced by exercise in equine and humans, because the increase in the respiratory rate and decrease in the time of erythrocyte transit through pulmonary capillaries due to increased heart rate are mechanisms which compromise and worsen the gas diffusion through the alveolar-capillary membrane.

Understanding the physiological adaptations which occur in response to exercise is of fundamental importance in seeking the optimum performance. In this way, it was sought to measure the venous blood gases (pO2, pCO2), as well as the oxygen saturation (SaO2) in healthy equines, Arabian horses, finalists in 90km endurance races.

**MATERIALS AND METHODS**

In this study we used 14 horses, nine males and five females, Arabian aged six to 12 years old, subjected to endurance training and participants of regional endurance championship of the Equestrian Federation of Brasília in the mode of 90 km. The races occurred in July, August, October and December 2009, covering the dry period with relative humidity of around 43% (April-September) and the rainy period with relative humidity of approximately 57% (October-March), with average temperature of 25ºC. The study was approved by the Ethics Committee on Animal Use of the University of Brasília under the protocol # 88-2009.

Animals were given different types of food and electrolyte supplements before and after the race. The health of the animals was proven by clinical and hematological evaluation, using an automatic cell counter (Abacus Júnior Vet®, Diagon, Ltda.).

For blood gas analysis, 1.6ml blood from the external jugular vein was collected anaerobically (0.75x25mm, 22G, BD Preset Eclipse®). Samples were taken before (M0) and immediately after (MF) the exercise, being then identified and stored in ice bath (Lisboa et al. 2001) for a maximum period of 30 minutes until processing. By means of the automatic analyzer of gases, electrolytes and total hemoglobin (Analyzer of Blood Gas, Electrolyte, Hemoglobin, Hematocrit and O2 saturation (OMNIC® Roche Diagnostica, Brazil), it was obtained the partial pressure of oxygen pO2 (v); partial pressure of carbon dioxide pCO2 (v) and oxygen saturation SaO2 (v).

The evaluation before the exercise (M0) took place in the horse farm, in days previously established, avoiding exercising the animals, by conducting a thorough clinical examination and measurement of body weight (MGR 3000 scale Toledo®). The evaluation after the exercise (MF) occurred at the place of the race, by the end of the last ring of the competition, soon after the official veterinary inspection according to methodology abovementioned.

Parameters obtained before and after the exercise were subjected to the Kolmogorov-Smirnov normality test, and compared by applying the paired t-test for parametric data, and Wilcoxon test for non-parametric data, considering significant when \( p \leq 0.05 \) (Table 2).

**RESULTS AND DISCUSSION**

The study on blood gas parameters is essential for understanding physiological responses of horses properly trained and fit for high performance sports. The results of clinical and hematological evaluation carried out before the exercise (M0) (Table 1) confirmed the health of all animals that completed the 90Km endurance race, within the reference values.

With the analysis of pO2, pCO2 and SaO2, it was observed that all variables were slightly reduced compared with before the exercise (Table 2).

Values of pO2 were lower than described for Arabian horses (Silva 2008), with minimum limit below physiological standards, 37 to 56 mmHg (Watanabe et al. 2006). In the studied animals, the reduction was 10.08% (p=0.044), after the exercise (Table 2, Fig.1b), coinciding with that found in horses competitors of 60 Km-endurance races (Di Filipo et al. 2009) and differing from observed for jumping horses (Aguilera-Tejero et al. 2000). During intense exercises, the marked increase of cardiac output led to a reduction in the capillary transit time, compromising the oxygen equilibrium time, preventing the alveolar-capillary diffusion, resulting in hypoxemia (Wilkins et al. 2001). A fact proven when induced the hypervolemia in an attempt to reduce the hypoxemia, i.e., during periods of moderate to intense exercises the pO2 has reduced in approximately 15 mmHg (Tennent-Brown et al. 2006). This suggested that the difference between the types of exercise explains the divergent and varied values found by these authors.

**Table 1. Hematological values obtained for Arabian horses, finalists of a 90 km endurance race, before and after exercise. Brasília, 2012**

| Parameters | Before the exercise (M0) | After the exercise (MF) | Reference Values |
|------------|--------------------------|-------------------------|-----------------|
| HR (bpm)   | 34.71±3.3                | 51.78±6.08              | 35±5<sup>a</sup> |
| RT (°C)    | 36.9±0.4                 | 38±0.6                 | 37.5±38.5<sup>b</sup> |
| Weight (kg) | 377±23.64               | 369.85±26.63<sup>a</sup> | 390±25.4<sup>a</sup> |
| Ht (%)     | 37.29±3.29               | 45.9±7.08<sup>*</sup>  | 39±1<sup>a</sup> |
| TPP (g/dL) | 7.1±0.24                 | 7.6±0.59<sup>a</sup>   | 6.0±8.5<sup>a</sup> |
| Platelets (mm3) | 156714.29±38698.89 | 20200±45802.30 | 100000±60000<sup>b</sup> |
| Leukocytes (mm3) | 87128±1616.54 | 14971.4±2297.30 | 8490.00±2280.00<sup>b</sup> |

Values followed by * in the same row are significantly different (p<0.05) by the paired t-test, in the evaluations before and after the exercise. HR = heart rate, bpm = beats per minute, RT = rectal temperature, °C = degrees centigrade, Ht = hematocrit, PPT = total plasma protein, g/dL = grams per deciliter. a Ferraz et al. 2009, b Thomassian 2005.
Animals used in endurance tests, Arabian horses, have presented hyperventilation due to the more efficient adaptation to prolonged compared with other breeds, characterizing a gradual increase in arterial and reduced venous pO2 throughout the exercise (Taylor et al. 1998), corroborating thus the results for animal finalists in 90 km-races.

The hematocrit (Ht) and the concentration of plasma protein (PPT) have increased after the 90 km-endurance exercise (Table 1), suggesting a dehydration according to substantial losses of fluid during this type of activity (Robert et al. 2010). The increase in hematocrit along with plasma pO2 influences the transport of oxygen per unit of blood volume, and its availability is essential for efficient production of ATP during the resistance exercise (Hoffman et al. 2002). Thus the positive association between speed with variables of exercise imposed.

...
The Pure Blood Arabian animals, finalists in 90 km races, showed an efficient ventilatory process, without any alterations in the athletic performance and thus being adapted to the type of exercise imposed.

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