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Blood Oxygen Dynamic, during the Effort Test in Conjunction with the New Technologies for Sports Horse Training

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Abstract

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The purpose of this study was to reveal the oxygen blood content in horses, due to training for sport performances, in order to sustain the importance of equestrian sports for multidimensional education, as a interdisciplinary combination of veterinary medicine and sport. The quantity of circulating red cells and haemoglobin, carried by the arterial blood, influences favourably the amount of circulated oxygen. Ensuring a higher aerobic capacity in horses used in equestrian sports, by increasing the oxygen transport capacity, associated with erythrocytes realising through splechnocontraction, is a factor of prime importance. The present work aim at measuring the values of arterial oxygen in the effort test, during the different periods of training. Increasing the speed determine a decrease in the partial pressure of O_2 no matter which month was assessed, the most important being in heating in the third month (13,46±0,05 KP), while the lowest was also in the third month at 500 m/minute speed (7,59±0,04 KP), most differences being highly significant. It can be noted a decrease in pO_2 value, which is less important compared to the second month of training. Understanding the influence and interaction of factors dependent or independent of the animal body, in conditions of health security for sport horses, go to the application of innovative methods of training appropriate to obtain athletic performance. On international level the importance of this topic is seen in the necessity of knowing the dynamic of oxygen levels. These researches lead to obtain horse performances but also to avoid illness situation.

Keywords: Blood; effort; horse; oxygen; sport.

1. Introduction

Hipic sport is seen by some authors as a science or an art, but the most horse lovers consider the hipic sport as something more complex and complete, based on deep communication between horses and humans.

Hipic sports or ridding art is helping to physical development of the riders, maintaining their health and also to create good and moral features (courage, skills, optimism, and patience).

In horses used in equestrian sports, the adaptability to effort and high performances is an indispensable requirement.

Muscle in labour requires oxygen which is ensured by the functioning of ATP metabolic pathways.

The sanguine oxygen is reached into the lungs along with the air and is used in aerobic processes which are taking place in mitochondria.

Muscle activity, activated by muscle labouring, is supplied with oxygen which was coupled with haemoglobin and transported through the blood vessels. Heart activity during training is regulated depending on the effort intensity and length.

Cardiovascular adjustments that occur in the increasing transport capacity and oxygen intake during muscle labour in horses used in equestrian sports are:

1. Increasing the cardiac output by means of the increasing heart rate;
2. Intensifying blood activity towards active areas;
3. Increasing blood oxygen transport capacity;
4. Economical use of oxygen at muscle level.

The resemblance between human beings and horses is the increasing cardiac output during effort, which is possible by increasing the cardiac frequency and systolic ejection volume.

In muscular effort made by horses used in hipic sports becomes hypoxemic in efforts with intensity higher than 65% from maximum oxygen volume (Amory, Art &Lekeux, 1989; Corouce, 2000; Evans & Rose, 1988; Georgescu et. al., 1971).

Hypoxemia is due to the high level of muscle aerobic capacity and also to respiratory diseases(Amory, Art &Lekeux, 1989; Beech, 1991).

In sport horses, highly developed aerobic capacity of skeletal muscle is a limiting factor of performance, seemingly paradoxical.

2. Materials and methods

For biochemical and physiological measurements the biological material was represented by a total livestock of 15 sport horses.

There were studied both females and males, aged 5 to 10 years old and over 10 years old, specialized and well trained for Eventing horse trials.

The used breeds were Romanian Sport horse and English thoroughbred (Table 1 and Figure 1, 2 and 3).

Table 1. The studied biological material

SPECIFICATION		Total	n	%
Breed	Romanian Race Horse Sport	15	9	60,00
	English thoroughbred		6	40,00

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Age	5-10 years old	15	7	46,67
	over 10 years old		8	53,33
Gender	Males	15	10	66,67
	Females		5	33,33

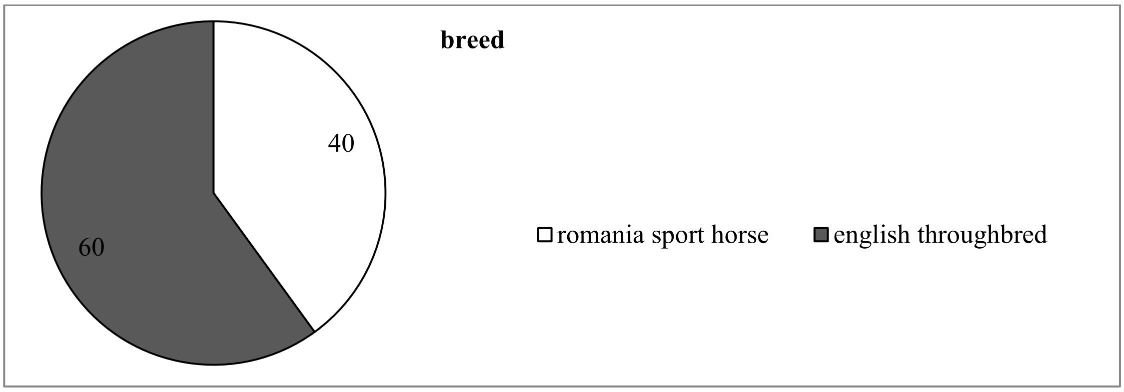

Fig. 1. The used biological material, depending on breed

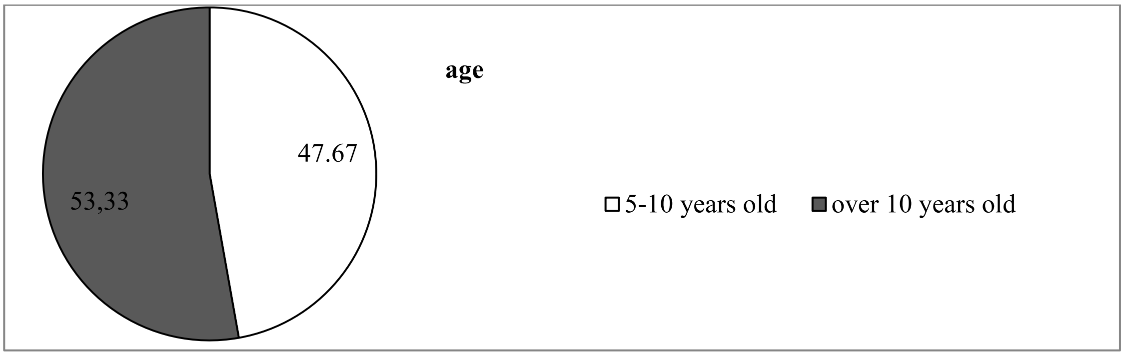

Fig. 2. The used biological material, depending on the age

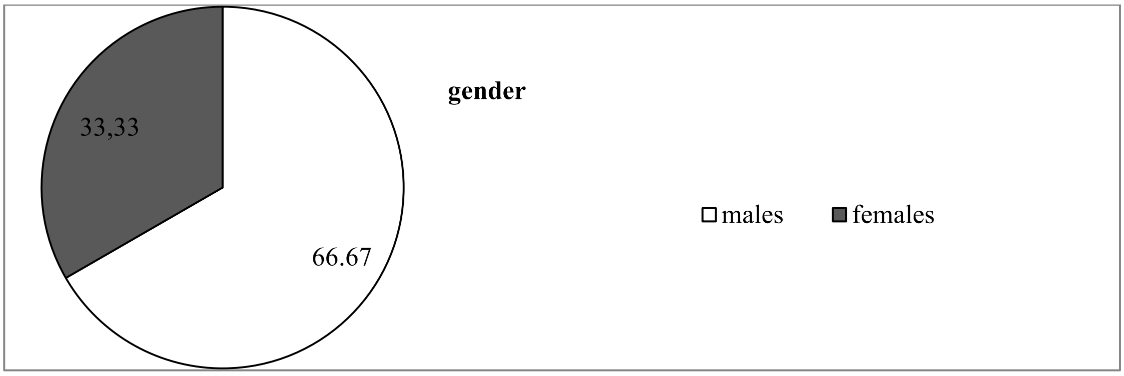

Fig. 3. The used biological material, depending on gender

Blood harvesting was made immediately after effort in Li-heparin tubes.

Plasma was separated by centrifugation and put in different tubes, immersed in cold water with ice and maintained in isotherm bags, at maximum 4 ºC. Plasmatic lactate dosing was done within 30 minutes after collection.

This test was repeated for 3 times, at heating period, and after exercise, at various speeds, while the horses were gradually trained.

There were analysed for each period, a total of 75 samples, 15 samples in heating, 15 samples at 350 m/minute, 15 samples at 400 m/minute, 15 samples at 450 m/minute and 15 samples at 500 m/minute, in total 215 samples being analysed for all 3 periods.

For standardized effort test under field conditions, horses were put to the following levels of effort (Couroucé, 2000).

- Heating to small trot – 5 minutes;
- Level II – 3 minutes in gallop at speed 350 m/minutes;
- Level III – 3 minutes in gallop at speed 400 m/minutes;
- Level IV – 3 minutes in gallop at speed 450 m/minutes;
- Level V – 3 minutes in gallop at speed 500 m/minutes;
- Pause between levels – 1 minute;
- Active recovery to small trot – 5 minutes

In order to eliminate the possible errors, the land that was used in the test was the same used during horse training.

The horse riders were also the same persons who trained the horses.

Arterial blood samples were sampled before exercise and at the end of each effort level, from transverse facial artery, using a catheter with 20 G diameter and 32 mm length (Georgescu et al., 1971).

This operation was carried on as follows:

- identifying the artery found in the zigomatic left region, by palpation;
- local disinfection with alcohol and superficial dermal anaesthesia above the artery with 0,2 ml lidocaine 2%. Exceeding this amount may lead to facial nerve anaesthesia with possible facial paralysis and therefore is not recommended.
- after 3-5 minutes the artery is cannulated, advancing 3-4 mm into the vessel lumen, tan the needle is withdrawn partially to maintain the rigidity of the cannula. The cannula will be pushed slightly forward to the end and the needle will withdraw within its total;
- injection of 0,2 ml saline solution 0,9 % with heparin (4 I.U/ml saline solution) in the cannula, followed by quick application of the cannula cap. This will prevents blood clotting within the cannula
- bounding the two wings of the cannula to the skin with special adhesive and securing the cannula position by application of additional adhesive tape.

Arterial blood collection was carried out in syringes of 2 ml heparin, airtight, avoiding contact with air. Blood samples were stored on ice flask at 0-4 ºC.

Transportation to the laboratory was made during about one hour.

By means of blood samples there were determined the oxygen levels. In order to determine the blood gases there was used a gas analyser – AVL 995-S-type.

3. Results and discussions

The oxygen values obtained from blood horses, after exercise test in three different periods, are presented in table 2 and fig. 4.

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Table 2. Average values for arterial oxygen, in horses, after exercise test, in three different periods

Period	**Month I**		**Month II**		**Month III**	
	$\bar{x} \pm s\bar{x}$	v %	$\bar{x} \pm s\bar{x}$	v %	$\bar{x} \pm s\bar{x}$	v %
Heating	13,6 ± 0,05	1,67	13,42 ±0,05	1,68	13,46 ±0,05	1,51
350 m/minute	12,8 ± 0,10	3,28	11,42 ±0,11	3,98	11,34 ±0,05	1,99
400 m/minute	12,21±0,11	3,58	10,61 ±0,07	2,73	10,62 ±0,03	1,12
450 m/minute	11,34 ±0,12	4,35	9,71 ± 0,08	3,19	8,18 ± 0,10	4,92
500 m/minute	10,53 ±0,13	5,09	8,82 ± 0,12	5,43	7,59 ± 0,04	2,25

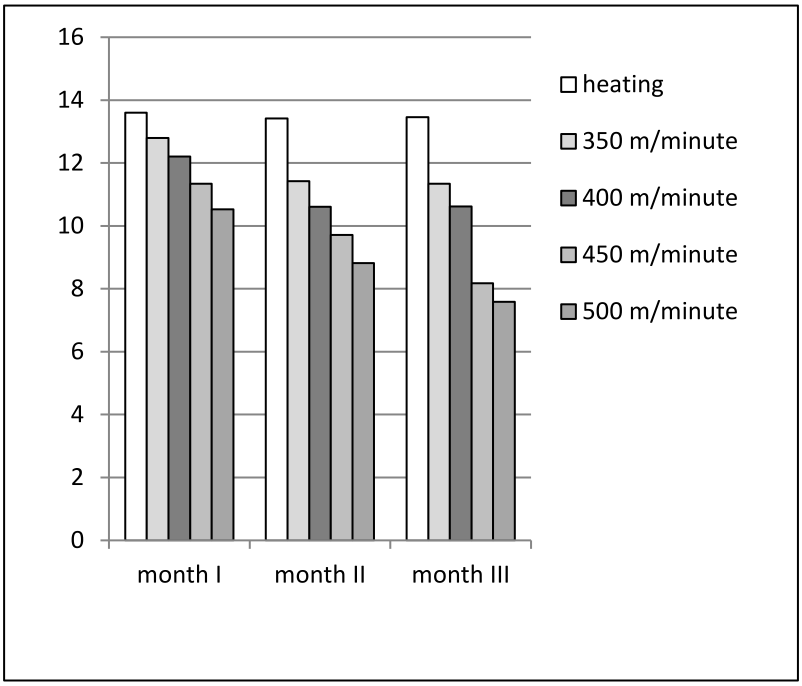

Fig. 4. Average values for arterial oxygen, in horses, after exercise test, during three different periods

Arterial partial pressure of O_2 in the first month, gradually decreases with the increasing speed, from the heating average value of 13,6 KP to an average of 10,53 KP to the last level of speed (500 m/minute). The same dramatic decrease in pO_2 is also found in the second month, from 13,42 KP at heating level to 8,82 KP al last level. In the third month of training, pO_2 kept the same decreasing line, from 13,46 KP when heating, to 7,59 KP to the last level. Comparing the average values of pO_2 in the three month of training, it can be seen that although the average values with heating are about the same after completing the four levels of effort, pO_2 decreases in all periods mainly in the third month, where the value reached an average of 7,59 KP.

Statistical calculations are presented in table 3, 4, 5, 6 and 7.

Table 3. The significance of differences between the values of O2 partial pressure, during heating, in the three different seasons

Month		**Heating**						
		n	$\bar{X}_1$	$\bar{X}_2$	d	calculated t	table t (t α) p<0.05	**Signification**
I	II	30	13,6	13,42	-0,18	-2,16	2,04	Significant differences
	III	30	13,6	13,46	-0,14	-1,73	2,04	Insignificant differences
II	III	30	13,42	13,46	0,04	0,55	2,04	Insignificant differences

Table 4. The significance differences between the values of O2 partial pressure, at 350 m/minute speed, during three differentseasons

Month		Speed = 350 m/minute							
		n	$\overline{X}_1$	$\overline{X}_2$	d	calculated t	table t (t α)		**Signification**
							p<0.05	p<0.001	
I	II	30	12,8	11,42	-1,38	-8,65	-	3,67	Important significant differences
	III	30	12,8	11,34	-1,46	-11,86	-	3,67	Important significant differences
II	III	30	11,42	11,34	0,08	-0,59	2,04	-	Insignificant differences

Table 5. The significance of differences between the values of O2 partial pressure, at 400 m/minute speed, during three different seasons

Month		Speed = 400 m/minute							
		n	$\overline{X}_1$	$\overline{X}_2$	d	calculated t	table t (t α)		**Signification**
							p<0.05	p<0.001	
I	II	30	12,21	10,61	-1,6	-11,80	-	3,67	Very significant differences
	III	30	12,21	10,62	-1,6	-13,56	-	3,67	Very significant differences
II	III	30	10,61	10,62	0,01	0,14	2,04	-	Insignificant differences

Table 6. The significance of differences between the values of O2 partial pressure, at 450 m/minute speed, during three different seasons

Month		Speed = 450 m/minute						
		n	$\overline{X}_1$	$\overline{X}_2$	d	calculated t	table t (t α)	**Signification**
							p<0.001	
I	II	30	11,34	9,71	-1,63	-10,79	3,67	Important significant differences
	III	30	11,34	8,18	-3,16	-19,19	3,67	Important significant differences
II	III	30	9,71	8,18	-1,53	-11,66	3,67	Important significant differences

Table 7. The significance of differences between the values of O2 partial pressure, at 500 m/minute speed, during three different seasons

Month		Speed = 500 m/minute						
		n	$\overline{X}_1$	$\overline{X}_2$	d	calculated t	table t (t α)	**Signification**
							p<0.001	
I	II	30	10,53	8,82	-1,71	-9,19	3,67	Important significant differences
	III	30	10,53	7,59	-2,94	-20,23	3,67	Important significant differences
II	III	30	8,82	7,59	-1,23	-9,39	3,67	Important significant differences

Statistical calculations for pO_2 indicate in the heating period insignificant differences between the first and third month and second and third month and significant differences between the first and second month (Table 3).

At 350 m/minute and 400m/minute speeds, the differences were very significant, except for the differences between the first and the third month, for both speeds, where the differences were insignificant (Table 4 and 5). At 450 m/minute and 500 m/ minute speeds between the three training periods were reported very significant differences (Table 6 and 7).

Performances achievements as well for human beings as for animals are undoubtedly linked to O_2 blood amounts which allow the physical effort process. The balance between maximum performance and health status represents the basic aim of sports medicine because subliminal physical effort may be considered a significant stressing agent able to induce the disease status. This is the main reason on account of which, both in human sports medicine as in sports skills breeds medicine (horse, camel, dog), one has tried the scientific rationalization of training and physical activity methods.

The approach of this topic is requested by the necessity of identifying some objective and practical assessment ways for the sports horse , which will help to a precise dimensioning of trainings length and intensity but also for the assessment of their effects upon the physical training level.

The awareness of these physiological and biochemical processes will certainly lead to the improvement of the effort capacity and consequently to performances achievement.

Understanding the influence and interaction of factors dependent or independent of the animal body, in conditions of health security for sport horses, go to the application of innovative methods of training appropriate to obtain athletic performance.

4. Conclusions

The carried out analyses shoes that the chemical energy output, so necessary for the physical effort of horses used in equestrian sports, is produced via aerobic metabolism, mechanism which has the highest yield.

Production of chemical energy through aerobic path metabolism, required by physical effort with horses used in hipic sports, is a lucrative biochemical mechanism.

The efficiency is in a strong relationship with the glucose oxidation yield and AGL in relation to anaerobic glycolysis.

Secondary products activity of aerobic metabolism (CO_2 and H_2O) has less negative influences than the ones resulting from anaerobic metabolism (lactic acid).

For very high yield during training, increasing the oxidative capacity of skeletal muscle, to horses used in equestrian sports, is one of the main objectives in order to obtain high performances.

These transformations have been demonstrated by several authors (Courouce, 2000; Georgescu et. al, 1971; Beech, 1991). Along with these oxidative increases during exercises, it is required concentration measurements of arterial blood gases (O_2, CO_2), measurements that help determining directly of anaerobic capacity and indirect by aerobic capacity.

This is closely related to higher energy yield of glucose oxidation versus anaerobic glycolysis. Following the results obtained from test it is obvious that the training affect significantly the arterial blood concentrations of O_2, CO_2 and pH values.

Increasing the speed determine a decrease in the partial pressure of O_2, no matter which month was assessed. The most important decrease was in heating in the third month, while the lowest was also in the third month but at 500 m/minute speed, and most differences being highly significant. It can be noted a decrease in pO_2, value, which is less important compared to the second month of training, with reference to the first month of training. In the third month of training pO_2 values have maintained the same trend.

Availability of a higher aerobic capacity provided by training, leads to more important decrease in arterial blood pO_2 with horses in the first month of training, compared to the other month of training. This is explained by the increasing the O_2, uptake of the muscle during activity

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