The Effect of Race in the Clinical, Hematological and Biochemical Biomarkers in Thoroughbred Horses

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Key words: clinical, hematological, biochemical, race, Thoroughbred horses.

ABSTRACT:

Thoroughbred horse racing is a worldwide sport and industry involving the racing of Thoroughbred horses. It is governed by different national bodies. There are two forms of the sport: flat racing and jump racing. So the study the clinical, hematological and biochemical biomarkers are most useful information that make the race horse such a super athlete and good managed. This study was carried out on twenty one thoroughbred race horses in order to evaluate physical performance and recovery time through measuring the clinical parameters (Heart rate, Respiratory rate, Body temperature and capillary refill time), hematological (RBCs, PCV, Hb, total and Differential leucocytic count) and biochemical biomarkers (TP, Albumin, AST, ALT, CK, LDH, Lactic acid, Glucose, Cholesterol, Na, K, Cl and Urea, Creatinine, Ca, P and Mg ). Clinical and blood samples were occurred just before and at 5, 15 and 60 minutes after 1600 meter race. The results showed significant increase in all clinical and hematological and biochemical biomarkers 5 min after end of exercise and returned to basal levels after 60 minutes rest. The results can be useful index about horse performance, the effect of race on horse metabolism and helpful in management protocols of athletic horses during training under hot climate conditions.

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1. INTRODUCTION

The Thoroughbred racehorse is one of nature’s most gifted athletes, capable of utilizing nearly every muscle in its body when at a full gallop. One of the most important roles of research in equine physiology is to obtain new useful information on characteristics that make the horse such a super athlete (Jones, 2005). Perhaps the most important change for an athletic horse is in the cardiovascular system, although during acute and intense training other important modifications arise (Catalani et al., 2007). Exercise, in fact, can induce variations in plasma biochemical constituents (Chanoit et al., 2002) and (Falaschini and Trombetta 2001). The principal method to assess the efficacy of training is to verify the modifications of blood parameters relatively to the effort. Repetitive exercise induces a multitude of physiologic and anatomic adaptations in horse, these adaptive responses act to reduce the effect of the strain induced by the physiologic stressors associated with exercise (Hinchcliff and Geor 2004). In addition to physical modifications such as muscle remodeling, there are changes in blood constituents (Balogh, et al. 2001), and these reflect the metabolic pathways and the functional processes involved in the particular athletic discipline (Piccione et al., 2007). Over the years, evaluation of haemogram and plasma or serum biochemistry was used to assess the health status or function of a range of different body systems and type of energy utilization in the athletic horse It is important to understand the biochemical changes produced by various types of exercises, because they reflect changes in the functions of different systems and in the type of energy utilized (De Miranda et al., 2009). Observed changes in human blood responses to exercise highlighted the importance of monitoring the physiological effects of training in sport conditions according to individual characteristics (Desgorses et al., 2008) (Manna et al., 2009) and (Manna et al., 2010). A training program must account for the proper balance between workloads and adequate periods of rest; its success can be evaluated through the regular monitoring of selected biochemical and physiological markers (Silva et al., 2010). In the horse, hematological and haematochemical parameters were evaluated during trot races
by auscultation, respiratory rate (RR) through observation of chest-wall movement, rectal temperature (RT) with an electronic thermometer in °C (Vedodigit II-PIC) and capillary filling by observation. All measures were taken by the same veterinarian according to the international reference rules on race horse.

2.4. Hematological examination:
Complete hematological measurements was done according to the method described by (Schalm, 1965.), while Haemoglobin was determined calorimetrically by using Hb kit that was produced by Egyptian company for biotechnology according to method described by (Tietz, 1990.)

2.5. Biochemical analysis
2.5.1. Total protein and albumin :
Total protein and albumin was measured in serum by UV -calorimetric spectrophotometric method by using kits supplied by vitro scient company according to method described by (Grant, et al., 1987).

2.5.2. Lactate dehydrogenase, Alanine aminotransferase and aspartate amino transferase
Alanine aminotransferase and aspartate amino transferase were measured in serum Calorimetrically by using kits produced by vitro scient company while lactate dehydrogenase was measured by kinetic method by using LDH kit supplied by Egyptian company for biotechnology according to the method described by (Young, 1990).

2.5.3. Glucose and cholesterol
Serum glucose was measured by Colorimetric method by using glucose kit that was produced by vitro scient company according to the method described by (Caraway, 1987). Serum Cholesterol was measured by CHOD-PAP-enzymatic colorimetric method by using cholesterol kit that was produced by Egyptian company for biotechnology according to the method described by (Elefson, and Caraway, 1976).

2.5.4. Urea and Creatinine
Urea and creatinine were measured in serum by colorimetric method by kits supplied by Egyptian company for biotechnology according to the method described by Tietz (1990).

2.5.5. Bilirubin
Bilirubin was measured in serum by colorimetric method by using kit supplied by BioMed company according to the method described by (Walters, et al., 1970).

2.5.6. Creatine kinase (CK), Lactate, Sodium, potassium, Chloride

**2. MATERIAL AND METHODS**

2.1. Animals
Twenty one thoroughbred race horses (ten mares and eleven stallion, the age ranged from 3 to 5 years weighting 350 to 400 kg. The body condition score is 3 and height 146-148 cm.). They were proved to be clinically healthy by clinical checkup.

This study were carried out at shams and Aljazeera equestrian clubs during summer season from (September to October 2011; average temperature 33°C and relative humidity 78% according to climate agency of Egypt ) and exercised by official trot with average speed 830 ± 2 m / min. for 1600 m. distance. Training and general animal care were performed by professional staff not associated with the research team at race track standardized for trotters according to (Couroucé, et al., 2000). The horses were fed standard rations, calculated to fulfill all the nutritional requirements according to NRC.

2.2. Samples:
Blood samples were obtained in duplicate from jugular vein by sterile needle before and 5, 15 and 60 minutes after1600 m. exercise from each animal. The first sample was added to EDTA for hematological examination. The others collected in plain tube for biochemical analysis. Serum was immediately collected and frozen until used.

2.3. Clinical examinations
Clinical examination and physiological parameters had been done to all tested horses in stall before and 5, 15 and 60 minutes after exercise. Each examination included recording the heart rate (HR)
Creatine kinase was measured by kinetic method while lactate, sodium, potassium and chloride were measured in serum by colorimetric method by using commercial kits supplied by Egyptian company for biotechnology according to the method described by Tietz (1990).

2.5.7. Magnesium, Calcium and phosphorus.
Magnesium, Calcium and phosphorous were measured in serum by colorimetric method by using their kits that were supplied vitro scient company according to the method described by Thomas (1998).

2.2.4. Statistical Analysis
The data were analyzed by using SPSS computer software version 17. The differences between different times were analyzed by using one-way analysis of variance (ANOVA) and all values were expressed by means ± standard error (SE). The effects were considered to be statistically significant at P< 0.05; differences between means were tested using least significant difference (LSD).

3. RESULTS

3.1. Clinical parameters of thoroughbred race horse before and after 5, 15, 60 minutes of 1600 m race:
Heart rate was significantly increased from 42.85 ± 0.31 to 180.70 ± 0.89 beats/min after 5 min before returning again to basal levels at 60 min. rest. Similarly, respiratory rate started to significantly increase from 14.85 ± 0.19 to 91.00 ± 0.82 cycles/min after 5 min rest before returned to basal value at 60 min rest. By the same way, body temperature significantly increased started from 5 min after exercises to reach to basal value at 60 min rest while capillary refilling time increased significantly after 5 min. rest to reach 3.75 ± 0.00 second that returned to normal time after 60 minutes rest as shown in (Table. 4).

3.2. Hematological changes before and after 1600 m exercise.
Hematological data of thoroughbred race horse before and after 1600 meters exercise were presented in table (2, 3). Hematogram including Red blood cells, PCV, Hb and total leukocytic count appeared significant lymphoctosis accompanied with neutropenia associated with significant lowered N/L ratio at 5 min. rest before achieving pre-exercise data at 60 min.

3.3. Biochemical analysis before and 5, 15, 60 minutes after 1600 meters exercise:
The biochemical parameters of thoroughbred race horse before and after 1600 meter exercise was presented in table (4). The results appeared significant increase in all data reported at 5 min. after exercise than that detected before. All data were returning to basal levels after 60 min. rest.

Table (1). Clinical examination of thoroughbred race horse before and after 1600 meter exercise.

<table>
<thead>
<tr>
<th>Items</th>
<th>Before exercise</th>
<th>5 m after exercise</th>
<th>15 m after exercise</th>
<th>60 m after exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate (beats/min)</td>
<td>42.85 ± 0.31 a</td>
<td>180.70 ± 0.89 a</td>
<td>57.85 ± 0.65 b</td>
<td>42.50 ± 0.43 c</td>
</tr>
<tr>
<td>Respiratory rate (cycles/min)</td>
<td>14.85 ± 0.19 c</td>
<td>91.00 ± 0.82 a</td>
<td>51.20 ± 0.76 b</td>
<td>15.00 ± 0.19 c</td>
</tr>
<tr>
<td>Body temperature (°C)</td>
<td>37.73 ± 0.003 c</td>
<td>40.14 ± 0.001 a</td>
<td>38.34 ± 0.003 b</td>
<td>37.77 ± 0.003 c</td>
</tr>
<tr>
<td>Capillary refilling time/second</td>
<td>1.00 ± 0.00 c</td>
<td>3.75 ± 0.00 a</td>
<td>2.00 ± 0.00 b</td>
<td>1.00 ± 0.00 c</td>
</tr>
</tbody>
</table>

Means within the same raw having the different letters are significantly different at (P<0.05).

Table (2). Hematological parameters of thoroughbred race horse before and after 1600 m exercise.

<table>
<thead>
<tr>
<th>Items</th>
<th>Before exercise</th>
<th>5 m after exercise</th>
<th>15 m after exercise</th>
<th>60 m after exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBCs x10^6 mm^-3</td>
<td>8.47 ±0.16 a</td>
<td>12.32±0.19 b</td>
<td>9.50 ±0.15 c</td>
<td>8.34 ±0.16 a</td>
</tr>
<tr>
<td>PCV %</td>
<td>44.50±1.93 a</td>
<td>56.75±1.45 b</td>
<td>46.50±1.85 a</td>
<td>44.75±1.87 a</td>
</tr>
<tr>
<td>Hemoglobin (gm/dl)</td>
<td>15.45±0.19 a</td>
<td>20.60±0.17 c</td>
<td>16.53±0.09 b</td>
<td>15.51±0.07 a</td>
</tr>
<tr>
<td>MCV (fl)</td>
<td>50.45±1.09 a</td>
<td>52.45±0.95 b</td>
<td>48.78±0.46 c</td>
<td>50.65±0.55 a</td>
</tr>
<tr>
<td>MCH (pg)</td>
<td>18.23±0.09 b</td>
<td>17.64±0.42 b c</td>
<td>17.40±0.32 c</td>
<td>18.71±0.03 a</td>
</tr>
<tr>
<td>MCHC (gm/dl)</td>
<td>35.78±0.55 a</td>
<td>33.86±0.09 b</td>
<td>35.12±0.35 c</td>
<td>35.48±0.05 a</td>
</tr>
</tbody>
</table>

Means within the same raw having the different letters are significantly different at (P<0.05)
Table 3. Total and differential leucocytic count of thoroughbred race horses before and after 1600 meters exercise

<table>
<thead>
<tr>
<th>Items</th>
<th>Before exercise</th>
<th>5 min. after exercise</th>
<th>15 min. after exercise</th>
<th>60 min. after exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBCs x10^5 mm^-1</td>
<td>7.66±0.09 a</td>
<td>9.68±0.08 b</td>
<td>8.62±0.19 c</td>
<td>7.86±0.09 a</td>
</tr>
<tr>
<td>N %</td>
<td>59.50±0.19 a</td>
<td>42.25±0.15 b</td>
<td>55.00±0.21 c</td>
<td>59.50±0.32 a</td>
</tr>
<tr>
<td>L %</td>
<td>38.75±1.12 a</td>
<td>56.75±0.42 b</td>
<td>43.75±0.85 c</td>
<td>39.50±0.73 a</td>
</tr>
<tr>
<td>M %</td>
<td>1.75±0.28 a</td>
<td>1.00±0.55 a</td>
<td>1.25±0.73 c</td>
<td>1.40±0.52 a</td>
</tr>
<tr>
<td>N/L ratio</td>
<td>1.54±0.01 a</td>
<td>0.76±0.03 b</td>
<td>1.18±0.02 c</td>
<td>1.51±0.01 a</td>
</tr>
</tbody>
</table>

Means within the same raw having the different letters are significantly different at (P<0.05).

4. DISCUSSION

The characteristics of racing horses have been essentially required for a rapid speed-up and short time to complete the competition. Thoroughbred horses have been selected for this sport for its own inheritance in greatest speed running among all animals. Clinical examination was used to determine physical fitness and performance of horses before exercise and was done according to method described by (Imren et al., 1997).

The heart rate and respiratory rate of thoroughbred race horses showed significant increases (P<0.05) 5 minutes after exercise then decreased gradually after 15 minutes till reach to normal baseline after 60 minutes. This result was similar to data observed by Snow and Mackenzie (1997); Katz, et al. (2000). The increase of heart and respiratory rate after exercise may be attributed to stimulation of sympathetic nervous system before starting competition included the process of warming-up, resulting in an increase in catecholamine (adrenaline) levels. These findings could be referred to high core body temperature that occurs during exercise, compromising cardiovascular, respiratory and heat loss mechanism (Malinowski et al., 1993).

The rectal temperature of thoroughbred race horses showed significant increase (P<0.05) 5 minutes after exercise then decreased gradually after 15 minutes till reach to pre-exercise baseline after 60 minutes. This result was similar to data observed by Morgan, et al. (2002); McKeever (2002); Lisa, et al. (2011). This significant increase in core body temperature that occurred when exercise is undertaken in hot and humid ambient conditions where body temperature rises excessively, the demands of muscle metabolism and skin blood flow for heat dissipation arise concurrently resulting in dehydration as proved by Evans (1994).

Hematological examination include RBCs count, Hb, PCV total and differential leucocytic count were used to determine the effects of exercise on the hemogram of thoroughbred race horses. The Red blood cells, hemoglobin and packed cell volume in this study showed significant increase (P<0.05) 5 minutes after exercise then decreased gradually after 15 minutes till reach to baseline after 60 minutes. This result was compatible with that recorded by Andrews et al. (1995); Thompson et al. (2001); Ricketts (2004). These changes may be attributed to releasing of spleenic erythrocytes under the influence of catecholamine during exercise and haemoconcentration resulted from dehydration (Ricketts, 2004).

The total count of white blood cells in this study showed significant increase (P<0.05) 5 minutes after exercise then decreased gradually at 15 minutes till reach to baseline after 60 minutes (table 2). This data agreed with Rose and Hodgson (1982); Snow et al., (1983); these reported significant leukocytosis accompanied with exercises. Leukocytosis accompanied with exercise are likely due to catecholamine.

Release and splenic contraction. The spleen releases not only the stored erythrocytes but also the leukocytes into the peripheral circulation. As the spleen is an important production site mainly for lymphocytes, the leukocytic increase in the peripheral circulation is proportionally higher in lymphocytes than other type of leukocytes 46. The previous data could be explained by significant lymphocytosis observed in the present study.
Table 4. Biochemical assay of serum of thoroughbred racing horse before and 5, 15, 60 minutes after 1600 meters exercise.

<table>
<thead>
<tr>
<th>Items</th>
<th>Before exercise</th>
<th>5 min. after exercise</th>
<th>15 min. after exercise</th>
<th>60 min. after exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total protein (mg/dl)</td>
<td>6.64±0.009 c</td>
<td>7.50±0.002 a</td>
<td>7.03±0.009 b</td>
<td>6.67±0.008 c</td>
</tr>
<tr>
<td>Albumin (gm/dl)</td>
<td>2.85±0.005 a</td>
<td>3.82±0.004 a</td>
<td>3.29±0.006 b</td>
<td>3.25±0.008 b</td>
</tr>
<tr>
<td>Globulin (gm/dl)</td>
<td>3.94±0.11 a</td>
<td>3.68±0.006 a</td>
<td>3.75±0.008 a</td>
<td>4.01±0.13 a</td>
</tr>
<tr>
<td>A/G ratio</td>
<td>0.68±0.002 c</td>
<td>1.03±0.007 a</td>
<td>0.87±0.003 b</td>
<td>0.66±0.003 c</td>
</tr>
<tr>
<td>CK (IU/L)</td>
<td>181.25±0.44 c</td>
<td>239.26±0.59 a</td>
<td>220.33±0.26 b</td>
<td>191.58±0.21 c</td>
</tr>
<tr>
<td>LDH (IU/L)</td>
<td>387.60±0.44 a</td>
<td>454.77±0.79 a</td>
<td>432.27±0.41 b</td>
<td>390.58±0.75 c</td>
</tr>
<tr>
<td>AST (IU/L)</td>
<td>264.47±0.46 c</td>
<td>350.21±0.43 a</td>
<td>324.94±0.33 b</td>
<td>271.13±0.62 c</td>
</tr>
<tr>
<td>Total bilirubin (mg/dl)</td>
<td>1.43±0.003 c</td>
<td>2.69±0.007 a</td>
<td>2.49±0.005 b</td>
<td>1.40±0.008 c</td>
</tr>
<tr>
<td>ALT (IU/L)</td>
<td>16.96±0.16 c</td>
<td>21.61±0.56 a</td>
<td>18.93±0.47 b</td>
<td>17.01±0.31 c</td>
</tr>
<tr>
<td>AST (IU/L)</td>
<td>264.47±0.46 c</td>
<td>350.21±0.43 a</td>
<td>324.94±0.33 b</td>
<td>271.13±0.62 c</td>
</tr>
<tr>
<td>Urea (mg/dl)</td>
<td>21.16±0.52 c</td>
<td>46.20±1.42 a</td>
<td>39.26±0.65 b</td>
<td>22.16±0.90 c</td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td>1.58±0.002 a</td>
<td>3.30±0.16 a</td>
<td>2.74±0.18 b</td>
<td>1.44±0.006 c</td>
</tr>
<tr>
<td>Cholesterol (mg/dl)</td>
<td>111.29±1.56 b</td>
<td>177.76±1.39 a</td>
<td>172.88±0.99 a</td>
<td>110.71±1.49 b</td>
</tr>
<tr>
<td>Glucose (mg/dl)</td>
<td>107.11±1.04 c</td>
<td>162.50±0.81 a</td>
<td>135.80±1.85 b</td>
<td>111.53±0.63 d</td>
</tr>
<tr>
<td>Lactic acid (mmol/L)</td>
<td>1.047±0.11 c</td>
<td>24.74±0.71 a</td>
<td>9.757±0.61 b</td>
<td>1.506±0.11 c</td>
</tr>
<tr>
<td>Sodium (mmol/L)</td>
<td>139.43±0.40 b</td>
<td>145.21±1.05 a</td>
<td>142.10±1.16 a b</td>
<td>139.33±0.53 b</td>
</tr>
<tr>
<td>Potassium (mmol/L)</td>
<td>4.62±0.004 c</td>
<td>5.36±0.004 a</td>
<td>4.84±0.007 b</td>
<td>4.66±0.002 c</td>
</tr>
<tr>
<td>Chloride (mmol/L)</td>
<td>102.16±0.22 a</td>
<td>100.89±0.12 c</td>
<td>99.47±0.008 d</td>
<td>101.57±0.006 b</td>
</tr>
<tr>
<td>Calcium (mg/dl)</td>
<td>11.84±0.10 a</td>
<td>11.37±0.11 b</td>
<td>11.64±0.10 a</td>
<td>11.90±0.002 a</td>
</tr>
<tr>
<td>Phosphorous (mg/dl)</td>
<td>3.20±0.14 a</td>
<td>3.90±0.18 b</td>
<td>3.69±0.11 b</td>
<td>3.47±0.20 a</td>
</tr>
<tr>
<td>Magnesium (mg/dl)</td>
<td>2.36±0.003 b</td>
<td>2.12±0.003 b</td>
<td>2.30±0.006 b</td>
<td>2.53±0.004 a</td>
</tr>
</tbody>
</table>

Means within the same raw having the different letters are significantly different at (P<0.05).

The total protein, albumin of thoroughbred race horses showed significant increased (P<0.05) 5 minutes after exercise then decreased gradually after 15 minutes till reach to normal baseline after 60 minutes. These results were the same that reported by Sommardahl et al. 1994; Stockham and Scott 2002). They attributed that to redistribution of fluid and electrolytes from the vascular compartment to the tissue extra-cellular fluid spaces and decrease of plasma volume due to withdrawal of fluid from blood leading to heamoconcentration and dehydration.

The Creatine kinase (CK) and aspartate aminotransferase (AST) of thoroughbred race horses showed significant increased (P<0.05) 5 minutes after exercise then decreased gradually after 15 minutes till reach to normal baseline after 60 minutes, this result was parallel to that observed by Kobluk et al. (1995). This increase of both serum enzymes (CK and AST) is due to increase permeability of both enzymes from muscle cells due to muscular stress (Watson 1998).

The lactate dehydrogenase (LDH) of thoroughbred race horses showed significant increased (P<0.05) at 5 minutes rest then decreased gradually at 15 minutes till reach to normal baseline after 60 minutes (Kratz et al., 2002a; Tateo et al. 2008) were observed the same results and attributed that to releasing of LDH from horse tissues after exercise, it is documented that the source have been mostly from muscles.

The glucose level of thoroughbred race horses showed significant increase (P<0.05) after 5 minutes rest then decreased gradually after 15 minutes till reach to normal baseline after 60 minutes, this result was similar to that reported by SimOes et al. 1999; Nakata et al. 1999. These increases may be attributed to hyper activity of sympathetic system and adrenaline release which activate hepatic glycogenolysis (Trilk et al., 2002).
The lactate level of thoroughbred race horses showed significant increase (P<0.05) 5 minutes after exercise before reaching the baseline after 60 minutes, this result was similar to that observed by Gollnick et al. (1996); Marlin and Nankervis (2002); Kratz et al. 2002b) and this may be attributed to anaerobic glycolysis that accompanied intense exercise with decreased ATP/ADP ratio and decreased oxygen tension (Trilk et al., 2002); Kratz et al. 2002b). A prompt lactate recovery after exercise is an index of animal fitness (Pösö et al. 2004).

The sodium level of thoroughbred race horses showed significant increased (P<0.05) 5 minutes after exercise then decreased gradually after 15 minutes till reach to normal baseline after 60 minutes, those data opposed to that reported by Carlsson, 1992; Nemec-Svete, et al. 2008; McCutcheon and Geor 1998; Goundasheva, and Katsarova 2008 were observed the same result and they attributed that to aldosterone release as the result of water deficit during exercise.

The potassium level of thoroughbred race horses showed significant increase (P<0.05) 5 minutes after exercise then decreased gradually till reach to baseline at 60 minutes, this data was compatible to that recorded by Harris and Snow (1986.). They returned these changes to releasing of potassium from exercising muscles to extra-cellular space. On contrary, the chloride level showed significant decrease (P<0.05) after 5 minutes rest then increased gradually till reach to baseline after 60 minutes, this result was the same observed by Mckeeever (1991). This may be attributed to depletion and are often a predisposing factor, along with dehydration, in fatigue, muscle cramps, colic, synchronous diaphragmatic flutter (“thumps”), diarrhea and other symptoms of exhausted horse syndrome (Nemec-Svete et al. 2008).

The urea and creatinine of thoroughbred race horses showed significant increase (P<0.05) 5 minutes after exercise then decreased gradually till reach to baseline after 60 minutes and this result similar to that observed by Pringle (1995). These increases may be attributed to extensive fluid loss in the sweat, the reduction in renal blood flow and glomerular filtration rate that leads to elevation of urea concentrations after exercise (Piccione et al. 2010). In the same respect Härtlová (2010) return this changes to increased production of creatinin from working muscle. So the change in serum creatinin cannot use as indicator for reduced glomerular filtration rate.

The calcium and magnesium levels of the present study showed significant (P<0.05) decrease at 5 minutes after exercise then increased gradually at 15 minutes till reach to baseline at 60 minutes, this result agreed with (Schryver et al., 1978) and this may be attributed to action of calcitonin possibly persisted, which might decrease the serum Ca concentration in this period and another alternative factor that affects serum Ca concentration in exercising horses indicated that approximately of Ca was lost through sweat during exercise.

The phosphorous level in this study showed significant increase at (P<0.05) 5 minutes after exercise then decreased gradually at 15 minutes till reach to baseline at 60 minutes this result agreed with Yamada et al. (1996); Arslan et al., (2002), they attribute this change to escaping of phosphate from muscles during break down of high energy phosphate (ATP) during exercise.

5. CONCLUSION

Clinical and hemato-biochemical changes observed in this study were indicative of a physiological response to an acute intense exercise. This is confirmed by the optimum recovery time of some parameters (i.e., heart rate, respiratory rate, body temperature and lactate) and from the fact that the majority of the parameters, although significantly changed, were near the physiological range immediately after exercise.

Therefore, the present data can be useful to assess the status of an athlete and the degree of its training adaptability providing an opportunity to modify the training schedule to achieve the desired performance.

6. REFERENCES


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