Physiological and hemato-chemical evaluation of thoroughbred race horse after exercise

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Abstract

Exercise physiology is the 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 fitness and performance through physical (Heart rate, Respiratory rate, Body temperature and capillary refilling time), hematological (RBCs, PCV, Hb, total and Differential leucocytic count) and hematochemical evaluation (TP, Albumin, AST, ALT, CK, LDH, Lactic acid, Glucose, Cholesterol, Na, K, Cl and Urea, Creatinine, Ca, P and Mg). Physical examination and Blood samples were collected before and at 5, 15 and 60 min. after 1600 meter exercised. The results showed significant increase in all physiological, hematological and hematochemical parameters 5 min after exercise that returned to basal levels after 60 min. rest. The results can be useful index about horse performance, the effect of exercise on horse metabolism and helpful in management protocols of athletic horses.

Key Words: physiology, hematology, biochemical, exercise, Thoroughbred horses.

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 1. Perhaps the most important change for an athletic horse is in the cardiovascular system, although during acute and intense training other important modifications arise 2. Exercise, in fact, can induce variations in plasma biochemical constituents 3,4. The principal method to assess the efficacy of training is to verify the modifications of blood parameters relatively to the effort 5. 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 5. In addition to physical modifications such as muscle remodelling, there are changes in blood constituents 6, and these reflect the metabolic pathways and the functional processes involved in the particular athletic discipline 7. Over the years, evaluation of haemogram and plasma or serum biochemistry was used to assess the health status or function of a range of body systems in the athletic horse 8. Biochemical alterations are produced by various
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type of exercise, and they reflect alterations in the functions of different systems and in the type of energy utilized \[^6,9\]. The massive metabolic demands of going from rest to a gallop in a matter of seconds require exceedingly high rates of ATP provision. Owing to the sluggishness of the aerobic system to provide the required ATP and the limited ATP that can be supplied via the phosphocreatine system, the requirement is therefore for very high rates of glycolytic ATP production \[^10\].

Physical exercise can modify the animal's physiologic metabolism. This is because the different types of training, racing, transport, breed and temperament can produce variations in blood constituents levels \[^11\]. However, only few researches studied the responses during a specific training period \[^9\]. Although the changes occur after exercise were poorly studied so the aim of this research was planned to evaluate the modifications of some physiological and heamatochemical parameters occurring after exercised thoroughbred horse at different interval of rest.

Material and methods

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 and exercised by official trot with average speed 200 m / min. for 1600 m. distance. Training and general animal care were performed by professional staff not associated with the research team. The horses were fed standard rations, calculated to fulfill all the nutritional requirements according to NRC.

2- samples:

Blood samples were obtained in duplicate from jugular vein by sterile needle before and 5, 15 and 60 minutes after 1600 m. exercise from each animal. The first blood sample was anticoagulated with EDTA for hematological examination.

The second blood sample is collected without anticoagulant in centrifuged tubes for serum collection that stored at \(-20^\circ C\) for biochemical assay.

METHODS

A- Physiological and clinical parameters:

Clinical examination and physiological parameters had been done to all tested horses before and 5, 15 and 60 minutes after exercise according to the method described by Imren (1997) \[^12\].

B- Hematological examination:

Complete hematological analysis was done according to the method described by Schalm (1965) \[^13\], while Haemoglobin was measured colorimetrically by using Hb kit that was produced by Egyptian company for biotechnology according to method described by Tietz (1990) \[^14\].

C- Biochemical analysis:
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1- Total protein and albumin:

Total protein and albumin was measured in serum by UV-calorimetric spectrophotometric method by using total protein kit that was supplied by vitro scient company according to method described by Grant et al (1987).\(^{15}\)

2- Lactate dehydrogenase, Alanine aminotransferase and aspartate amino transferase:

Alanine aminotransferase and aspartate amino transferase were measured in serum calorimetrically by using kits that were produced by vitro scient company while lactate dehydrogenase was measured by kinetic method by using LDH kit that supplied by Egyptian company for biotechnology according to the method described by Young (1990).\(^{16}\)

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).\(^{17}\)

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).\(^{18}\)

4- Urea and creatinine:

Urea and creatinine were measured in serum by colorimetric method by using urea and creatinine kits that were produced by Egyptian company for biotechnology according to the method described by Tietz (1990).\(^{14}\)

5- Bilirubin:

Bilirubin was measured in serum by colorimetric method by using bilirubin kit that was produced by BioMed company according to the method described by Walters et al (1970).\(^{19}\)

6- Creatine kinase (CK), Lactate, Sodium, potassium, Chloride:

Creatine kinase was measured by kinetic method while lactate, sodium, potassium and chloride were measured in serum by colorimetric method by using their kits that were produced by Egyptian company for biotechnology according to the method described by Tietz (1999).\(^{14}\)

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).\(^{20}\)

D-Statistical Analysis

A p <0.05 was considered statistically significant. All results were expressed as mean ± SE. The data were analysed using ANOVA by using SPSS version 17 computer software package.

Results

1-Clinical examination of thoroughbred race horse before and after 5, 15, 60 minutes of 1600 m. exercise:
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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 levels after 60 minutes exercise as shown in (Table. 1).

2-Hematological changes before and after 1600 m exercise.

Hematological data of thoroughbred race horse after 1600 meters exercise were presented in table (2, 3). Hemogram including Red blood cells, PCV, Hb and total leukocytic count showed significant increased after 5 min from exercise before returned back to basal levels within 60 minutes. In the same respect, differential leucocytic count appeared significant neutrophilia accompanied with lymphocytopenia at 5 min. rest before achieving pre-exercise data at 60 min.

4-Biochemical analysis before and 5,15,60 minutes after 1600 meters exercise:

The hemato-chemical 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 meters exercise (Mean ± Se)

<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 a</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 a</td>
<td>40.14 ± 0.001 a</td>
<td>38.34 ± 0.003 b</td>
<td>37.77± 0.003 a</td>
</tr>
<tr>
<td>Capillary refilling time/second</td>
<td>1.00 ± 0.00 a</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 row having the different letters are significantly different at (P<0.05).
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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 min after exercise</th>
<th>15 min after exercise</th>
<th>60 min 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 c</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 ab</td>
<td>17.64± 0.42 bc</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 a</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 (mean ±Se)

<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 x10^3 mm^-3</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>60.00± 0.00 c</td>
<td>67.00± 0.44 a</td>
<td>64.00± 0.44 b</td>
<td>59.50± 0.22 c</td>
</tr>
<tr>
<td>L %</td>
<td>38.50± 0.22 a</td>
<td>32.00± 0.44 c</td>
<td>35.00± 0.44 b</td>
<td>39.00± 0.00 a</td>
</tr>
<tr>
<td>M %</td>
<td>1.50± 0.22 a</td>
<td>1.00± 0.00 a</td>
<td>1.00± 0.00 a</td>
<td>1.50± 0.22 a</td>
</tr>
<tr>
<td>N/L ratio</td>
<td>1.55± 0.008 c</td>
<td>2.10± 0.004 a</td>
<td>1.83± 0.003 b</td>
<td>1.52± 0.004 c</td>
</tr>
</tbody>
</table>

Means within the same raw having the different letters are significantly different at (P<0.05).
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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 c</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 c</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 b</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 c</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>1.04±0.11 c</td>
<td>24.74±0.71 a</td>
<td>9.75±0.61 b</td>
<td>1.506±0.11 c</td>
</tr>
<tr>
<td>Sodium (Meq/L)</td>
<td>139.43±0.40 b</td>
<td>145.21±1.05 a</td>
<td>142.10±1.16 b</td>
<td>139.33±0.53 b</td>
</tr>
<tr>
<td>Potassium (Meq/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 (Meq/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>
</tbody>
</table>

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<table>
<thead>
<tr>
<th></th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
<th>Sample 4</th>
</tr>
</thead>
<tbody>
<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>

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 (1997)\(^{12}\).

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 ,similar result was observed by Snow and Mackenzie\(^{1}(997)\)\(^{22}\) and Katz et al (2000)\(^{23}\). 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. It increase metabolic rate, aerobic and anaerobic glycolysis and that the increase in metabolic rate leads to major changes in cardiovascular and respiratory functions in addition to using respiratory system to lose the heat that generated during exercise\(^{24}\).

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 . Many studies were recorded similar data\(^{28,26,27}\). This increases may be attributed to continues muscular contractions that requires a constant supply of energy that generated from fat metabolism and the Energy derived from the breaking down of ATP molecule is generally used to maintain body temperature, nerve and muscle functions of many vital organs\(^{28,29}\).

The capillary refilling 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 state after 60 minutes .This result was similar to data observed by Fritzsche and Coyle (2000)\(^{30}\), Morgan and Funquist.(2002)\(^{31}\) and McKeever (2002)\(^{32}\). This significant increase in capillary refilling time may be attributed to hyperthermia 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 a proved by Lisa(2011)\(^{33}\).

Hematological examination include RBCs count , Hb, PCV total and differential leucocytic count was 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
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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 Evans, (1994) 34, Andrews et al (1995) 35 and Thompson et al (2001) 36. These changes may be attributed to releasing of splenic erythrocytes under the influence of catecholamine during exercise and haemoconcentration resulted from dehydration 36.

The total count of white blood cells in this showed significant increase at (P<0.05) 5 minutes after exercise then decreased gradually after 15 minutes till reach to baseline at 60 minutes. This data agreed with Rose and Hodgson (1982) 37 and Snow et al. (1983) 38, they reported significant leukocytosis accompanied with exercises. Differential leucocytic count of thoroughbred race horses showed significant neutrophilia, lymphocytopenia and increase in N/L ratio (P<0.05) 5 minutes after exercise then returned to normal baseline after 60 minutes, this result agreed with Zobba et al (2011) 64 and they return this changes to corticosteroid release. The total protein, albumin of thoroughbred race horses showed significant increase (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) 39 and Stockham, and Scott (2002) 40. 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 haemoconcentration and dehydration.

The Creatine kinase (CK) and aspartate aminotransferase (AST) of thoroughbred race horses showed significant increase (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 Hodgson and Rose, (1994) 41 and Kobluk et al (1995) 42. This increase of both serum enzymes (CK and AST) is due to increase permeability of both enzymes from muscle cells due to muscular stress 43.

The lactate dehydrogenase (LDH) of thoroughbred race horses showed significant increase (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) 44 and Tateo et al (2008) 45 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 Simões et al (1999) 46, and Nakata et al (1999) 47. These increases may be attributed to hyper activity of sympathetic system and adrenaline release which activate hepatic glycogenolysis 48.

The lactate level of thoroughbred race horses showed significant increase (P<0.05) 5 minutes after exercise then decreased gradually after 15 minutes till reach to normal baseline after 60 minutes, this was similar to observed by Gollnik et al (1996) 49, Marlin and Nankervis, (2002) 50 and this may be attributed to anaerobic glycolysis that accompanied intense exercise with decreased ATP/ADP ratio and decreased oxygen tension 48.51.

The sodium level of thoroughbred race horses showed significant increase (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 Carlson, (1992) 52 and Nemec Svete et al.
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while McCutcheon and Geor, (1998) 54 and Goundasheva and Katsarova, (2008) 55 was 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 at 15 minutes till reach to baseline at 60 minutes, this data was compatible to that recorded by Harris And Snow (1986) 56, Hodgson and Rose, (1994) 41. They returned these changes to releasing of potassium from exercising muscles to extra-cellular space

The chloride level of thoroughbred race horses showed significant decrease (P<0.05) 5 minutes after exercise then increased gradually after 15 minutes till reach to normal baseline after 60 minutes, this result was the same observed by Mckeever et al (1991) 57. 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 53.

The urea and creatinine of thoroughbred race horses showed significant increase (P<0.05) 5 minutes after exercise then decreased gradually after 15 minutes till reach to normal baseline after 60 minutes and this result similar to that observed by Snow et al., (1983) 38, Hodgson and Rose, (1994) 41 and Pringle, (1995) 58. This increase 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 59. In the same respect Hartlova et al (2010) 60 return this changes to increased production of creatinin from working muscle. So the change in serum creatinin cannot used as indicator for reduced glomerular filtration rate 59.

The calcium and magnesium levels of thoroughbred race horses showed significant decrease at (P<0.05) 5 minutes after exercise then increased gradually at 15 minutes exercise till reach to baseline at 60 minutes exercise this result agreed with Schryver et al. (1978) 61 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) 62 and Arslan et al (2002) 63 and they attribute this change to escaping of phosphate from muscles during break down of high energy phosphate (ATP) during exercise.

Conclusion
Equine exercise physiology is important science for sport horses for evaluation of horse fitness. Because physiological and haematochemical parameters change with the performance, the interpretation of the values of athletes cannot be limited to the comparison with a static normal range, but in relation to the dynamic evolution of the values with the progression of training. 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.

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