Effect of endurance exercise on sweat constituents of athletic Iraqi Arabian horses

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(Received May 8, 2017; Accepted August 30, 2017)

Abstract

It is well known that Iraq has dry hot weather, especially during summer, so horses sports competitions are stopped. The aims of our research were to study the effect of endurance exercise on sweat constituents of Iraqi Arabian horses. The results show that, after trot, the body temperature was 37.600±0.058, the heart rate was 45.875±0.819, and the respiration rate was 35.750±0.708. After canter, the body temperature was 38.512±0.058, the heart rate was 76.000±0.819 and the respiration rate was 49.250±0.708. After gallop, the body temperature was 39.512±0.058, the heart rate was 99.875±0.819, and the respiration rate was 60.875±0.708. All mean values were significantly different at P≤0.01. The mean of body weight was 460.5 kg. The total body surface mean was 396.1Cm^2. The mean values of albumin, globulin, Na^+, K^+, Cl^-, Ca^{++}, Mg^{++}, Fe^{++}, Cu^{++}, and Zn^+, in trot were 3.512±0.089, 3.875±0.725, 3.637±0.072, 2.062±0.086, 5.962±0.141, 0.167±0.006, 0.987±0.007, 4.875±0.700, 0.712±0.515, 11.750±0.422 and 0.180±0.002, respectively, while the results in canter were 3.925±0.086, 4.750±0.111, 4.787±0.104, 3.637±0.285, 6.637±0.090, 1.487±0.953, 0.161±0.008, 5.537±0.105, 0.987±0.666, 12.262±0.106 and 0.236±0.007, respectively. In gallop were 5.612±0.107, 6.012±0.158, 6.675±0.144, 5.062±0.138, 7.550±0.090, 2.750±0.122, 0.256±0.009, 6.400±0.070, 1.600±0.845, 12.650±0.073 and 0.276±0.004, respectively. Our results indicate clearly a high loss of essential proteins and minerals during sweating which must be compensated by food additives specially during summer, to prevent many healthy problems so we believe that ratios of these proteins and minerals must be calculated according to many factors like, weather climate, the type of the horse jobs (jump, polo, races, show,…..etc.) and the body weights and ages.

Keywords: Endurance, Exercise, Sweat, Constituents, Iraqi, Horses.
Available online at http://www.vetmedmosul.org/ijvs

تأثير التمرين الشاق على مكونات العرق في الخيل الرياضية العراقية العربية

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الخلاصة

من المعروف ان طقس العراق يتميز بكونه طقس حار جاف خصوصاً في فصل الصيف، وهذا يؤدي الى توقف مسابقات الخيول الرياضية. الهدف من هذا البحث هو دراسة تأثير التمارين على محتويات العرق للخيول العربية العراقية ،أظهرت النتائج ان الخيول بعد سرعة الخبب درجة حرارة جسمها كانت ٣٧,٦٠٠±٠,٠٥٨ معدل ضربات القلب ٤٥,٨٧٥±٠,٨١٩, ومعدل التنفس ٣٥,٧٥٠±٠,٧٠٨. اما الخيول بعد سرعة الهذب فأن درجة حرارة اجسامها كانت ٣٨,٥١٢±٠,٠٥٨، معدل ضربات القلب كانت ٧٦,٠٠٠±٠,٨١، ومعدل التنفس ٤٩,٢٥٠±٠,٧٠٨، اما الخيول الحضر فأن درجة حرارة جسمها كانت ٣٩,٥١٢±٠,٠٥٨، معدل ضربات القلب ٩٩,٨٧٥±٠,٨١٩ ومعدل التنفس ٦٠,٨٧٥±٠,٧٠٨ جميع معدلات هذه القيم كانت عالية المعنوية (P≤0.01). اوزان اجسام الخيول كانت ٤٥٧،٤٣٩،٤٣٠،٤٦٧،٤٧٨،٤٨٠،٤٥٤،٤٧٨ على التوالي حيث بلغ متوسط هذه الاوزان ٤٦٠.٥ كغم ومتوسط المساحة السطحية ٣٩٦.١سم^2. ان متوسط القيم±الخطأ القياسي للألبومين، الكلوبيولين،Na،K،Cl،Ca،Fe،Cu،Zn بلغت في الخيول بعد سرعة الخبب

٠,٠٨٩±٣,٥١٢ ، ٠,٧٢٥±٣,٨٧٥ ، ٠,٠٧٢±٣,٦٣٧ ، ٠,٠٨٦±٢,٠٦٢ ، ٠,١٤١±٥,٩٦٢ ، ٠,٠٠٦±٠,١٦٧ ، ٠,٠٠٧±٠,٩٨٧ ، ٠,٧٠٠±٤,٨٧٥ ، ٠,٥١٥±٠,٧١٢ ، ٠,٤٢٢±١١,٧٥٠ ، ٠,٠٠٢±٠,١٨٠ على التوالي بينما بلغت القيم في الخيول سرعة الهذب ٠,٠٨٦±٣,٩٢٥ ، ٠,١١١±٤,٥٠ ، ٠,١٠٤±٤,٧٨٧ ، ٠,٢٨٥±٣,٦٣٧ ، ٠,٠٩٠±٦,٦٣٧ ، ٠,٩٥٣±١,٤٨٧ ، ٠,٠٠٨±٠,١٦١ ، ٠,١٠٥±٥,٥٣٧ ، ٠,٦٦٦±٠,٩٨٧ ، ٠,١٠٦±٢,٢٦٢ ، ٠,٢٣٦ ±٠,٠٠٧ على التوالي. اما الخيل بعد سرعة الحضر فقد بلغت ٠,١٠٧±٥,٦١٢ ، ٠,١٥٨±٦,٠١٢ ، ٠,١٤٤±٦,٦٧٥ ، ٠,١٣٨±٥,٠٦٢ ، ٠,٠٩٠±٧,٥٥٠ ، ٠,١٢٢±٢,٧٥٠ ، ٠,٠٠٩±٠,٢٥٦ ، ٠,٠٧٠±٦,٤٠٠ ، ٠,٨٤٥±١,٦٠٠ ، ٠,٠٧٣±١٢,٦٥٠ ، ٠,٠٠٤±٠,٢٧٦ على التوالي. أظهرت نتائج البحث فقدان كبير للبروتينات والمعادن خلال التعرق والتي يتوجب تعويضها بالاضافات الغذائية خصوصا في فصل الصيف. وللوقاية الصحية يتوجب حساب الكميات المطلوبة للبروتينات والمعادن وفقا لعوامل عديدة منها المناخ ونوع فعالية الخيل ووزن الجسم والعمر.

Introduction

It is well known that, Iraq has a dry hot weather specially during summer, so the horse sports competitions are stopped. Iraqi Arabian horses have the capacity to carry on the external influences by adaptation. It is well known that, horses have capable of maintaining their internal body temperature relatively constant because they are homoeothermic animals. This feature is achieved by activating thermo- regulatory mechanism. The physiological mechanisms like sweating, respiratory rate, skin blood flow, and changes in heart rate play essential especial roles (1,2).

The horses ability is the key factor to recognize the condition as a trigger for all the physiological processes, this we can called «stress response» but the hypothalamus – pituitary – adrenal axis is regarded the real regulating system in the background of these processes (3). The exercise is just a such stressor, it is responsible of energy mobilization, enforce blood circulation, and maintain the constant body temperature which require sensors in the regulatory system, to formulate the exact response which lead to sweat production (3). The autonomic nervous system is responsible of maintaining the body temperature by regulating the sweat production (4). During sport competitions the veterinarian evaluate at checkpoints, the hydration of the horses by heart rate measurement, in addition to evaluate many subjective parameters like the mucous membranes color and refill time measurements, persistence of a skin tent, jugular vein fill time measurements, and the intestinal motility auscultation. With the measurement of the body mass changes in working horses, unfortunately, there are no well comparison of these measurements (5,6).

For thermoregulatory cooling of the horse body, and during the exercise the cardiac output also increase in response to demands of increased skin flow, and as well as the demands of the metabolic demands of active skeletal muscles (7).The horses can consumed the electrolytes in the feed, and lost them by three ways, sweat, feces, and urine. In contrast, sodium intake is more variable and can be marginal, investigations of electrolytes balance has revealed that most horses eating predominantly forage ingest excess potassium and chloride (8). 10 gm/day is calculated as the maintenance requirement for Na+ for a sedentary 500 kg. horse weight (9) or provide by ~ 25 gm of sodium chloride/day. The horses that are being supplemented with sodium chloride, the adequacy of dietary sodium is most practically estimated by measurement of urine sodium concentration, urine sodium can be < 10 mmol/L in those horses with a marginal sodium diet urine sodium should be collected from resting horses because urine sodium can be affected by exercise (10). Within narrow ranges, the maintain body ions contents may be matched appropriately the daily intake and output of electrolytes. The balance is greatest for sodium, potassium and chloride ions that provided the osmotic skeleton of all the body fluids. More than 90% of exchangeable sodium and chloride is contained within the extracellular fluid component so further the Na+, K+, and Cl^- are not evenly distributed throughout the total body weight, while more than 98% of potassium is contained within the intracellular fluid constituents (11).

According to our knowledge, there is no any previous study in our Iraqi horses, we design this research to study the effects of endurance exercise on sweat constituents of Iraqi Arabian horses.

Materials and methods

Experimental animals

At May (35°C), 8 athletic Iraqi Arabian horses that were housed in a private stable, sporadic stall for each one in Al- Najaf province were used. Their ages range 36-42 months, with calculated body weights range 430-480 kgs. Which were estimated according to (12) by dividing chest girth, ($Cm.^2$) x body length, (Cm.) on 11.9. The total body surfaces were estimated according to Meeh's formula (13) Body surface(S) = Meeh's constant (K) x Body weight $^{0.6}$. They had exercised daily with many different speeds. The horses were under veterinarian routine check regularly. They also were subjected to preventive deworming treatments, feed was balanced in terms of energy, proteins, vitamins, and minerals considering the specific

requirements connected with standards of animal feeding. The main feed were grains, alfalfa hay, straw, mineral blocks with ad libitum clean water.

Table 1: Distribution of age, sex, and color of the 8 Iraqi Arabian horses included in the study

N	Age (months)	Sex	color
1	40	Mare	White
2	38	Stallion	Red
3	36	Mare	Brown
4	39	Stallion	Brown
5	40	Stallion	Red
6	42	Stallion	Black
7	39	Mare	White
8	41	Stallion	Black

Sample collection

The athletic horses were washed with shampoo, clean water and dried with clean towels before and after running, which were (24) hours interval. The body temperatures, respiration rates and heart beats were recorded before and after each type of run. The horses ran at trot (20 km/h), canter (30 km/h) and gallop (60 km/h) for (5 km) distance, the speed is calculated by using sports clock. The sweat samples, were collected from those, that formed at the animals neck and chest, a dirty brown fluid were collected directly after each speed by special curate in sterile containers, send to laboratory in ice box. The samples were filtrated to exclude dust, hair, sand particles then centrifuged at 5000 rpm for 10 min. Then sulphosalicylic acid was added to the highly turbid supernatant. The supernatant was analyzed by spectrophotometer (Chrom Tech, V-1100 spectrophotometer MED &Lab Instrument, USA). using commercial special kits for albumin and globulin, Na^{+}, K^{+}, Cl^{-}, Ca^{++}, Mg^{++}, Fe^{+}, Cu++, Zn^{+}, and Mn^{+}.

Statistical analysis

The results are expressed as mean ± SE. Statistical analysis was carried out using SPSS version 11 for Windows (IBM, Armonk, NY, USA). Group differences were analyzed by one and two-way analysis of variance (ANOVA), followed by Least significant differences; $P < 0.01$ was considered significant (14).

Results

Table 2 shows the mean values± standard errors of the body temperature (Cº), the heart rates (beats/min.), and the respiration rates (breath/min.) before and after each running speed. Before trot, the body temperatures are (37.437±0.058), the heart rates are (34.000±0.819), and the respiration rates are (15.250±0.708), while after trot, the body temperatures are (37.600±0.058), the heart rates are (45.875±0.819), and the respiration rates are (35.750±0.708). Before canter, the body temperatures are (37.437±0.058), the heart rates are (34.750±0.819), and the respiration rates are (15.750±0.708), while after canter, the body temperatures are (38.512±0.058), the heart rates are (76.000±0.819), and the respiration rates are (49.250±0.708). Before gallop, the body temperatures are (37.500±0.058), the heart rates are (35.000±0.819), and the respiration rates are (15.250±0.708), while after gallop, the body temperatures are (39.512±0.058), the heart rates are (99.875±0.819), and the respiration rates are (60.875±0.708). All the mean values are highly significant at ≤0.01.

Table 3 shows the body weights (kg), the body weight mean value (kg), the total body surfaces (Cm^2), and the surface mean value (Cm^2). The body weights are 457, 439, 430, 467, 478, 480, 454 and 478 kg, respectively. The body weight mean value was 460.5 kg. The total body surfaces were 394.4, 385.0, 380.2, 399.5, 405.1, 406.2, 393.8 and 405.1 Cm^2, respectively. The total surfaces mean value was 396.1Cm^2.

Table 2: M±SEM of body temperature (ºC), heart rate (beats/min.), and respiration rate (breaths/min.), before and after different running speeds

Speeds	Time of collection	Parameters		
		Body Temperature (C°)	Heart rate (beats/min.)	Respiration rate (breaths/min.)
Trot	Before	37.437±0.058	34.000±0.819	15.250±0.708
	After	37.600±0.058	45.875±0.819	35.750±0.708
Canter	Before	37.437±0.058	34.750±0.819	15.750±0.708
	After	38.512±0.058	76.000±0.819	49.250±0.708
Gallop	Before	37.500±0.058	35.000±0.819	15.250±0.708
	After	39.512±0.058	99.875±0.819	60.875±0.708
$LSD_{0.01}$		0.921	6.312	7.346

Similar letters: mean no significant variations at P≤0.01.

Table 3: shows the body weights (kg), the body weight mean value (kg), the total body surfaces (Cm^2), and the total body surface mean value (Cm^2)

No. of horses	Body weights (kg)	Body weights mean value (kg)	Total body surfaces (Cm^2)	Total body surfaces mean value(Cm^2)
1	457	460.5	494.4	396.1
2	439		385.0	
3	430		380.2	
4	467		399.5	
5	478		405.1	
6	480		406.2	
7	454		393.8	
8	478		405.1	

S: Total body surface (TBS), K: Meeh's constant=10, W: Body weight$^{0.6}$

Table 5 shows that the mean values ± standard errors of albumin, globulin, Na, K, Cl, Ca, Mg, Fe, Cu, Zn, Mg levels in trot were 3.512±0.089, 3.875±0.725, 3.637±0.072, 2.062±0.086, 5.962±0.141, 0.167±0.006, 0.987±0.007, 4.875±0.700, 0.712±0.515, 11.750±0.422 and 0.180±0.002, respectively, while in canter they were 3.925±0.086, 4.750±0.111, 4.787±0.104, 3.637±0.285, 6.637±0.090, 1.487±0.953, 0.161±0.008, 5.537±0.105, 0.987±0.666, 12.262±0.106 and 0.236±0.007, respectively, and in gallop were 5.612±0.107, 6.012±0.158, 6.675±0.144, 5.062±0.138, 7.550±0.090, 2.750±0.122, 0.256±0.009, 6.400±0.070, 1.600±0.845, 12.650±0.073 and 0.276±0.004, respectively.

Table 4: shows the normal values of sweat constituents according to their references

Constituents	Values	References
Albumin (g/l)	2.9	(15)
Globulin (g/l)	3.2	=
Sodium (g/l)	2.8	(16),(17)
Potassium (g/l)	1.4	=
Chloride (g/l)	5.3	=
Calcium (g/l)	0.12	=
Magnesium (g/l)	0.05	=
Iron (mg/l)	4.3	=
Copper (mg/l)	0.3	=
Zinc (mg/l)	11.4	=
Manganese(mg/l)	0.16	=

Table 5: M± SEM of some sweat constituents after different running speeds

Speeds	Parameters										
	Albumin (g/100ml)	Globulin (g/100ml)	Na (g/l)	K (g/l)	Cl (g/l)	Ca (g/l)	Mg (g/l)	Fe (mg/l)	Cu (mg/l)	Zn (mg/l)	Mn (mg/l)
Trot	3.512± 0.089	3.875± 0.725	3.637± 0.072	2.062± 0.086	5.962± 0.141	0.167± 0.006	0.987± 0.007	4.875± 0.700	0.712± 0.515	11.750± 0.422	0.180± 0.002
Canter	3.925± 0.086	4.750± 0.111	4.787± 0.104	3.637± 0.285	6.637± 0.090	1.487± 0.953	0.161± 0.008	5.537± 0.105	0.987± 0.666	12.262± 0.106	0.236± 0.007
Gallop	5.612± 0.107	6.012± 0.158	6.675± 0.144	5.062± 0.138	7.550± 0.090	2.750± 0.122	0.256± 0.009	6.400± 0.070	1.600± 0.845	12.650± 0.073	0.276± 0.004
$LSD_{0.01}$	0.287	0.362	0.335	0.575	0.334	0.271	0.033	0.253	0.209	0.237	0.010

Discussion

It is well known that, Iraqi Arabian horses can carry on the hot, humid conditions. Iraq, has long summer (hot weather), begins from June to November, so at this period, the Iraqi sports are stopped. A lot of researchers studied many aspects of Iraqi Arabian horses (19-22). Dehydration is one of the most important health problems of Iraqi sports horses which veterinarians and trainers are deal with.

Sweat is a physiological response to heat stress (exercise, weather, fear, fighting….etc.), under conditions of heat stress, the body stores the heat, resulting in an increase of the circulatory blood temperature. This increase is sensed by the hypothalamus, which is responsible for the thermoregulation response to heat stress through cutaneous vasodilation, increased production of sweat by sweat glands (18). In hoses, in particular, prolonged periods of sweating at high rates results in water and electrolyte losses that can lead to dehydration with ensuing poor performance and clinical signs of heat strain if unchecked (23). Table 2 shows an highly significant variations at $P \leq 0.01$ of the increase of body temperatures according to the top of exercise (gallop) 60 km/h., this indicate to high increase of heat storage. These results accompanied with a lot of researchers in their previous studies in many breeds. Our results, indicate that heart beats are highly significantly at

P≤0.01, and the increases are threefold (from 32 to 99 bpm), similarly (24) and (25) found that top athletes bpm increases less than fourfold. We believe that, rise of body temperature may be due to the physiologic effect of the release of adrenaline circulating levels during gallop. During exercise, skeletal muscle contraction generates high heat that could be get rid of convective blood flow throughout the body to the skin for dissipation to the environment since evaporation of sweat provides the greatest cooling effect (26).The high level of heart beats occurs to provide the requirements of blood to the cutaneous dilated vessels. Also, the increase in respiratory rate due to the running speeds may assist in cooling blood circulation which lead to decrease the heat storage and at the same time demand the requirements of more quantities of blood particularly to the cutaneous dilated vessels. Our findings indicate a highly significant variations at P≤0.01of respiratory rate, that may refer to increase of VO_2 value during the maximal exercise. It is empirically confirmed that one of the results of intense training of horses is an increase $VO_{2\ max}$ by about 25% (27). Horses may even double the number of erythrocytes circulating in the blood which is translated into facilitating the transport of oxygen in the body (28,29). It is well known that, Iraqi Arabian horses are classified as a light horses. A lot of researchers estimate the total body surfaces of about (30) mammals depending on the calculated body weight by using Meeh's formula. Body weights (metabolic rates) can be influenced by the hot weather. The high total body surface will increase the sweat out put particularly in hot weather as in Iraq, although Arabian breed has adapted genetically among thousands of years on the hot climate, it's worthwhile to mention that no previous research estimate the total body surfaces of our Iraqi Arabian horses, which add a knowledge about dehydration problem and its complications in our Iraqi horses. We find, it's very useful to high light the normal values of some essential sweat constituents as in table 4 to understand clearly the changes of these values according to each running speed which is included in our study. Table 5 shows clearly the highly significant variations at P≤0.05 of the proteins and the essential different minerals specially in high speed (gallop). These results are accompanied with a lot of studies in different breeds of horses (24-26,30). Our results indicate clearly to the high lost of these essential proteins and minerals during sweating which must be compensated by food additives specially during summer, to prevent many healthy problems so we believe that ratios of these proteins and minerals must be calculated according to many factors like, weather climate, the type of the horse jobs (jump, polo, races, show,…..etc.), the body weights and ages. We hope that our study may open the door for more future studies in Iraq to design the standard feeding ratios according the previous factors.

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