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Effects of sex and season on 10 haematological values of normal adult one-humped camel

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RÉSUMÉ

Influence du sexe et de la saison sur 10 valeurs hématologiques du dromadaire adulte normal

Les auteurs ont étudié, au cours des dernières semaines des mois de juillet, octobre et décembre, 10 paramètres sanguins de dromadaires de travail, dont 10 mâles et 10 femelles, vivant dans des conditions naturelles, dans la région de Thal, près de Bhakhar au nord-ouest du Pakistan.

La coagulation sanguine intervient en moyenne au bout de 244 $\pm$ 1,73 s et la vitesse de sédimentation des érythrocytes (ESR) atteint 8,87 $\pm$ 0,36 mm en 8 h ; le taux d'hémoglobine est de 11,11 $\pm$ 0,3 g/dl et le nombre des hématies est de 10,56 $\pm$ 0,41 $\times$ 10^3/l.

Le rapport lymphocytes/neutrophiles, qui est approximativement de 1 (47,46 $\pm$ 1,42 p. 100 et 44,65 $\pm$ 1,37 p. 100), une éosinophilie modérée (7,22 $\pm$ 0,4 p. 100), un taux de monocytes faible (1,2 $\pm$ 0,1 p. 100) et la rareté des basophiles (0,05-0,03 p. 100) sont les principales caractéristiques de la formule leucocytaire.

Les saisons ont un effet significatif sur 8 des 10 paramètres étudiés. ESR, l'hémoglobine, éosinophiles et monocytes sont à leur taux maximal en été ; les lymphocytes sont plus fréquents en automne mais le temps de coagulation, le nombre des globules rouges et des neutrophiles sont supérieurs en hiver. Des 2 paires de paramètres qui croissent et décroissent simultanément, celle composée des hématies et des neutrophiles montre une augmentation en hiver et une chute en automne alors que l'autre composée des lymphocytes et des éosinophiles présente l'allure inverse. Cependant la seconde paire semble avoir la même mouvance que les neutrophiles aux différentes saisons et la vitesse de sédimentation des érythrocytes est inversement proportionnelle au temps de coagulation.

Pour ce qui est de l'influence du sexe, on observe chez les femelles un taux significativement plus élevé en ce qui concerne l'ESR ainsi que de plus nombreux éosinophiles, tandis qu'on note chez les mâles un taux de lymphocytes plus élevé.

INTRODUCTION

Much can perhaps be learnt from the queer form and singular physiology of this dubious animal : appropriately called « The ship of the desert », which has survived not only the rigours of its trying environments but also the centuries of development and change. Scattered information on individual parameters of camel's blood are not altogether wanting. Effects of season (6, 5) and sex (11) have also been tested on some of its constituents. Yet there appears to be so much dearth of comprehensive information on the blood of this mysterious animal that even the norms remain to be firmly established. Physiological causes which influence the various haematological values are also little understood. An attempt is therefore being made to study the effects, if any, of three seasons and two sexes on 10 different parameters of blood among the same 20 camels of Thal.

MATERIALS AND METHODS

Blood was drawn from 11 to 17 adult apparently healthy one-humped (*Camelus dromedarius*) camels of either sex during each season, but the data included in the present write-up pertain only to those 20 animals, 10 males and 10 females, which were sampled consistently during the three seasons. For this purpose an ambulatory laboratory was established in village Panj-Giraen ; about 30 km north of Bhakhar during the last weeks of July, October and December, for summer, autumn and winter samples respectively. All these animals were routinely managed and customarily employed by their various owners in their natural habitat of Thal, in the north-west of the Punjab.

Samples were collected after overnight rest and before the morning feed was allowed. About 5 ml of blood was taken directly into an oxalate containing test tube, by the usual jugular puncture method. Samples were kept in an ice box and all tests were completed the same day. Smears were as usual prepared and the coagulation time recorded from the fresh unpreserved blood. Following 10 parameters were studied.

Slide method was followed after KOLMER *et al.* (8) to record the coagulation time, in seconds.

Erythrocyte Sedimentation Rate (ESR) was determined by the Westergen sedimentation tubes after BENJAMIN (2). Readings, in millimeters (mm), were recorded after 1 and 8 hrs, separately.

Haden-Hausser method was employed for the estimation of hemoglobin, as described in KOLMER *et al.* (8). The readings are expressed in grams (g) for 100 ml (dl) of blood.

Red Blood Cell (RBC) count was done with the help of a hemocytometer. The blood was diluted 200 times in Toisson's fluid and five small squares of the counting chamber were scanned (KOLMER *et al.*, 1959). The count is expressed in millions ($\times 10^6$) for each cubic mililiter (µl) of blood.

Total Leukocytic Count (TLC) was also made by the hemocytometer. A 1 : 20 dilution was obtained in 3 p. 100 aqueous acetic acid. The count was spread over 4 large squares (KOLMER *et al.*, 1959), which was expressed in thousands ($\times 10^3$) per cubic mililitre (µl) of blood.

Differential Leukocytic Count (DLC) was obtained by the Battlement technique. As described by KOLMER *et al.* (8), a total of 100 leukocytes were counted from each smear, stained with the modified Wright's stain (9). Actual numbers of neutrophils, lymphocytes, monocytes, eosinophils and basophils thus registered were expressed directly as percentages.

The whole data was tabulated in 6 lots of 10 camels each : separating the two sexes and the three seasons studied. As two samples were tested from each animal the arithmetic mean of the two observations made on them was used in

TABLE 1. All the 10 hematological values analysed. Overall, seasonal and sex-wise averages,

(A) Analysis of Variance :

Sources of variation	df	Coagulation Time	E S R (8 hours)	Hemoglobin Contents	RBC Count	T L C
Seasons	2	2,253 **	57.14 **	82.64 **	19.71 **	24.72
Sex	1	355	31.25 *	7.48	0.01	9.92
Season x Sex	2	10	2.84	11.21 *	2.40	10.01
Error	54	108	5.78	2.73	1.47	10.23

(B) Averages + Standard Errors:

Average	Dénominations Seconds	mm	g/dl	x 10^6/ul	x 10^3/ul
Overall Average:	244 ± 1.73	8.87 ± 0.36	11.11 ± 0.30	6.72 ± 0.17	10.56 ± 0.41
Summer Season:	233 ± 3.0	10.8 ± 0.8	12.9 ± 0.6	6.7 ± 0.3	11.2 ± 0.8
Autumn Season:	245 ± 2.1	8.5 ± 0.6	8.9 ± 0.3	5.9 ± 0.4	9.3 ± 0.8
Winter Season:	255 ± 2.0	7.5 ± 0.4	11.6 ± 0.5	7.9 ± 0.3	11.3 ± 0.8
Female Camel:	247 ± 2.5	9.6 ± 0.6	10.8 ± 0.5	6.7 ± 0.2	10.2 ± 0.6
Male Camel:	242 ± 2.4	8.2 ± 0.4	11.5 ± 0.4	6.7 ± 0.3	11.0 ± 0.6

All figures in the Analysis of Variance section above are Mean Squares.

the analysis. Effects of sex and season were studied jointly by the analysis of variance technique, following STEEL and TORRIE (14). In addition, arithmetic mean or average, and the standard error (SE) of each of the 10 parameters studied was also calculated on overall, sex, and seasonal basis, separately.

RESULTS

Overall averages and standard errors of all the 10 haematological values, studied among the same 10 adult camels of either sex during the three seasons under investigation, are listed in Table 1. Also shown in the table are their season and sex-wise means. Furthermore, the effects of sex and season on these parameters were ascertained by the analysis of variance test at 0.01 and 0.05 levels of significance.

Seasons are found to make significant effect on coagulation time, ESR, hemoglobin level, RBC count and the percentages of lymphocytes, neutrophils, eosinophils and monocytes. Thus this source of variation remains inert in so far as TLC or basophils are concerned. ESR, lymphocytes and eosinophils, on the other hand, are the three values of blood which differ significantly in between the two sexes (Table I). The one-humped camel, therefore, seems to make more drastic seasonal adjustments in its blood in order to successfully counter the equally intense seasonal changes in its environments.

A close scrutiny of Table I would bring out :

(i) The highest seasonal averages of ESR (10.8 $\pm$ 0.8 mm), hemoglobin (12.9 $\pm$ 0.6 g/dl), eosinophils 8.5 $\pm$ 1.1 p. 100, and monocytes (1.7 $\pm$ 0.3 p. 100) are recorded in summer ; lymphocytes (53.3 $\pm$ 1.2 p. 100) are most frequent in autumn ; whereas coagulation time (255 $\pm$ 2 sec.), neutrophils (53.9 $\pm$ 1.7 p. 100), and RBC count (7.9 $\pm$ 0.3 $\times$ $10^6/\mu l$) are all at their maximum in winter.

(ii) Lymphocytes (50.2 $\pm$ 2.2 p. 100) are more numerous in males, but the females excell in ESR (9.6$\pm$0.6 mm) and eosinophils (7.7$\pm$0.5 p. 100).

(iii) In different seasons, RBC's and neutrophils increased and decreased together, and so were the eosinophils and lymphocytes. However, the means of the former pair were highest in winter and lowest in autumn whereas the seasonal fluctuations in the latter pair showed just the opposite trends. In other words, when the values of one of these pair of parameters rose the values of the other pair fell, and vice versa.

(iv) Whenever and to whatever extent do the lymphocytes decrease the neutrophils increase accordingly, and vice versa : the two types together making between 91 and 93 p. 100 of the TLC.

(v) ESR is inversely proportional to the coagulation time.

along with their respective standard errors, are also given in each case.

Differential Leukocytic Count (DLC)				
Lymphocytes	Neutrophils	Monocytes	Eosinophils	Basophils
1,172 :::	1,172:::	2.39::	24.45:::	0.01
460::	215	0.06	14.51:::	0.00
228	198	2.31::	25.01:::	0.10::
73	65	0.56	0.99	0.03
p. 100	p. 100	p. 100	p. 100	p. 100
47.46 $\pm$ 1.42	44.65 $\pm$ 1.37	1.20 $\pm$ 0.10	7.22 $\pm$ 0.40	0.05 $\pm$ 0.03
50.3 $\pm$ 3.1	41.3 $\pm$ 2.8	1.7 $\pm$ 0.3	8.5 $\pm$ 1.1	0.1 $\pm$ 0.1
53.3 $\pm$ 1.2	38.9 $\pm$ 1.2	1.0 $\pm$ 0.2	6.9 $\pm$ 0.5	0.0. $\pm$ 0.0
38.8 $\pm$ 1.8	53.9 $\pm$ 1.7	1.0 $\pm$ 0.2	6.4 $\pm$ 0.7	0.1 $\pm$ 0.1
44.7 $\pm$ 1.7	46.6 $\pm$ 1.7	1.2 $\pm$ 0.1	7.7 $\pm$ 0.5	0.05 $\pm$ 0.0
50.2 $\pm$ 2.2	42.8 $\pm$ 2.2	1.2 $\pm$ 0.1	6.7 $\pm$ 0.7	0.03 $\pm$ 0.0

Significant at 1 (:::) and 5 (::) per cent levels.

DISCUSSION

On an average, camel blood takes 244 ± 1.73 sec. to coagulate. The process is quickest in summer (233 ± 3 sec.), medium in autumn (245 ± 2 sec.), and slowest in winter (255 ± 2 sec.). Although sex was found to make no significant effect on the parameter yet SOLIMAN and SHAKER (12) record 6.2 min. coagulation time among the egyptian she-camels. The cause of this variation is not known.

Average ESR of 1.4 ± 0.2 mm noticed in the 1rst hr was increased to 8.87 ± 0.36 mm after 8 hrs. In spite of the variable timings used, these means are in general comparable to (*a*) 0.9 and 8.1 mm ESR after 1 and 7 hrs respectively (3), (*b*) 1.1 ± 0.1 mm per hour ESR (1), (*c*) 1.9 mm sedimentation in 2 hrs (4), and (*d*) 1 mm ESR in the 1rst hr (12). The highest 8-hourly ESR is recorded in summer (10.8 ± 0.8 mm), next in order comes autumn (8.5 ± 0.6 mm) but the lowest ESR is encountered in winter (7.5 ± 0.4 mm). Between the two sexes, females show significantly higher ESR (9.6 ± 0.6 mm) than the males (8.2 ± 0.4 mm).

The highest hemoglobin concentration was recorded in summer (12.9 ± 0.6 g/dl), medium in winter (11.6 ± 0.5 g/dl) and the lowest in autumn (8.9 ± 0.3 g/dl). The overall average hemoglobin of 11.11 ± 0.3 g/dl is, however, way lower than the two means reported from Bikaner in India. SONI and AGGARWALA (13) gave an average of 15.5 g/dl, and BANERJEE *et al.* (1) that of 13.1 ± 0.5 g/dl. That these all-male studies were conducted in summer may at least in part account for the higher values because significantly higher hemoglobin contents are noticeable (*a*) in summer (Table I), as well as, (*b*) in males (11). In the present study, also male camels (11.5 ± 0.4 g/dl) gave higher averages than the females (10.8 ± 0.5 g/dl) but these differences were not significant (Table I). Nevertheless, an all-female study of Egypt gives 13.2 g/dl hemoglobin (12). The overall average of the present study, however, compares favourably with 11.8 g/dl reported from Hungary (4). The season during which this study was made, and the sex or ages of the camels studied could not be ascertained.

Studying 95 male camels in summer, SONI and AGGARWALA (13) came up with an average erythrocyte count of 8.2 × 10^6 µl, and in about 77 p. 100 of these animals the count ranged between 6 and 9 millions. However, BANERJEE *et al.* (1) examining 20 males, also from Bikaner in India, and SOLIMAN and SHAKER (12) working on 80 female camels in Egypt gave mean RBC count of 7.24 ± 0.185 × 10^6/µl and 7.2 × 10^6/µl, respectively. The average red cell count of 6.72 ± 0.17 × 10^6/µl (Table I), therefore, appears to be lower. Although seasons effect this count significantly, yet summer sampling alone cannot be made responsible for the higher averages reported above because summer (6.7 ± 0.3 × 10^6/µl) means, even in the present study, are midway between winter (7.9 ± 0.3 × 10^6/µl) and autumn (5.9 ± 0.4 × 10^6/µl) means. However, the mean RBC count reported herewith is higher than the one recorded among the hungarian camels (5.6 × 10^6/µl). Other details of this latter study of BOKORI (4) are not available.

It is obvious from Table I that neither season nor sex make any significant effect on TLC yet four of the five types of these leukocytes are influenced by seasons and the effect of the sex is restricted to lymphocytes and eosinophils. In a way, this would suggest that different varieties of the WBCs vary in such a manner that their total number remain unmoved. If one looks at the percentages formed by the two most frequent of these leukocytes, it becomes clear that whatever the sex or whichever the season lymphocytes and neutrophils together make an aggregate of between 91 and 93 p. 100 of the total count. The observation is supported by the findings of BANERJEE *et al.* (1). Even among the 80 egyptian she-camels where the lymphocytes formed 63 p. 100 this total was maintained although the neutrophils had to be brought down to 29.3 p. 100. It, therefore, appears that if one variety of camel's white cells decline some other type proliferates to take its place.

During the course of the present study, it was observed that some eosinophils, some monocytes and rare basophils, at times, approached almost two times the length of the surrounding red cells in their diameter. Plate I illustrates the morphology of the various cellular elements of blood. The exceptionally large RBC shown therein is obviously larger than the largest red cell calibrated by KOHLI (7). The frequency and significance of such giant cells needs further work.

Although average RBC and various leukocyte counts of camel (Table I) fall within the generally accepted normal ranges of other domestic ruminants (10) yet its DLC shows following peculiarities :

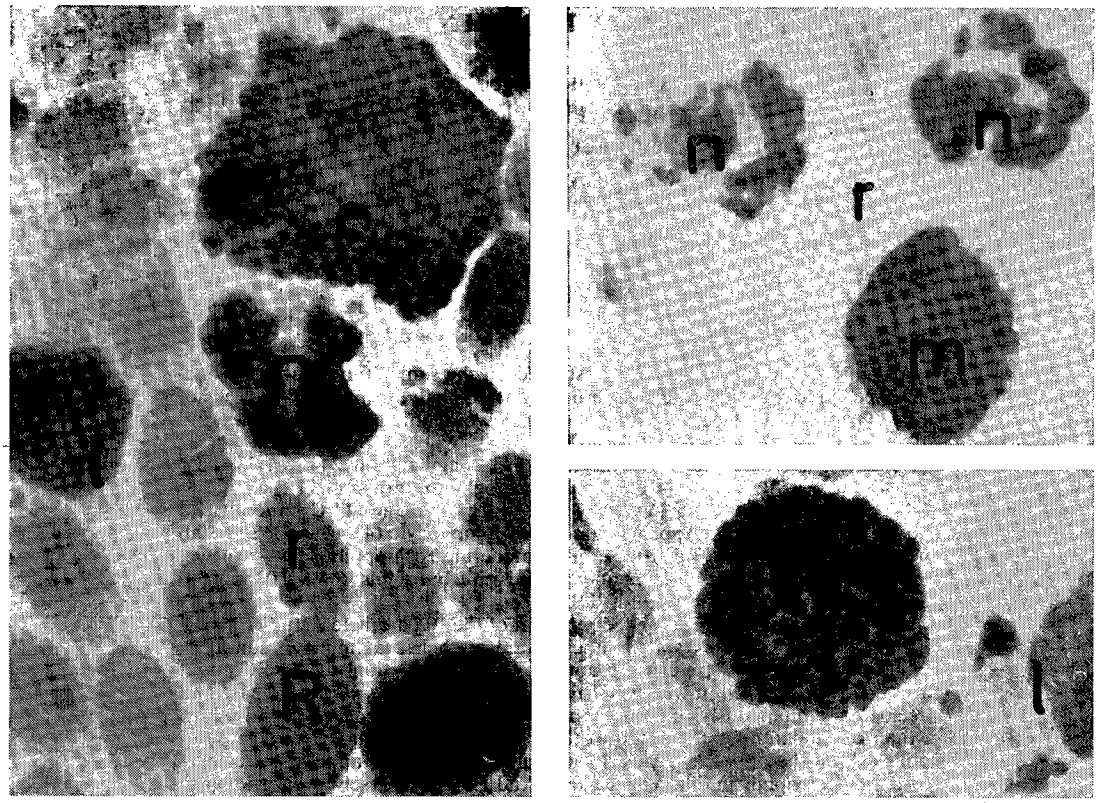

Plate I. — The cellular elements in the peripheral blood.

b = The differently shaped nucleus of the rather large basophil is obscured by dark, metachromatic, unevenly distributed granules which vary in number, size and shape.

e = The large eosinophils carry band shaped or bi-lobed nuclei. Their evenly distributed spherical granules of golden red colour and uniform size give their pink cytoplasm a purplish hue.

l = The single, large, rounded nuclei of the frail lymphocytes are prominantly placed, at time displacing their distinct blue cytoplasm towards the periphery. Intermediate forms in between the usual large and small sizes may sometimes be seen.

m = The dull grey-blue cytoplasm may not occupy as large a space as the centrally located, rounded or kidney shaped, single nucleus of the large monocytes.

n = The light-pink cytoplasm of the neutrophils is marked with numerous, pink coloured, small, evenly distributed granules ; which are visible only in good preparations. Filaments or chromatin strands connect the various lobes of their 3 to 5 lobed nuclei.

R = An unusually large RBC.

r = The usual non-nucleated elliptical RBC.

(i) The predominating WBC of camel is the lymphocyte, yet in this species the neutrophils are not far behind. The latter remains to be the commonest leukocyte of the monogastric animals. In fact, this variety forms the majority in male (50.2 $\pm$ 2.2 p. 100) specimens, and in autumn (53.3 $\pm$ 1.2 p. 100) as well as summer (50.3 $\pm$ 3.1 p. 100) seasons. Among the indian camels, BANERJEE *et al.* (1) likewise record 50.6 $\pm$ 1.88 p. 100 neutrophils.

(ii) In cow, sheep and goat the lymphocytes form 58, 62 and 56 and mature neutrophils 28, 30 and 36 p. 100, respectively (10). This roughly 2 : 1 lymphocyte neutrophil ratio is also on record in the 80 she-camels of Egypt (12). However, in the present study these leukocytes make 47 and 45 p. 100 of the TLC, respectively (Table I). Camel thus seems to show a 1 : 1 lymphocyte neutrophil ratio.

(iii) In comparison with other ruminants the blood of camel harbours a relatively lower percentage of monocytes. SOLIMAN and SHAKER (12), however, record 2.4 p. 100 monocytes in the egyptian she-camels.

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SUMMARY

Ten haematological values are studied on the same 20 normal adult one-humped camels, right in their natural habitat of Thal, during the last weeks of July, October and December. Ten of these work animals were females and 10 males.

On an average, the blood of the camel coagulates in 244 $\pm$ 1.73 sec. ; its 8-hourly ESR is 8.87 $\pm$ 0.36 mm ; hemoglobin forms 11.11 $\pm$ 0.3 g/dl ; RBC count comes to 6.72 $\pm$ 0.17 $\times$ 10^6/µl ; and the TLC amounts to 10.56 $\pm$ 0.41 $\times$ 10^3/µl. Approximately 1 : 1 lymphocyte (47.46 $\pm$ 1.42 p. 100) neutrophil (44.65 $\pm$ 1.37 p. 100) ratio, a moderate eosinophil (7.22 $\pm$ 0.4) yet low monocyte (1.2 $\pm$ 0.1) percentages, and rare basophils (0.05-0.03 p. 100) are the characteristic features of its DLC.

Seasons make significant effect on eight of the 10 parameters studied. ESR, hemoglobin, eosinophils and monocytes are at their maximum in summer ; lymphocytes are most frequent in autumn ; but coagulation time, RBC count and neutrophils excell in winter. Of the two pairs of values which increase and decrease simultaneously, the one comprising of RBC's and neutrophils show winter rise and autumn fall, but the other consisting of lymphocytes and eosinophils exhibit the opposite trends. Moreover, the latter pair appears to reciprocate the neutrophils in different seasons. And ESR is inversely proportional to coagulation time.

Female camels show significantly higher ESR and more numerous eosinophils whereas higher percentage of the lymphocytes is noticed in the males.

RESUMEN

Influencia del sexo y de la estación sobre 10 valores hematológicos del dromedario adulto normal

Los autores estudiaron, durante las últimas semanas de los meses de julio, octubre y diciembre, 10 parámetros sanguíneos de dromedarios de tiro, de los cuales 10 machos y 10 hembras viviendo en condiciones naturales, en la régión de Thal, cerca de Bhakhar al noroeste del Pakistan.

La coagulación sanguínea ocurre por término medio al cabo de 244 $\pm$ 1,73 segundos y la velocidad de sedimentación de los eritrocitos (ESR) llega a 8,87 $\pm$ 0,36 mm en 8 h ; la tasa de hemoglobina es de 11,11 $\pm$ 0,3 g/dl y el número de hematíes es de 10,56 $\pm$ 0,41 $\times$ 10^3/l.

Las principales características de la formula leucocitaria son la relación linfocitos/neutrofilos, que es aproximadamente de 1 (47,46 $\pm$ 1,42 p. 100 y 44,65 $\pm$ 1,37 p. 100), una eosinofilia moderada (7,22 $\pm$ 0,4 p. 100) una tasa reducida de monocitos (1,2 $\pm$ 0,1 p. 100) y la presencia escasa de basofilos (0,05-0,03 p. 100).

Las estaciones tienen un efecto significativo sobre 8 de los 10 parámetros estudiados. ESR, hemoglobina, eosinofilos y monocitos tienen su tasa maxima en verano ; los linfocitos son más frecuentes en otoño pero la duración de coagulación, el número de los globulos rojos y de los neutrofilos son superiores en invierno.

De dos pares de parámetros que crecen y disminuyen simultaneamente, la compuesta por hematíes y neutrofilos muestra un aumento en invierno y una baja en otoño mientras que otra compuesta por línfocitos y eosinofilos presenta lo contrario.

Sin embargo, la segunda par parece tener la misma variación que los neutrofilos en las diferentes estaciones y la velocidad de sedimentación de los eritrocitos es inversamente proporcional a la duración de coagulación.

En cuanto a la influencia del sexo, se observa en las hembras una tasa significativamente más elevada en lo referente al ESR y los eosinofilos más numerosos, mientras que se nota en los machos una tasa de linfocitos más elevada.

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