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The Effect of Seasonal Variations, Pregnancy and Management System on the Blood Minerals and Thyroid Hormones of Camels

Hozifa S. Yousif[1], Shadia A. Omer[2], Shamseldein H. Ahmed[2]
[1]Department of Physiology, University of Albutana, Tamboul, Gizera State, Sudan
[2]Department of Biomedical Sciences, Sudan University of Science and Technology, Khartoum, Sudan

***Abstract*—** *The present study was carried out to investigate the effect of the season, management system and physiological status on the blood minerals and thyroid hormones of camels. Sixty healthy one-humped she-camels (Camelus dromedarius) aged between 6 and 9 years were used in the study. The animals were divided into four groups: group (1) penned camels, group (2) grazing camels, group (3) pregnant camels and group (4) non-pregnant camels. Blood samples (6ml) were collected from jugular vein, monthly throughout the experimental period. T_3, T_4, Mg^+, Na^+, K^+ and Ca^{++} were determined using the standard laboratory methods. The animals showed lower values for T_3 and T_4 (nmol) during summer (1.36±0.36, 114.91±3.84), respectively, compared to autumn (1.67±0.46, 129.35±4.55) and winter (1.73±0.41, 132.63±4.44). T_3 and T_4 values obtained by group (2) were higher than those obtained by the group (1). T_3 level was higher in group (3) than that in group (4). During winter there were high levels of K^+ (mEg/L) (4.72±0.55) and Ca^{++} (mg/dl) (9.05±1.01) compared to autumn (4.24±0.58, 8.75±0.95) and summer (4.30±0.43, 8.27±1.51). Group (2) registered higher values for Na^+ (mEg/L) and K^+ than group (1), while group (1) registered higher values for Ca^{++} than group (2). Pregnancy significantly reduced serum Ca^{++}. It was concluded that, the season, management system and pregnancy affected some serum minerals, and thyroid hormones.*

***Keywords*—** *Seasonal variations, Pregnancy, Management system, Blood minerals, Thyroid hormones, Camel.*

I. INTRODUCTION

Camels' population is found in two main regions, the Butana in the East and the states of Darfur and Kordofan in the West of Sudan. These regions differ in their soil, temperature, rainfall and pasture [1]. The pasture quantity and quality are influenced by the seasonal changes in rainfall [2]. This in turn could influence the nutritional status and so the blood constituents of camels [3]. The unique characteristics of camel physiology pose an exciting challenge to interested research workers [4]. Changes in rainfall during seasons of the year have influence on pasture quantity and quality. Therefore, could influence the nutritional status and subsequently the blood constituents of camels [3]. Since the camel is an adaptable species, the standard serum biochemical and haematological values need to be determined in a number of animals in variable environmental conditions [5]. Minerals has long been known to be important in animal nutrition as they may be dietary essential and vital to enzyme processes of living cells or have some metabolic activity. Compared to other domestic animals such as dairy cattle, sheep, and goats, our understanding about the physiological and hormonal changes that the camel undergoes during pregnancy is inadequate. Because of the long pregnancy period of camels, it was assumed that energy requirements of pregnant camels increase rapidly during the heavy pregnancy. This may affect the concentration of some biochemical parameters [6]. Pregnancy is a dynamic process characterized by dramatic physiological changes that may influence biochemical values in human and animal [7]. Thyroid hormones are known as important modulators of general metabolism [8]. In dairy cows, these hormones regulate energy metabolism in which carbohydrates and lipids are the major constituents [9]. Serum levels of thyroid hormones are mainly affected by general body metabolism [10], season [11] and the water availability [10]. Serum biochemical parameter can provide valuable information regarding health, sex, age, nutritional and physiological status of the animals [12].

The specific objectives of this study is to determine the effect of seasonal variations, pregnancy and management system on the blood minerals and thyroid hormones of camels and to contribute to data base available on the blood minerals and thyroid hormones of Sudanese camels.

II. MATERIALS AND METHODS

A. Study Area

This study was done in Butana area, Sudan, which it lays approximately between latitude 14º-16º N and longitude 33º-36º E.

B. Animals

The study was carried out on sixty one-humped she-camels (*Camelus dromedarius*) aged between 6 and 9 years. Animals were divided into four groups: group (1) penned camels, group (2) grazing camels, group (3) pregnant camels and group (4) non-pregnant camels. All the camels were clinically healthy and free from any physical abnormalities.

C. Housing and Feeding

Thirty camels were free grazing in pasture and the other thirty camels were housed at open partially shaded yard in Tamboul Camel Research Centre.

The penned animals were fed twice daily, sorghum straw and a concentrate composed of molasses 30%, bagasse 20%, sorghum grain 15%, groundnut cake 17%, wheat bran 15%, urea 2% and salt 1%.

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D. Meteorological Data

Meteorological data during the study period, which are ambient temperature (Ta) and relative humidity (RH), were provided monthly for Butana area (14°-16°N, 33°-36°E) by the Meteorological Unit, Wad-Medani city.

E. Sira Collection

6ml of blood were taken by jugular venipuncture into vacutainers tube without any anticoagulant used for serum separation.

F. Sira Analysis

Triiodothyronine (T_3) and Thyroxin (T_4) concentration were determined by RIA-Spec MIS kit and ^{125}1-T_4 RIA-Spec MIS kit (Hungary) respectively. According to the method described by [13] Mg^+ concentration was determined by atomic absorption spectrophotometer (3110, Germany), using a commercial kit (Fortress, diagnostics. Spin). Plasma sodium (Na^+) and potassium (K^+) concentration was determined by flame photometer technique according to [14]. Calcium concentration was determined by spectrophotometric method using a commercial kit (Liner chemical, Spin).

G. Statistical Analysis

Data were analyzed as with a 3x2x2 factorial arrangement of treatments using analysis of variance, treatments means were compared by Duncan's multiple range tests and ANOVA table, and an interaction between three factors (season, management system and physiological status of animals) analyzed by general linear model by using SPSS version 16 computer programs.

III. RESULTS

The ambient temperature during the experiment range was 15.7°C - 41.63°C while the relative humidity fluctuated between 21% and 70%. The highest value of ambient temperature was recorded during May, while the lowest value was recorded during January. The highest value of relative humidity was recorded during August, while the lowest value was recorded during April.

Table I shows the effect of seasonal changes, management system and physiological status in thyroid hormones. Animals registered significantly lower values for T_3 and T_4 during summer while no variation was found between autumn and winter. T_3 and T_4 values were higher in the grazing camels than that measured in the penned ones. T_3 was higher in the pregnant camels than that obtained in the non-pregnant ones. T_4 did not vary with the physiological status.

There was an interaction between season and management system on T_3 while there was an interaction between season and physiological status on T_3 and T_4. There was an interaction between management system and physiological status with regard to the T_4 while there was an interaction of season, management system and physiological status with regard to the T_3.

Table II shows that there are seasonal changes in some serum minerals. Mean values of Mg^+ and Na^+ were not vary with the season. K^+ level was significantly higher during winter than those observed during summer and autumn. Mean values of Ca^{++} were varied with the season; the highest value of Ca^{++} was obtained during winter while the lowest one obtained during summer.

As shown in Table II Mg^+ did not vary with the management system. Na^+ and K^+ increased significantly in grazing camels compared with the penned Ones, while Ca^{++} decreased significantly in grazing camels compared with the penned ones. Mg^+, Na^+ and K^+ were not vary with the physiological status, Ca^{++} was significantly increased in the non-pregnant camels.

TABLE I. The effect of the season, management system and physiological status on thyroid hormones.

Factors		**Parameters**			
		T_3 (nmol)		**T_4 (nmol)**	
Management System	Season	Pregnant	Non pregnant	Pregnant	Non pregnant
Grazing Camels	Summer	1.57	1.68	125.02	120.60
	Autumn	1.79	1.86	139.76	125.71
	Winter	2.13	1.64	142.89	134.36
Penned Camels	Summer	1.03	1.10	94.96	107.01
	Autumn	1.66	1.51	126.67	125.97
	Winter	1.74	1.59	124.42	126.64
Overall mean		1.61±0.48		124.50±5.14	
Main effect (mean+SD)					
Season	Summer	1.36^b ± 0.36		114.91^b ± 3.48	
	Autumn	1.67^a ± 0.46		129.35^a ± 4.55	
	Winter	1.73^a ± 0.41		132.63^a ± 4.44	
	Level of Significant	***		***	
Management System	Grazing Camels	1.78^a ± 0.45		131.39^a ± 4.93	
	Penned Camels	1.40^b ± 0.35		119.87^b ± 3.82	
	Level of Significant	***		***	
Physiological Status	Pregnant Camels	1.65^a ± 0.43		125.62^a ± 4.14	
	Non-pregnant Camels	1.52^b ± 0.45		125.64^a ± 4.00	
	Level of Significant	**		N.S	
Season*Management System		**		N.S	
Season*Physiological Status		***		***	
Manage. System*Physiological Status		N.S		***	
Season*Manage.System*Physiol.Status		***		N.S	

a, and b: means values within the same column having different superscripts, differ significantly.
N.S: not significant, **: (P< 0.01), ***: (P< 0.001).

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TABLE II. The effect of the season, management system and physiological status on some serum minerals.

Factors		Parameters							
		Mg (mg/dl)		Na (mEg/L)		K (mEg/L)		Ca (mg/dl)	
Management System	Season	Pregnant	Nonpregnant	Pregnant	Nonpregnant	Pregnant	Nonpregnant	Pregnant	Nonpregnant
Grazing Camels	Summer	1.52	1.73	148.97	150.24	4.31	4.27	8.96	9.41
	Autumn	1.49	1.58	154.44	152.99	4.73	4.42	8.88	8.91
	Winter	1.76	1.52	151.65	146.31	5.07	4.81	9.31	9.18
Penned Camels	Summer	1.63	1.63	139.88	141.12	4.14	4.31	6.94	7.39
	Autumn	1.68	1.59	135.84	138.71	3.74	3.91	8.14	8.59
	Winter	1.55	1.66	138.98	142.23	4.33	4.49	8.40	8.85
Overall mean		1.60±0.52		145.11±13.87		4.38±6.20		8.58±1.63	
Main effect (mean+SD)									
Season	Summer	1.63^{a} ± 0.50		145.36^{a} ± 7.34		4.30^{b} ± 0.43		8.27^{c} ± 1.51	
	Autumn	1.59^{a} ± 0.48		146.21^{a} ± 13.68		4.24^{b} ± 0.58		8.75^{b} ± 0.95	
	Winter	1.62^{a} ± 0.47		144.61^{a} ± 7.67		4.72^{a} ± 0.55		9.05^{a} ± 1.01	
	Level of Significant	N.S		N.S		***		***	
Management System	Grazing Camels	1.60^{a} ± 0.41		150.76^{a} ± 5.77		4.60^{a} ± 0.48		8.28^{b} ± 0.88	
	Penned Camels	1.62^{a} ± 0.51		140.02^{b} ± 6.44		4.24^{b} ± 0.58		9.11^{a} ± 1.37	
	Level of Significant	N.S		***		***		***	
Physiological Status	Pregnant Camels	1.61^{a} ± 0.47		144.96^{a} ± 12.11		4.36^{a} ± 0.60		8.11^{b} ± 1.28	
	Non-pregnant Camels	1.62^{a} ± 0.49		145.83^{a} ± 7.30		4.45^{a} ± 0.52		8.95^{a} ± 1.10	
	Level of Significant	N.S		N.S		N.S		***	
Season*Management System		N.S		***		***		***	
Season*Physiological Status		N.S		N.S		N.S		N.S	
Manage. System*Physiological Status		N.S		***		***		***	
Season*Manage.System*Physiol.Status		N.S		N.S		N.S		:N.S	

a, b and c: means values within the same column having different superscripts, differ significantly.
N.S: not significant, ***: (P< 0.001).

There was an interaction between season and management type on Na^{+}, K^{+} and Ca^{++} while there was no an interaction between season and physiological status on these serum minerals. There was an interaction between management system and physiological status with regard to the Na^{+}, K^{+} and Ca^{++} while there was no an interaction between season, management system and physiological status on these serum minerals.

IV. Discussion

Animals registered significantly lower values for T_3 and T_4 during summer. The findings of the current study about T_3 and T_4 level were comparable to [11] and [15] who reported that T_3 and T_4 increased during winter compared to summer. Cold environment increases the secretion of thyrotrophic hormone, which results in a higher serum concentration of these hormones [16]. [10] reported that camel thyroid was inhibited in hot season due to dehydration; this inhibition assists in the preservation of body water by decreasing pulmonary water loss and reducing the basal metabolism. Similarly, [17] reported that during summer, T_4 levels fell gradually in dehydrated dromedary camels and increased after rehydration, whereas in winter, T_4 levels increased in dehydrated camels.

T_3 and T_4 increased in grazing camels than that measured in Penned camels. This may be attributed to movement stress caused more stimulation to thyroid gland for release these hormone and increases basal metabolism.

T_4 did not vary between non-pregnant camels and pregnant ones. This similar to the finding of [18] and [6] who found that T_4, did not change between pregnant and non-pregnant she camels.

Mg^{+} did not vary with the seasons. This result on Mg^{+} agrees to [19] who found that there was no effect of season on Mg+ level.

The overall mean of Mg^{+} is on line with that found by [12], [20], [21], [22] and [19].

The results showed that Na^{+} did not vary with the seasons. The result of Na^{+} was comparable with [23] who reported that Na^{+} did not vary with seasons but not on line with [19] and [24] who reported that Na^{+} level increased during summer. [24] attributed their result to the combined effect of both absorption and reabsorption of sodium and chloride from the alimentary tract and kidney, under the effect of aldosterone which show high level in summer and this was accompanied by an increase of plasma sodium level.

The overall mean of Na^{+} is comparable to that found by [12], [25], [21], [23], [22] and [19].

K^{+} level increased during winter than those observed during summer and autumn. The finding of K^{+} in this results comparable with that fund by [26] who found marked increases of K^{+} during winter, not on line with [19] who found K^{+} level was increased during summer compared to winter and [24] who found K^{+} level was increased during summer and spring. The decrease of potassium concentration during summer may be attributed to an increase of aldosterone secretion in hot and dry climate which was enhanced by renin-angiotensin system in response to changes in effective circulating fluid volume where aldosterone balance largely plasma potassium, through its effect on renal reabsorption of sodium in exchange for potassium and hydrogen ion [8].

The overall mean of K^{+} is comparable to that obtained by [12], [25], [21], [23], [22], and [19].

Mean value of Ca^{++} varied significantly with season; the highest value of Ca^{++} obtained during winter while the lowest value obtained during summer. This result in Ca^{++} agrees to [19] who reported that Ca^{++} level was increased during winter compared to summer, and [3] who observed marked increase in the concentration of serum Ca^{++} during autumn compared to summer, and not on line with [24] who found that the highest

value of calcium concentration of the dromedary she camels during summer. The rise in serum concentrations of calcium during the wet season can be attributed to the availability of plants rich in minerals during the rainy season [3] and [19]. Rainfall can affect the mineral composition of pasture herbage [27].

The overall mean of Ca^{++} is on line with that found by [12], [21], [22] and [26], and higher than that reported by [23] and [19].

Na^{+} and K^{+} significantly higher in grazing camels compared with the penned camels while Ca^{+} significantly lower in grazing camels compared with the penned ones. This result on Na^{+} and K^{+} agrees with [21] and [22] who found that K^{+} in grazing camels was higher than that found in penned camels and disagrees with their result that Na^{+} level was not different between grazing and penned camels.

The higher values for serum Na^{+} and K^{+} in free grazing camels compared with penned ones could be due to the free grazing camels graze on plants rich in this mineral [21] and [22] or/ and may be contaminated with the soil [21].

The results showed that Mg^{+}, Na^{+} and K^{+} did not vary with the physiological status, while Ca^{++} significantly higher in non-pregnant camels compared with pregnant ones. This result on Ca^{++} agrees with that found by [28] and [29] and disagrees with [30] who found there was no significant difference in Ca^{++} level due to pregnancy. The reduction of Ca^{++} in pregnant camels is attributing to the formation of the fetus bones.

The lack of published biochemical reference values for camel in Sudan makes it inevitable for both the researchers to establish their local reference values. At present, most of the comparisons are being made either with the that values obtained in other countries of the world which are internationally famous for having camel as a major part of their livestock; or with values given in certain text books [31] and [32] which provide a ready reference. However the observed values obtained in this study were within the normal values range reported previously by other researchers and compiled by [31] and [32].

The slight variation observed between the present study and earlier researchers may be attributed to many factors such as interlabrotory variation, size of samples, geographical location, quality and quantity of pasture and availability of water. Some of the differences can be explained by seasonal, nutritional and managemental factors and by the effects of age, sex, rut and stage of pregnancy.

V. Conclusions

Animals registered significantly lower values for T_3 and T_4 during summer. T_3 and T_4 values obtained by the grazing camels were higher than those obtained by the penned ones. The pregnancy increased level T_3 and did not affect T_4.

The season had no effect on Mg^{+} or Na^{+}. During winter, there were high levels of K^{+} and Ca^{++}. The macro mineral (Na^{+}, K^{+}, Ca^{++}) in camel serum varied significantly with the management system. Grazing camels registered higher values for Na^{+} and K^{+}, while penned one registered higher values for Ca^{++}. Pregnant animals registered significantly lower Ca^{++} concentration.

All the obtained values in this study were within the normal values range.

VI. Recommendation

Animal owners should be aware, through extension, to the importance of minerals for the herd health, production and reproduction.

Soil and plant of the grazing area should by analyze for minerals.

These findings and previous data could be used as a database for Sudanese camels' improvement.

References

[1] I. A. Ishag, M. O. Eisa, and M. A. Ahmed, "Effect of breed, sex and age on body measurements of Sudanese camels (*Camelus dromedarius*)". *Australian J. of Bas. and App. Sci*., vol. 5, 6, 311-315, 2011.

[2] J. H. G. Lebon, "Land Use in Sudan". *World land use survey monograph 4th*. Bude Publishing, Cornwall, UK, 1956.

[3] A. S. A. Amin, K. A. Abdun, and A.M. Abdelatif, "Seasonal variation in blood constituents of one-humped camel (*Camelus dromedaries*)". *Paki. J. Bio. Sci.*, vol.10, 8, 1250-1256, 2007.

[4] W. M. Hashim, M. Y. Galal, A. M. Ali, I. K. Abdelmalik, S. A. Hamid, and S.A. Salah Eldein, "Dromedary camels in Sudan, types and sub types, distribution and movement". *Inter. J. of Pharm. Rres. and Analy*., vol. 5, 1, 8-12, 2015.

[5] K.A. Al-Busadah, "Some biochemical and haematological indices in different breeds of camels in Saudi Arabia". *Sci. J. of King Faisal University* (*Basic and Applied Sciences*)., vol. 8, 1, 14-28, 2007.

[6] A. Omidi, Z. Sajedi, M. B. Montazer, and M. Mostafai, "Metabolic profile of pregnant, non-pregnant and male two-humped camels (*Camelus bactrianus*) of Iran". *Iranian J. of Vet. Med*., vol. 10, 3, 354-360, 2014.

[7] F. Aziz Khan, S. K. B. Patil, and A. S. Thakur, "Lipid profile in thyroid dysfunction". *J. Clin. Anal. Med*., vol. 5, 12-14, 2014.

[8] J. J. Kaneko, "Clinical Biochemistry of Domestic Animals3Ed", Academic Press New York, London – Toronto, Sydeny and San Francisco.

[9] M. Mohebbi-Fani, S. Nazifi, and E. Rowghani, "Thyroid hormones and their correlations with serum glucose, beta hydroxybutyrate, nonesterified fatty acids, cholesterol and lipoproteins of high-yielding dairy cows at different stages of lactation cycle". *Comp. Clin. Path*., vol. 18, 3, 211-216, 2009.

[10] R. E. Yagil, and J. Gannani, "Camel thyroid metabolism: effect of season and dehydration". *J. Appl. Physiol*., vol. 45. 540–544, 1978.

[11] S. Nazifi, H. R. Gheisari, and H. Poorabbas, "The influence of thermal stress on serum biochemical parameters of dromedary camels and their correlation with thyroid activity". *Comp. Haem. Inter*., vol. 9, 49–54, 1999.

[12] T. E. A. Osman, and K. A. Al-Busadah, "Normal concentration of twenty serum biochemical parameter of she-camels, cows and ewes in Saudi Arabia". *Pakistan. J. Biol. Sci.*, vol. 6, 1253-1256, 2003.

[13] F. J. Fernandez, and H. L. Khan, "Clinical methods for atomic absorption spectroscopy". *Clin. Chem. Neurol*., vol. 3, 24-34, 1971.

[14] T. P. Wooton, "Plasma Sodium and Potassium Microanalysis". *In: Medical Biochemistry 5th Ed*. Press. London. 62-62, 1974.

[15] T. Javad, S. Alireza, H. Seyed, and R. Aria, "Serum concentrations of thyroid hormones, cholesterol and triglyceride, and their correlations together in clinically healthy camels (*Camelus dromedarius*): Effects of season, sex and age". *Vet. Res. Forum*., vol. 4, 4, 239–243, 2013.

[16] P. Prakash, and V. S. Rathore, "Seasonal variations in blood serum profiles of triiodothyronins and thyroxine in goat". *Ind. J. Anim. Sci*., vol. 61, 12, 1311-1312, 1991.

[17] D. Khanna, S. P. Agarwal, and M. L. Gupta, "Effect of water deprivation during summer and winter on thyroid hormones concentration in the Indian camel". *Ind. J. Anim. Sci*., vol. 66, 3, 253-255, 1996.

[18] H. Rahman, M. AraChowdhury, and M. TowhidulAlam, "Serum Thyroxin and Triiodothyronine Levels in Normal Pregnancy and Pre-eclampsia". *J. Teach. Assoc*., vol. 20, 6-10, 2007.

[19] [A. Ahmed, M. Belhadia, and H. Aggad, "Mineral indices in Algerian camels (*Camelus dromedarius*): effect of season". *Cam. Inter. J. of Vet. Sci*., vol. 1, 1, 29-36, 2013.
[20] S. A. AL-Sultan, "Studies of some normal biochemical parameters of majaheem breed of camel (*Camelus dromedarius*) in Saudi Arabia". *J. of Anim. and Vet. Adv*., vol. 12, 2, 646-647, 2003.
[21] S. M. Barakat, I. Y. Turkey, S. M. El Bashir, S. A. Ali, and S. A. Omer, "Comparison of some blood constituents in pennedand grazing camels (*Camelus dromedarius*) in Sudan". *J. of Sci. and Tech*., vol. 8, 2, 21-26, 2007.
[22] S. A. AL-Shami, "Comparative Determination of Serbiochemical Constituents In-door and Free Grazing Camels". *J. of Anim. and Vet. Adv*., vol. 8. 5, 898-909, 2009.
[23] A. K. Mohammed, A. K. Sackey, L. B. Tekdek, and J. O. Gefo, "Serum Biochemical Values of Healthy Adult One-humped Camel (*Camelus dromedaries*) Introduced into a sub-humid Climate in Shika-zaria, Nigeria". *J. of Anim. and Vet. Adv*., vol. 6, 5, 597-600, 2007.
[24] M. A. El-Harairy, A. E. Zeidan, A. A. Afify, H. A. Amer, and A. M. Amer, "Ovarian Activity, Biochemical Changes and Histological Status of the Dromedary She-camel as Affected by Different seasons of The Year". *J. Nat. and Sci*., vol.8, 5, 54-65, 2010.
[25] O. A. Al-Sagair, S. I. Fathalla, and H. A, Abdel-Rahman, "Reference Values and Age-related Changes in Cerebrospinal Fluid and Blood Components in The Clinically Normal Male Dromedary Camel". *J. of Anim. and Vet. Adv*., vol. 4, 4, 467-469, 2005.
[26] E. A. Babeker, Y. H. A. ElMansoury, and A. E. Suleem, "The Influence of Seasons on Blood Constituents of Dromedary Camel (*camelus dromedarius*)". *J. of Anim. and Feed Res*., vol. 3, 1, 1-8, 2013.
[27] P. McDonald, R. A. Edwards, J. F. D. and Greenhalp, "Animal Nutrition 5th Ed". *Longman Scientific and Technical*. UK, 1995.
[28] A. Saeed, I. A. Khan, and M. M. Hussein, "Change in Biochemical Profile of Pregnant Camels (*Camelus dromedaries*) at Term". *Comp. Clinic. Path*., vol. 18, 139-143, 2009.
[29] B. F. Muhammad, D. Aliyu, A. A. Njidda, and I. L. Madigawa, "Some Haematological, Biochemical and Hormonal Profile of Pregnant and Non-pregnant She-camels (*camelus dromedarius*) Raised in a Sudan Savanna zone of Nigeria". *J. of Cam. Pr. and Res*., vol. 18, 1, 73-77, 2011.
[30] A. Sarwar, M. A. Majeed, G. Hur, and I. R. Khan, "Two Transferases and Four Electrolytes in Normal One-humped Camel Serum". *J. of Cam. Sci*., vol. 1, 1, 57-61, 2004.
[31] A. J. Higgins, and R. A. Kock, "A guide to The Clinical Examination, Chemical Restraint and Medication of The Camel". *In: The Camel in Health and Disease*. Bailliere Tindall, London, 21 – 40, 1986.
[32] N. C. Jain, "Essentials of Veterinary Hematology 2nd Ed". Lea and Febiger; Philadelphia, USA, 65-68, 1998.