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Post-Partum Hematological, Biochemical, Mineral And Hormonal Changes In Blood Of Maghrebian She-Camels With Different Parity Orders Under Egyptian Condition

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Abstract: *The aim of this study was to evaluate the effect of parity on some hematological, biochemical, mineral and hormonal parameters from the last 2 months of gestation up to 4 months post-partum in blood of Maghrebian She-Camels with different parities during breeding season under Egyptian condition. Total of 21 pregnant camels in late pregnancy were divided into 3 experimental groups (7 in each) according to parity order and age as the following: G1 (1-3 parities), G2 (4-6 parities) and G3 (7-9 parities). Blood plasma samples were collected at the beginning of 2 and 1 month before calving, at calving and end of 1, 2 and 3 months after calving to determined some hematological, biochemicals, mineral, hormonal parameters in blood plasma. Results showed that overall mean of all hematological parameters packed cell volume, hemoglobin concentration and count of red and white blood cells, uric acid concentration, K, Ca, P and Mg contents, E2 concentration decreased (P<0.05), while concentration of total proteins (TP), albumin (AL), globulin (GL), urea, creatinine, cholesterol and triglycerides, activity of AST and ALT, Na contents, and leptin concentration increased (P<0.05) in G3 (7-9 parities) than in G1 (1-3 parities). However, AL: GL ratio, glucose concentration, LDH activity and P4 concentration were not affected by camel parity. These results indicated slight changes in blood composition by increasing camel parity more than three parities, while remarkable changes in all parameters studied by advancing camel parity more than 6 parities. Also, there was trend of change in these parameters at different pre- and post-partum months.*
In conclusion, these results may be utilized as references for she-camels during different reproductive statuses, which may form a useful baseline for future research in this field and may have a key part in assessing the metabolic status in late pregnant and early lactating she-camels.

Keywords: *She-camel, hematology, blood biochemicals, leptin, parity, breeding season.*

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I. Introduction

Blood, as a mirror of the beings health, is a basis for several metabolic processes of the body and reflect the status of the organs of the body and health, hence production of the animal. Blood biochemical composition is considered an important advice in relation to the health status of the camel (**Momenah, 2014**). Hematological and biochemical assay of blood can regularly provide information regarding health and sickness of animals. Consequently, the study of blood composition is critical for assessing the health and the physiological status of animals (**Omidi *et al.*, 2014**).

Leptin is a 16kDa hormone that is essentially secreted by white fat tissue of camels (**Al-Azraqi 2007)**. Leptin and its receptor were expressed by fat tissue, mammary alveolar epithelial cells, liver hepatocytes, and the covering epithelium of the bile conduit of the one-bumped camel (**Sayed-Ahmed *et al.*, 2005**). Plasma leptin level was emphatically associated with plasma levels of insulin and glucose, and contrarily correlated with plasma levels of growth hormone and non-esterified fatty acids **(Block *et al.*, 2001**). In the youthful camel, leptin has been emphatically identified with back-fat thickness (**Al-Azraqi, 2007**) and differentially influenced by season in capacity of sex without clear relation to insulin or glucose regulation (**Al-Suhaimi *et al.*, 2009**). Leptin plays an important role in regulating hunger and satiety, enabling the upkeep of ordinary weight (**Popovic and Casanueva, 2002**).

Dromedary camels are characterized by a seasonal activity and as induced ovulators. Reproductive physiology of Arabian dromedary camels has gotten little interest compared to other animal species, especially in relation with changes in blood omposition **(Zarrouk *et al.*, 2003**). Changes in several biochemical compositions have been reprimanded for reproductive disappointments. In Egypt, only limited data on serum biochemistry and hematology of one humped camel are available in the literature (**Osman and Al-Busadah, 2000**). Additionally, the role of leptin in she-camel is as yet obscure; there is little data about the blood leptin in

she-camels and there is no data about the connection of blood leptin level with concentration of cholesterol, triglycerides **as** lipid profile (**(Park *et al.,* 2010**).

On the other hand, effect of parity order on hematological and biochemicals parameters and enzyme activity in blood of ewes (**Anwar *et al.* (2012**), mineral contents in (**Mamun *et al.,* 2013**) and biochemicals concentration **(Elgabbani, 2007**) in blood of dairy cows were studied. Level of leptin was investigated in primiparous than in multiparous cows **(Meikle *et al.,* 2004**) and as affected by number of parity in cows **(Hussein, 2010**). However, effect of age on hematology in camels was studied by **Saeed and Hussein (2008)**. Therefore, the current work aimed to study changes in hematological and biochemical constituents, mineral content, enzyme activity, and reproductive hormones and leptin concentrations in blood of Maghrabian she-camels with different parities.

II. Materials And Methods

This study was carried out at Center of Studies and Development of Camel Production, belonging to Animal Production Research Institute, Agricultural Research Center, Marsa Matrouh Governorate, Egypt, during the breeding season.

Animals:

Twenty one Maghrebian She-camels at the last two months of pregnancy having 420-596 kg live body weight, 5-17 years old and 1-9 parities were used in this study. Animals were divided based on order of parity into three experimental groups (7 animals in each). Animals had 1-3 parities and 5-9 years in the 1st group (G1), 4-6 parities and >9-13 years in the 2nd group (G2) and 7-9 parities and >13-17 years in the 3rd group (G3). She-camels were hand milked twice daily after born calves were allowed to suckle colostrum from their dams for the first seven days.

Feeding system:

Animals in all groups were fed a daily basal diet consisting of 3.5 kg concentrate feed mixture (CFM), 2.5 kg berseem hay (BH) and 2.5 kg rice straw (RS) per animal. The CFM used in feeding all the experimental animals was composed of 25% wheat bran, 25% yellow corn, 9% uncorticated cotton seed meal, 20% barely, 15% rice brain, 3% molasses, 2% premix and 1% common salt. Feeds were offered to animals in all groups twice daily, while drinking water was offered all day time. Chemical analysis of CFM, BH and RS are shown in Table (1).

Table 1: Chemical analysis (on DM basis) of different feed stuffs of the basal diet used in feeding She-camels in all groups.

Item	**CFM**	**BH**	**RS**
DM (%)	89.44	88.91	88.46
Chemical analysis (%):			
OM	92.43	82.92	82.24
CF	8.85	24.91	35.69
CP	12.24	13.85	2.53
EE	4.64	1.14	1.52
NFE	66.70	43.02	40.50
Ash	7.57	17.08	19.76

CFM: Concentrate feed mixture. BH: Berseem hay. RS: Rice straw.

Blood sampling:

Blood samples were collected from the jugular vein of each animal, before morning feeding and water offering, at beginning of each of the 2nd and 1st month of pre-partum period, calving and end of the 1st, 2nd and 3rd month post-partum period. Blood samples were withdrawn into two heparinized tubes, one for hematological parameters in fresh whole blood and another for separation of blood plasma. Blood plasma was obtained from heparinized tubes by centrifugation at 3000 rpm for 15 min, and then stored at -20 ^{o}C for further analyses.

In fresh whole blood samples, hematological parameters, including count of red (RBCs) and white (WBCs) blood cells, packed cell volume (PCV %) and hemoglobin (Hb) concentration were performed according to **Schalm *et al.* (1975**). However, concentration of total proteins (**Armstrong and Carr 1964**), albumin **(Drupt, 1974**), glucose (**Trinder, 1969**), urea, creatinine and uric acid (**Fawcatt and Scott, 1960**), cholesterol **(Kostner *et al.,* 1979**) and triglycerides **(Schalm *et al.,* 1975**) as well as activity of asprtate (AST) and alanine (ALT) aminotransaminase **(Reitman and Frankel, 1957**), and lactic dehydrogenase (LDH, **Keiding *et al.,* 1974**), were determined in blood plasma. Globulin concentration was calculated.

Plasma levels of macro minerals, including sodium (Na), potassium (k), calcium (Ca), inorganic phosphorus (P) and magnesium (Mg) were determined in the Laboratory of Chemistry and Hormones at the Animal and Poultry Health Research Institute, Agricultural Research Center, Ministry of Agriculture.

Direct radioimmunoassay technique was performed for determination of progesterone (P4) and estradiol-17β in representative plasma samples. Commercial kits (Diagnostic Products Corporation, (DCP) Los Angles, USA) with ready antibody coated tubes were used according to the procedure outlined by the manufacturer. However, Camel leptin Cat.No: (MBS091173) was assayed using Quantitative Sandwich ELISA kit (MyBioSource.com) at Animal Health Research Institute. The detection range was from 0.5 to16 ng/ml.

Statistical analysis:

Data were statistically analyzed using the General Linear Model (GLM) procedure of the Statistical Analysis System **(SAS, 1999)**. Data obtained were tested by analysis of variance with one way design to test the parity group differences at each sampling time or during all pre- and post-partum months according to the following model: $Y_{ij} = \mu + P_i + e_{ij}$ where: Y_{ij}= observed values, μ= overall mean, P_i= experimental group and e_{ij}= Random error. Values were given as mean± standard error. The significant differences among groups were subjected to **Duncan's Multiple Range Test (1955)**.

III. Results And Discussion

Hematological parameters:

Data presented in Table (1) revealed insignificant effect of animal parity on all hematological parameters studied, packed cell volume (PCV%), hemoglobin concentration (Hb) as well as count of red (RBCs) and white (WBCs) blood cells at each month of pre- and post-partum period. However, overall mean, PCV, Hb concentration, and RBCs and WBCs counts significantly ($P<0.05$) increased by advancing parity, being the highest in G1 and the lowest in G3.

Results showed interrelation between each of hematological parameter studied, whereas increasing count of cellular contents (RBCs and WBCs) increased PCV value, consequently increasing Hb concentration within RBCs, in turn improving animal health. It is worthy noting that the relationship between PCV and RBCs count may be attributed to an expansion in RBC volume by increasing water in blood plasma **(Kataria *et al,* 2002)**. The present values of PCV at all parities were lower, while RBCs count was higher than those reported in camels by **Saeed and Hussein (2008).** It was reported that RBCs count was higher in camels than in other species, because of the smaller elliptical cells pack tighter in the camel **(Khalid and Al-Busadah, 2007).**

Variation due to parity is a signal of the health status of differences in age groups of she-camels. In this respect, **Ayoub *et al.* (2003)** observed that WBCs count in young camels was typically higher than those of grown-up. They ascribed that to the higher number of band cells, neutrophils, eosinophils, basophils and monocytes in younger camels. Also, **Dessouky (2006)** found that WBCs count declined with age in the camel, as these cells rise in suckling calves in comparison with weaning calves and lactating she-camels. This finding may be explained by that higher WBCs count is required in early period of life to give better defense capabilities **(Saeed *et al.*, 1995)**. In consistent with the obtained results in camels, **Anwar *et al.* (2012)** indicated that PCV value was lower in the 6th than in the 1st to 5th parity, and also Hb concentration was lower in the 6th parity than in the 3rd, 4th and 5th parity in sheep. Contrarily, **Saeed and Hussein (2008)** reported that RBCs count was not influenced by age of camel.

Table (1): Hematological measurements of she-camels in different experimental groups during pre- and post-partum months.

Item	Group	Pre-partum period		At calving	Post-partum period			Overall means
		2nd month	1st month		1st month	2nd month	3rd month	
PCV (%)	G1	33.23±0.36	31.36±0.32	31.54±0.38	31.91±0.74	31.44±0.66	31.64±0.79	31.85±0.29^{a}
	G2	32.77±0.46	31.04±0.58	31.24±0.59	31.51±0.99	31.06±0.72	31.23±0.88	31.48±0.27^{a}
	G3	31.94±0.66	30.34±0.38	30.41±0.42	30.51±0.27	30.37±0.34	30.51±0.42	30.68±0.25^{b}
Hb (g/dl)	G1	12.01±0.47	10.89±0.41	11.01±0.41	11.10±0.41	10.86±0.22	10.97±0.36	11.14±0.18^{a}
	G2	11.79±0.45	10.69±0.45	10.81±0.60	10.93±0.40	10.64±0.33	10.74±0.40	10.93±0.17^{ab}
	G3	11.26±0.38	10.29±0.26	10.56±0.40	10.51±0.32	10.26±0.39	10.29±0.45	10.53±0.18^{b}
RBCs (x10^{6}/m m^{3})	G1	3.84±0.21	3.91±0.23	3.67±0.29	3.74±0.26	3.69±0.24	3.71±0.31	3.76±0.11^{a}
	G2	3.61±0.22	3.49±0.23	3.24±0.23	3.32±0.24	3.28±0.30	3.37±0.37	3.39±0.12^{ab}
	G3	3.48±0.19	3.14±0.38	2.90±0.33	2.99±0.34	2.94±0.19	3.17±0.37	3.11±0.27^{b}
WBCs (x10^{3}/m m^{3})	G1	3.74±0.20	3.99±0.25	4.21±0.20	4.01±0.16	4.13±0.20	4.16±0.18	4.04±0.12^{a}
	G2	3.59±0.14	3.84±0.15	4.14±0.17	3.99±0.17	4.07±0.18	4.11±0.23	3.96±0.09^{a}
	G3	2.97±0.37	3.19±0.38	4.09±0.26	3.37±0.43	3.44±0.45	3.37±0.47	3.41±0.15^{b}

Means with different small letters in the same column with different capital letters in the same column for each parameter are significantly different at P<0.05.

Results also showed that PCV value and Hb concentration in all groups decreased during the last 2 months of pre-partum period, then showed insignificant changes at calving and post-partum months, while count of WBCs increased at calving as compared to pre-partum, but showed insignificant increase at post-partum months. However, RBC count showed slight changes at pre- and post-partum months in all parity groups

(Table 1). In the same line, **Nazifi *et al.* (2008)** demonstrated that PCV value and Hb concentration were significantly higher in pregnant than in the postpartum cows. In comparable with the present results, PCV values were less in the last month of pregnancy when comparable with the 1st month after delivery in camels **(Saeed and Hussein (2008)** and in ewes (**Anwar *et al.*, 2012).** Also, RBCs count was higher, while WBCs count was lower in the last 3 weeks before parturition than in 3 weeks after natal. However, less PCV values were observed in both of early and last when comparable with mid of pregnancy stage in cows (**Manzoor *et al.*, 2008).** The changes in the hematological parameters were likely because of the pregnancy stress and glucocorticoid release (ACTH) from the adrenal gland **(Nazifi *et al.*, 2008)**.

Blood plasma biochemicals:

Total proteins and their fraction:

Concentrations of total proteins (TP), albumin (AL) and globulin (GL) in blood plasma of she-camels were significantly (P<0.05) higher in G3 than in G1 and G2 at each month of pre- and post-partum period and as overall mean for the whole experimental period. This trend of change in TP and their fractions indicated that increasing TP concentration was attributed to increasing in AL and GL concentrations by advancing parity, which reflected insignificant increase in AL: GL ratio at each month or as overall mean (Table 2). The present results indicated significant increase in plasma concentration of TP and their fractions by increasing she-camels more than 6 parities.

Both TP and AL are markers of hepatic function and decline in their concentration may suggest imply fat infiltration into the liver **(Bobe *et al.*, 2004)**. The AL has the water pulling in holding property and higher incentive in camel likely show particular adjustment for the desert environment **(Salman and Afzal, 2004)** and it is a pointer of liver function whose low focus is ascribed to greasy liver illness in dairy cattle **(Faramarzian *et al.*, 2016)**.

Table (2): Concentration of total proteins and their fraction in blood plasma of she-camels in different experimental groups during pre- and post-partum months.

Item	Group	Pre-partum period		At-calving	Post-partum period			Overall means
		2nd month	1st month		1st month	2nd month	3rd month	
TP (g/dl)	G1	6.54±0.29^{b}	6.74±0.32^{b}	5.73±0.28^{b}	6.14±0.22^{b}	6.26±0.29^{b}	6.34±0.28^{b}	6.29±0.12^{b}
	G2	6.67±0.18^{b}	6.81±0.27^{b}	5.96±0.33^{b}	6.29±040^{b}	6.37±0.38^{b}	6.56±0.42^{b}	6.44±0.14^{b}
	G3	7.79±0.13^{a}	7.70±0.15^{a}	7.52±0.14^{a}	7.62±0.10^{a}	7.77±0.26^{a}	7.80±0.13^{a}	7.70±0.06^{a}
AL (g/dl)	G1	3.16±0.25	3.26±0.26^{b}	2.97±0.26^{b}	3.11±0.25^{b}	3.26±0.30^{b}	3.39±0.20^{b}	3.19±0.14^{b}
	G2	3.23±0.34	3.34±0.12^{b}	3.04±0.25^{b}	3.17±0.21^{b}	3.31±0.33^{b}	3.43±0.14^{b}	3.25±0.06^{b}
	G3	3.99±0.34	4.07±0.28^{a}	3.93±0.29^{a}	4.14±0.24^{a}	4.22±0.21^{a}	4.24±0.34^{a}	4.10±0.11^{a}
GL (g/dl)	G1	3.39±0.31	3.49 ±0.38	2.76±0.34	3.03±0.24	3.14±0.42	2.96±0.18	3.13±0.12^{b}
	G2	3.44±0.40	3.47±0.22	2.91±0.43	3.11±0.42	3.06±0.42	3.13±0.36	3.19±0.17^{b}
	G3	3.80±0.43	3.63±0.42	3.59±0.32	3.48±0.22	3.55±0.32	3.56±0.33	3.60±0.10^{a}
AL:GL ratio	G1	0.99±0.11	1.06±0.23	1.25±0.25	1.10±0.18	1.46±0.44	1.16±0.09	1.17±0.10
	G2	1.08±0.22	0.99±0.06	1.36±0.44	1.19±0.25	1.25±0.22	1.21±0.17	1.18±0.08
	G3	1.26±0.32	1.32±0.30	1.22±0.25	1.24±0.14	1.27±0.17	1.31±0.23	1.27±0.07

Means with different superscripts in the same column for each parameter are significantly different at P<0.05.

In accordance with the present results in camel, **Anwar *et al.* (2012)** found that concentrations of TP in the 1st, 2nd and 3rd parity, AL concentration in the 1st and 4th parity, and GL concentration in the 1st, 2nd, 3rd and 4th parity were lower than in the 6th parity in sheep. In this respect, **Roubies *et al.* (2006)** indicated that mean concentrations of TP, AL and GL were lower in lambs than in older ewes. Also, **Mamun *et al.* (2013)** revealed that TP concentration declined at the rise of age in cattle. In one humped camel, **Sarwar *et al.* (1992)** reported insignificant effect of age on serum levels of TP in calves and their dams. The variation in plasma TP might represent an adaptive reaction to higher need of water mobilization and protein by blood to mammary glands for milk synthesis **(Anwar *et al.*, 2012)** by increasing camel parity.

Regarding the observed change in TP and their fractions during pre- and post-partum months, TP, AL and GL concentrations showed slightly higher at pre- than at post-partum months, being the lowest at calving. However, AL: GL ratio increased at pre- than at post-partum months, being the highest at calving (Table 2).

This trend is in agreement with **Roubies *et al.* (2006)**, who found that GL concentration in ewes was higher in the last 2 months of gestation compared to 4 months postpartum. The observed reduction in GL concentration after calving may be due to selective uptake of immunoglobulin by the mammary glands. Although **Tharwat *et al.* (2015)** demonstrated that post-partum concentration of AL decreased, while GL concentration increased when compared to 3 weeks pre-natal in camel, the reduction in TP concentration in post- than in pre-partum months in camel in our study may be due to that high degree level of GL transfer to the mammary glands in she-camels **(Saeed *et al.*, 2009)**.

Glucose, protein metabolites and lipid profile:

Effect of animal parity on glucose concentration was not significant at different pre- and post-partum months and as overall means (Table 3). Similarly in cows, **Elgabbani (2007)** found that serum glucose concentration during first and fourth parities did not show significant differences. However, **Anwar *et al.* (2012)** found that glucose concentration was higher in the 6th parity than in all previous parities (1-5 parities) in sheep.

Protein metabolites, including urea, creatinine and uric acid concentrations, and lipid profile, in terms of cholesterol and triglycerides concentrations, were the highest in G3, moderate in G2 and the lowest in G1, but the differences were significant ($P<0.05$) only in concentration of urea in 3rd post-partum month and as overall, creatinine, in 1st pre-partum, 2nd and 3rd post-partum months and as overall, uric acid in 2nd pre-partum month and as overall, cholesterol in 2nd pre-partum month, 2nd and 3rd post-partum months and as overall, and triglycerides in 2nd pre-partum month, 1st, 2nd and 3rd post-partum months and as overall mean (Table 3). These results may indicate increasing protein and lipid metabolism by advancing she-camel parity more than 6 parities.

In accordance with the present results, **Mamun *et al.* (2013)** revealed that uric acid levels were higher by increasing age in cattle. **Ivan *et al.* (2016)** observed that triglycerides level increased in multiparous as compared to primiparous cows. **Anwar *et al.* (2012)** found that concentration of cholesterol concentration was lower in the 1st, 2nd and 3rd parity than in the 5th parity in sheep. In contrast to the present results on camel, **Cozzi *et al.* (2011)** found that creatinine concentration was higher in primiparous than in multiparous cows. **Ivan *et al.* (2016)**, who demonstrated that cholesterol level decreased in multiparous as compared to primiparous cows.

Table (3): Concentration of some biochemicals in blood plasma of she-camels in different experimental groups during pre- and post-partum months.

Item	Group	Pre-partum period		At-calving	Post-partum period			Overall means
		2nd month	1st month		1st month	2nd month	3rd month	
Glucose (mg/dl)	G1	84.86±1.08	86.14±1.92	81.57±2.07	82.86±2.04	83.43±2.25	84.14 ±2.92	83.83±0.99
	G2	85.86±1.72	86.29 ±1.86	82.43±2.54	83.29±1.15	84.43 ±2.53	85.29 ±1.85	84.59±0.10
	G3	87.14±1.35	89.29 ±2.72	83.71±1.81	84.14±2.13	85.86 ±2.37	86.29 ±3.12	86.07±0.84
Urea (mg/dl)	G1	43.86±1.50	48.14±0.55	45.71±1.57	46.57±1.34	47.29±1.49	47.57 ± 1.09^{b}	46.52 ± 0.63^{b}
	G2	45.86±1.83	49.29±0.99	46.71±1.19	47.57±1.21	48.14±1.18	48.7 ± 0.68^{ab}	47.71 ± 0.58^{b}
	G3	48.43±1.21	50.29±1.44	48.86±0.55	49.71±1.09	49.86±1.01	50.29 ± 0.68^{a}	49.57 ± 0.47^{a}
Creatinine (mg/dl)	G1	0.91±0.08	0.97 ± 0.08^{b}	0.91±0.17	0.86±0.08	0.83 ± 0.05^{b}	0.79±0.10	0.88 ± 0.04^{b}
	G2	1.10±0.18	1.13 ± 0.13^{ab}	0.98±0.15	0.96 ±0.17	0.92 ± 0.10^{b}	0.90±0.10	1.00 ± 0.08^{b}
	G3	1.30±0.17	1.48 ± 0.19^{a}	1.41±0.20	1.35±0.19	1.31 ± 0.20^{a}	1.22±0.19	1.35 ± 0.14^{a}
Uric acid (mg/dl)	G1	8.99 ± 0.28^{b}	9.96±0.13	8.94±0.36	9.01±0.34	9.29±0.12	9.34±0.13	9.26 ± 0.16^{b}
	G2	9.44 ± 0.36^{ab}	10.41±0.23	9.60±0.36	9.71±0.32	9.89±0.43	9.94±0.41	9.83 ± 0.15^{a}
	G3	10.20 ± 0.29^{a}	10.59±0.30	9.59±0.28	9.77±0.34	9.96±0.32	10.13±0.28	10.04 ± 0.19^{a}
Cholesterol (mg/dl)	G1	125.71 ± 1.66^{b}	120.71±2.79	112.43±3.56	118.29±3.54	122.14 ± 1.72^{b}	127.14 ± 1.32^{c}	121.07 ± 2.18^{c}
	G2	128.43 ± 1.80^{ab}	123.57±3.72	116.43±5.59	123.14±4.01	128.43 ± 3.26^{ab}	135.14 ± 2.34^{b}	125.86 ± 2.59^{b}
	G3	133.29 ± 1.46^{a}	128.43±2.32	123.29±2.48	129.71±1.17	133.29 ± 1.51^{a}	142.14 ± 0.80^{a}	131.69 ± 2.58^{a}
Triglycerides (mg/dl)	G1	105.71 ± 2.47^{b}	103.57±1.34	98.43±1.54	99.14 ± 1.87^{b}	100.71 ± 1.51^{b}	102.43 ± 1.36^{c}	101.67 ± 1.13^{c}
	G2	109.14 ± 3.29^{ab}	106.29±3.72	102.43±1.23	103.86 ± 1.42^{ab}	105.71 ± 1.94^{a}	108.14 ± 0.96^{b}	105.93 ± 1.24^{b}
	G3	115.43 ± 1.73^{a}	112.71±2.83	105.71±2.88	108.43 ± 2.36^{a}	110.14 ± 1.37^{a}	113.43 ± 2.44^{a}	110.98 ± 1.46^{a}

Means with different superscripts in the same column for each parameter are significantly different at $P<0.05$.

Results also showed that glucose concentration increased the last month of gestation, then decreased to the lowest values at calving and increased during post-partum months (Table 3). The difference in glucose focus amongst pre- and post- natal periods uncovers the consumption of glucose by fetus and milk yield **(Ramin *et al.*, 2007)**. Similar to the present trend of change in glucose of camels, **Ashmawy (2015)** demonstrated that plasma glucose concentration increased during last period of pregnancy, while declined at early lactation stage in Egyptian buffaloes. Also, **Anwar *et al.* (2012)** found that glucose level increased during last pregnancy period when compared to period for up to 4 months after lambing in ewes. However, **Gürgöze *et al.* (2009)** reported that glucose concentration was lower in the last period of gestation when as compared to postpartum period, being significantly higher in 14 d after natal when compared to 21 and 120 d of gestation in sheep.

It is of interest to note that concentration of urea, creatinine and uric acid increased at the 1st as compared to the 2nd month pre-partum, decreased at calving and then increased during post-partum months. However, concentration of cholesterol and triglycerides was higher pre- than post-partum months, being the lowest at calving (Table 3).

In harmony with the present results, **Gürgöze *et al.* (2009)** mentioned that creatinine concentration in ewes was higher during last two months of gestation than for up to 4 months after natal. In cows, **Ivan *et al.* (2016)** found that cholesterol and triglycerides concentrations were higher during last gestation than that at post-partum months. Also, **Turk *et al.*, 2013)** observed a gradual increase in serum triglycerides level occurred during late month of gestation when compared with 2 months after parturition.

Blood urea concentration was reported to be higher in camel than in other species to give the ability of camels to use urinary nitrogen during grazing or deprivation of poor water **(Khalid and Al-Busadah, 2007)**. Increasing urea concentration at pre- as compared to post-partum months may be due to the consolidated pre-renal impacts of diminished implantation with lower glomerular filtration and most prominent load because of expanded metabolic activity **(Abdul-Rahaman *et al.*, 2015)**. Creatinine is one of the biochemical markers that permit to monitor the kidney condition**(Gwaze *et al.*, 2010)**, while uric acid is an essential metabolic result of protein metabolism **(Eggum *et al.*, 1982)**, Rise levels of creatinine in blood serum are regularly seen on account of dysfunction of kidneys, to be specific lessened filtration, stun or poison ingestion, and muscle catabolism **(Gwaze *et al.*, 2010).** The rise observed in creatinine at pre-partum as compared to post-partum months in our study may be due to development of the fetal musculature **(Roubies *et al.*, 2006)** and/or could be thus of higher protein needs and this is related with late stage of gestation might be due to the lower rate of kidney disposal **(Omidi *et al.*, 2014**). The rise cholesterol concentration at last of gestation is most likely due to the increased needs of the fetus for growth and development, and also the need of the ovaries for synthesis of steroid hormones **(Turk *et al.*, 2013)**. Blood triglycerides concentration is a critical source of long chain fatty acid for milk synthesis which explains significant triglyceride diminishes at the onset of lactation **(Kessler *et al.*, 2014).** Moreover**,** triglycerides are an indicator of lipids profile in the blood and considered as a very important group of fat in the blood, which is the main component of very low fat proteins in addition to chylomicrons, and is manufactured in the liver where it is stored until it is used as an energy source. They play an important role in the transport of dietary fats (**Bagnicka *et al.*, 2014).**

Enzyme activity:

Activity of AST at each of pre- and post-partum months was not significant, but ALT activity was significantly (P<0.05) the highest in G3, moderate in G2 and the lowest in G1 at all pre- and post-partum months, except at the 1st month post-partum. However, overall mean of AST and ALT activities were significantly (P<0.05) the highest in G3, moderate in G2 and the lowest in G1. On the other hand, LDH activity was not affected significantly by camel parity at each month of pre-and post-partum period or as overall mean (Table 4).

Role of AST during the different physiological stages depends on age (**Suzana Milinković *et al.*, 2005**). It is worthy noting that AST activity in camels is similar to its activity in ewes, whereas AST activity was higher in the 6th parity compared to the 2nd, 4th and 5th parity in sheep, while ALT activity showed an opposite trend, being lower in 6th parity as compared to the 1st -5th parity in ewes (**Anwar *et al.*, 2012).** In agreement with the obtained results, **Shumaila *et al.* (2012)** found no impact of age on LDH concentration in sheep and goat.

Table (4): Enzyme activity in blood plasma of she-camels in different experimental groups during pre- and post-partum months.

Item	Group	Pre-partum period		Post-partum period				Overall means
		2nd month	1st month	At-natal	1st month	2nd month	3rd month	
AST (U/l)	G1	45.43±1.31	42.86±2.65	39.43±0.95	40.14±1.63	42.29±0.87	44.43±1.65	42.43±0.96^{b}
	G2	47.14±1.16	44.86±1.67	41.43±0.69	42.57 ±2.34	43.29±1.34	46.43±1.89	44.29±0.92^{b}
	G3	51.00±2.36	46.29±1.89	43.29±1.34	44.86±1.63	45.86±2.39	48.57±2.09	46.65±1.12^{a}
ALT (U/l)	G1	18.29±1.06^{b}	15.43±1.19^{b}	14.29±1.11^{b}	17.14±1.01	17.57±1.15^{b}	17.86±1.30^{b}	16.76±0.64^{c}
	G2	20.57±0.95^{b}	17.57±1.33^{b}	16.4±1.29^{ab}	18.71±1.48	19.29±0.94^{ab}	19.43±0.69^{ab}	18.67±0.60^{b}
	G3	25.29±2.33^{a}	21.43±1.36^{a}	19.00±1.27^{a}	20.71±0.57	21.00±0.44^{a}	22.43±1.17^{a}	21.64±0.86^{a}
LDH (IU/dl)	G1	338.86±24.45	373.14±17.66	462.86±45.96	393.57±42.15	447.14±60.06	484.57±56.44	416.69±19.63
	G2	419.29±44.63	428.29±42.15	474.43±42.48	437.43±51.68	456.71±18.96	486.14±41.57	450.38±16.14
	G3	420.71±34.05	429.86±64.20	521.43±35.77	478.14±80.95	498.29±82.37	544.86±17.97	482.21±20.21

Means with different superscripts in the same column for each parameter are significantly different at P<0.05.

Results in Table (4) revealed marked reduction in ALS and ALT activities during the last two months of pregnancy, showing the minimal activity at calving, and then increased again during post-partum months. However, LDH activity showed an opposite trend. **Yotov *et al.* (2013)** mentioned that activity of AST and ALT in the blood is associated with implantation, fetus survival, development, uterine carbohydrate metabolism, amino acerbic metabolism and glycogen sedimentation. In accordance with the present results, **Tharwat *et al.* (2015)** found that AST activity was elevated in 3 weeks after natal as compared to last 3 weeks before parturition in camels. Also, **Talvelkar *et al.* (2008)** showed a rise in ALT and LDH activities during the last period of pregnancy compared to the postpartum period in buffaloes, while no changes in AST were reported in the gestation or natal periods in cattle (**Yokus and Cakmr, 2006)**.

It is known that AST is an intracellular enzyme plentifully found in heart and liver muscles and plays an essential part in amino acid metabolism and pathological changes in these organs raise the activity of AST in the blood **(Vojta *et al.*, 2011).** It had impact on the development of glutamate and oxaloacetate attributable to the transfer of the amino group from aspartate to ketoglutaric corrosive **(Abdelhamid *et al.*, 2012)**.Based on

these findings, increasing AST activity within the normal range by advancing camel parity may indicate higher amino acid metabolism by increasing age required for milk production. Rise in ALT activity during pregnancy may most likely be a direct result of source of this enzyme from either placenta or uterine muscle **(Singh *et al.,* 1992)**. On the other hand, ALT is an enzyme found in the highest amount in liver and commonly used to identify injury of liver or muscle **(Pratt *et al.,* 2010)**. It has an effect on glutamate and pyruvate due to the transfer of the amine group from alanine to ketoglutaric acid. Increased ALT activity leads to the occurrence of viral hepatitis or liver damage or metabolic disorders **(Bagnicka *et al.,* 2014)**. Generally, the observed changes in plasma ALT activity as affected by camel parity are within the normal range of camel. Lactic dehydrogenase (LDH) is an enzyme that plays an important role in the conversion of lactate to pyruvate, which is one of the important steps in the production of energy in the cell. The increase in activity of LDH may be due to clotting in blood vessels and bleeding as well as the breakdown of tissues, especially in kidneys and liver in infected animals **(Perez *et al.,* 2003)**. Increased plasma LDH activity may be important in determining tissue damage and disease within the living body. This enzyme works widely in blood cells, muscles, intestines as well as liver cells; it also converts hydrogen between molecules **(Goddard *et al.,* 1997)**. The decrease in LDH activity may indicate muscle damage, which results in disturbances in the balance of the diet, especially at the beginning of breastfeeding when it rises milk production is difficult to cover for the needs of animals or because of the length of storage period of the blood serum before analysis **(Bagnicka *et al.,* 2014)**. However, increasing LDH activity in mammary parenchyma at calving is required during start of lactation **(Visha *et al.* 2002).** In this respect, **Krsmanović *et al.* (2013)** concluded that the maximum LDH activity was at early lactation compared to pre-partum period in cows. Also, **Shumaila *et al.* (2012)** found that LDH activity increased after calving in comparison with the last period of gestation.

Mineral content in blood plasma:

At each month of pre- and post-partum period and as overall mean, Na concentration in blood plasma of she-camel was the highest in G3, followed by G2 and the lowest in G1, but the differences were significant only at 3rd month post-partum and as overall mean. An opposite trend of differences was observed significantly for K, Ca, P and Mg concentrations as overall mean with different levels of significance at each pre- and post-partum months (Table 5).

In consistent with the present results in camels, Ca concentration was significantly higher in the 1st and 2nd parities compared to 3rd parity in cows **(Perdo *et al.,* 2004)** and decreased by increasing age in cattle (**Mamun *et al.,* 2013)**. Contrary, insignificant differences in Ca and P (**Yuko *et al.,* 2004)** or P **(Cozzi *et al.,* 2011)** concentrations were reported between primiparous and multiparous cows. Also, **Perdo *et al.* (2004)** illustrated that Mg concentration was significantly lower in the 1st and 2nd parities than in 3rd parity in cows.

Table (5): Mineral concentrations in blood plasma of she-camels in different experimental groups during pre- and post-partum months.

Item	Group	Pre-partum period		At calving	Post-partum period			Overall Means
		2nd month	1st month		1st month	2nd month	3rd month	
Na (mg/dl)	G1	127.00±2.06	127.28±1.58	127.14±1.79	126.85±1.52	126.43±1.77	127.14±0.40^{b}	126.97±0.84^{b}
	G2	129.57±0.75	129.14±0.71	128.86±0.63	128.71±0.78	128.43±0.37	129.43±1.36^{ab}	129.02±0.44^{ab}
	G3	131.57±1.48	131.29±1.86	131.14±1.96	130.86±1.91	130.43±1.70	131.71±1.98^{a}	131.17±1.40^{a}
K (mg/dl)	G1	5.01±0.30	5.13±0.39	4.93±0.40	4.81±0.31^{a}	4.73±0.28^{a}	4.57±0.28^{a}	4.86±0.20^{a}
	G2	4.44±0.33	4.51±0.32	4.37±0.27	4.31±0.29^{ab}	4.26±0.24^{ab}	4.13±0.20^{ab}	4.34±0.15^{b}
	G3	4.23±0.20	4.33±0.22	4.11±0.21	3.66±0.36^{b}	3.57±0.25^{b}	3.49±0.33^{b}	3.90±0.15^{b}
Ca (mg/dl)	G1	7.69±0.35	7.91±0.32	7.74±0.32	7.89±0.50	8.03±0.31	8.06±0.37	7.89±0.19^{a}
	G2	7.36±0.37	7.54±0.38	7.46±0.37	7.49±0.54	7.53±0.38	7.54±0.20	7.49±0.20^{ab}
	G3	6.96±0.38	7.11±0.54	6.83±0.37	7.06±0.41	7.11±0.27	7.14±0.42	7.04±0.24^{b}
P (mg/dl)	G1	5.86±0.27^{a}	6.01±0.56	5.71±0.23^{a}	5.77±0.23	5.91±0.27	5.99±0.47^{a}	5.88±0.10^{a}
	G2	5.41±0.22^{ab}	5.53±0.34	4.93±0.22^{ab}	4.99±0.47	5.04±0.49	5.07±0.31^{ab}	5.16±0.23^{b}
	G3	4.87±0.34^{b}	4.91±0.34	4.59±0.41^{b}	4.64±0.43	4.70±0.48	4.77±0.37^{b}	4.75±0.16^{b}
Mg (mg/dl)	G1	3.71±0.41	3.94±0.31	3.57±0.44	3.63±0.54	3.64±0.36	3.67±0.40	3.69±0.17^{a}
	G2	3.14±0.52	3.36±0.46	2.99±0.56	3.13±0.43	3.19±0.52	3.21±0.60	3.17±0.18^{ab}
	G3	2.64±0.51	2.77±0.49	2.59±0.51	2.66±0.50	2.71±0.56	2.77±0.60	2.69±0.27^{b}

Means with different superscripts in the same column for each parameter are significantly different at P<0.05.

Results also showed slight reduction in Na, K, Mg and P concentrations during post-partum months as compared to that at calving or pre-partum months. Meanwhile, Ca concentration showed slight increase during the 3rd and 4th months of post-partum period in comparison with pre-partum and at calving (Table 5). Similar to the present results, **Tharwat *et al.* (2015)** illustrated that Ca concentration declined during 3 weeks before natal as compared with 3 weeks after calving in camel. Also, **Ashmawy (2015)** demonstrated a rise in Ca and P levels at late phase of gestation in comparison with serum Ca level in early phase of lactation in buffalo. Also, K

showed the highest concentration at last month before parturition and the lowest at lactation stage as well as a decline in P level after calving.

Sodium (Na) is an important electrolyte in all aspects of the body, and its rise level state demonstrates, e.g. dehydration or absence of water. On the other hand, decline levels of Na and potassium (K) show inter alia, starvation, severe diarrhea or metabolic acidosis **(Bagnicka *et al.*, 2014).** The changes in electrolytes levels, particularly Na variations in the last period of pregnancy may be related to high activity of rennin-angiotensin-aldosterone system at the end of gestation, and from joint cooperation with vasopressin, which may lead to positive balance of Na. Also, this arrangement of changes in Na ability may be due to the accretion in alkali appeal for pregnancy and lactation **(Donia *et al.*, 2014)**. High Na level immediately before natal may be linked with an increase in aldosterone concentration during the first week of lactation **(Skrzypczak *et al.*, 2009)**, while the slight reduction in Na concentration during the first weeks of lactation may be due to a decrease plasma renin activity after calving leading to Na loss in cows **(Ożgo *et al.*, 2008)** and/or being affected by the high concentration of prostaglandins, which leads to an increase in secretion of Na with urine **(Asif *et al.*, (1996)**. Potassium (K) is in charge of up keep of intracellular osmotic pressure. It additionally takes part of regular operations such as maintenance acid-base balance, conduction of nerve impulses, muscle contraction and relaxation, activity of many enzymes, glycogen and protein synthesis **(Hassabo, 2008)**. The obtained concentrations of K in camel plasma are nearly similar to those reported in cattle blood during pregnancy and suckling **(Winnicka, 2008)**. The raised Ca level in late pregnancy may due to rise of intestinal absorption of Ca and bone resorption as a result of hormonal changes amid pregnancy **(Abdelrahman *et al.*, 2002)**, while the decline in Ca levels at post-partum could be a result of the impaired absorption of food metabolites from the gastrointestinal precursor, over the top misfortunes through pee, colostrums as it was considerably more depleted in the colostrums during inordinate milking and may be due to lacking assembly from the skeleton **(Ashmawy 2015)**. The observed increase in P concentration may identify with higher growth hormone activity, advancing intestinal phosphate absorption and renal phosphate re-retention **(Meyer and Harvey, 2004)**, while the decline in P level after calving might be due to the need of P for the colostrum combination and improved carbohydrate metabolism (**Ashmawy, 2015)**.

Hormonal profiles:

Results in Table (6) revealed that concentration of leptin and P4 in blood plasma of she-camels was not affected significantly by animal parity at each of pre- and post-partum months. However, E2 concentration was significantly ($P<0.05$) the highest in G1, followed by G2 and the lowest in G3 at each sampling month. In addition, overall mean of leptin concentration was significantly ($P<0.05$) higher in G3 than in G1, but G2 did not differ from both groups. Meanwhile, E2 concentration showed an opposite trend of change, but overall mean of P4 concentration was not affected by animal parity. The present results indicated higher levels of leptin, P4 and E2 during pre-partum than in post-partum months, being the lowest at calving.

Table (6): Concentration of some hormones in blood plasma of she-camels in different experimental groups during pre- and post-partum months.

Item		Pre-partum period		At calving	Post-partum period			Overall means
		2nd month	1st month		1st month	2nd month	3rd month	
Leptin (ng/dl)	G1	7.36±0.46	7.07±0.43	6.33 ±0.32	6.37±0.30	6.42±0.30	6.54±0.42	6.68±0.18^{b}
	G2	7.84±0.30	7.37±0.26	6.53±0.15	6.59±0.30	6.66±0.21	6.83±0.30	6.97±0.21^{ab}
	G3	8.21±0.34	7.63±0.44	6.91±0.23	6.99±0.52	7.03±0.46	7.19±0.32	7.33±0.20^{a}
P4 (ng/dl)	G1	5.24±0.34	5.69±0.43	0.47±0.41	2.50±0.30	2.56±0.18	2.61±0.34	3.17±0.62
	G2	4.84±0.39	5.38±0.50	0.44±0.31	2.49±0.18	2.52±0.19	2.56±0.30	3.03±0.55
	G3	4.05±0.41	5.05±0.43	0.27±0.23	2.34±0.31	2.42±0.27	2.47±0.32	2.77±0.48
E2 (pg/dl)	G1	100.96±1.43^{a}	105.25±2.12^{a}	24.67±1.12^{a}	28.75±1.24^{a}	33.37±1.20^{a}	36.14±1.12^{a}	54.86±0.66^{a}
	G2	90.53±2.98^{b}	97.08±1.98^{b}	21.64±2.90^{ab}	26.37±1.91^{ab}	28.74±2.37^{ab}	30.92±1.71^{b}	49.21±0.92^{b}
	G3	79.55±0.66^{c}	84.40±1.05^{c}	18.57±0.89^{b}	21.86±1.33^{b}	25.57±1.15^{b}	27.50±1.53^{b}	42.91±0.42^{c}

Means with different superscripts in the same column for each parameter are significantly different at P<0.05.

Leptin hormone plays an important role in regulating feed intake and energy disposition and helping to coordinate the metabolic process during the transition from gestation to post-partum stage **(Smith and Waddell, 2003).** In all animals, plasma level of leptin raised by total adiposity, representing total mass of adipocyte hypertrophy **(Ehrhardt *et al.*, 2000)**, which associated with increasing adipose tissues by advancing animal parity. As proved in our study, some authors indicated effect of animal parity on leptin level, being lower in primiparous than in multiparous cows (**Meikle *et al.*, 2004)** and higher in 4th than in 3rd parity of cows **(Hussein, 2010)**. The observed increase in leptin during the last pre-partum months as compared to post-partum months was attributed to that leptin plays an essential role in the natural development of mammary glands during the last period of gestation **(Smith and Waddell, 2003).** However, the gradual increase of leptin during post-partum

months may reflect that, maternal leptin may be a key player in the hormonal control of early fetal development on the grounds that fetal fat tissue did not combine leptin until late pregnancy **(Ehrhardt et al., 2000)**.

The calving cyclic activity depends on the synchronous activity of hypothalamic-pituitary ovarian axis and consequently on P4 and E2 levels secreted from the ovaries (**Perea and Inskeep, 2008).** It is well known that both P4 and E2 levels are depending on the reproductive status, as well as size of CLs and the ovarian follicles rather than on age or parity of animals. The observed trend of increase in P4 and E2 concentrations at pre-partum months was confirmed from the results on camel reported by **Kelanemer *et al.* (2015)**, who revealed a sharp rise in P4 level in the last month of gestation and then diminished gradually from 2 days pre-natal**.** However, E2 significantly elevated on day 15 pre-natal and this rate had practically multiplied on 2 days before parturition. Also, **Tharwat *et al.* (2015)** found that serum P4 level diminished pointedly at parturition and from that point (0 to wk 3), while serum E2 level elevated from last 2 weeks and achieved its greatest crest at parturition and declined from that point. Moreover, **Ayoub *et al.* (2003)** concluded that P4 and E2 levels were rise towards the end of gestation and dropped after calving. The estradiol-17β measured in gestation was feto-placental in source and the rise in level of E2 during last period of gestation coincides with growth the embryo and increase in volume of fetal fluids. However, the reduction in P4 is physiologically because of the annihilation of the corpus luteum of pregnancy and the diminished level of P4 released from the placenta**.** Increasing the E2 level in the last period of pregnancy, which is the maximum at natal, is necessary for contractions of the uterus (**Alwan *et al.*, 2010)**.

IV. Conclusion

Based on the foregoing results, camel parity has an important factor influencing some blood hematological, biochemical, mineral and hormonal parameters. Also, there was trend of change in these parameters at different pre- and post-partum months. These results may be utilized as references for she-camels during different reproductive statuses. The obtained results may form a useful baseline for future research in this field and may have a key part in assessing the metabolic status in late pregnant and early lactation in she-camel.

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