

Some hematological and biochemical parameters and steroid hormone levels in the one-humped camel during different physiological conditions

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Abstract: Four non-pregnant, 4 late pregnant and 3 cycling camels were used for blood collection to determine estradiol-17 β and progesterone concentrations. Blood hematological and serum biochemical parameters were determined in non-pregnant and late pregnant camels. Hematological parameter levels varied between pregnant and non-pregnant camels. Equal values for packed cell volume (PCV), hemoglobin (Hb) and total white blood cell (WBC) counts were found in both groups. However, neutrophils and eosinophils showed higher ($P<0.05$) levels in the pregnant than those in non-pregnant camels. An opposite trend was found for lymphocytes ($P<0.05$) and monocytes. On the other hand, serum biochemical parameters showed elevated ($P<0.05$) levels in total protein, albumin, globulin ($P>0.05$), blood urea nitrogen, and creatinine in pregnant than in non-pregnant animals. However, total creatine kinase, alkaline phosphatase, alanine aminotransferase, aspartate aminotransferase, gamma-glutamyl transferase, lactic dehydrogenase and glucose showed lower ($P<0.05$) levels in pregnant than in non-pregnant camels. Levels of estradiol-17 β ranged from 1.29 to 13.42, 240.95 to 628.29 and 5.72 to 29.69 pg/ml in the non-pregnant, pregnant and in camels during estrous cycle, respectively. Progesterone levels ranged from 0.29 to 2.87, 1.40 to 6.45 and 0.50 to 1.80 ng/ml in non-pregnant, pregnant and in camels during estrous cycle, respectively. Levels of estradiol-17 β did not exceed 13.42 pg/ml in the non-pregnant not-cyclic camels, while it reached 29.69 pg/ml at standing estrus. However, in pregnant camels, estradiol-17 β increased steadily up to 628.29 pg/ml near parturition. Then it decreased to 20.36 pg/ml after parturition, suggesting a possible fetoplacental involvement in estradiol-17 β secretion. Progesterone concentration increased during pregnancy up to 6.45 ng/ml. Then it decreased to reach 1.19 to 2.47 ng/ml after parturition.

Key Words: blood, enzymes, estradiol, progesterone, camel.

مستويات بعض المعيير في الدم والقياسات البيوكيميائية و هرمونات الأستروجين و البروجسترون في سيرم دم إناث الإبل خلال مراحل فسيولوجية مختلفة.

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ملخص: استخدمت في الدراسة أربعة إبل غير حوامل وأربعة حوامل متأخرة و ثلاثة في أثناء الشياح وذلك لتقدير تركيزات هرمونات الأستروجين و البروجسترون وكذلك تم تقدير مستوى بعض المقاييس في الدم والسيرم للإبل غير الحوامل و الحوامل. أظهرت مستويات المعايير المقدر في الدم قيمًا متباينة بين الإبل الحوامل و غير الحوامل وقد وجدت قيم متساوية بين كلا المجموعتين بالنسبة لحجم خلايا الدم المضغوطة و الهيموجلوبين و خلايا الدم البيضاء و كانت قيم الخلايا البيضاء من أنواع النيوتروفيل و الإريثروفيل هي السائدة في الإبل الحوامل، بينما ظهر عكس ذلك في قيم الخلايا البيضاء من أنواع الليمفوسيت و المونوسيت حيث كانت أعلى في الإبل غير الحوامل. و من الناحية الأخرى أظهرت قيم المقاييس البيوكيميائية في السيرم مستويات عالية بالنسبة للبروتين الكلي، الألبومين، الجلوبيولين، نيوتروفيل بوريا الدم، الكرياتينين في الحيوانات الحوامل عن غير الحوامل، بينما كانت قيم كرياتين الكلي، انزيمات الفوسفاتاز القاعدي، الألبومين، أمينو ترانسفيراز، الأسيرتاز، أمينو ترانسفيراز، جاما جلوتاميل ترانسفيراز، لكتيك دي هيدروجيناز، الجلوكوز أقل في الحيوانات الحوامل عن غير الحوامل. تراوحت قيم هرمون الأسترايول من 1.29 إلى 13.42، 240.95 إلى 628.29، 5.72 إلى 29.69 بيكو جرام/مل في الحيوانات غير الحوامل، الحوامل، الحيوانات أثناء دورة الشياح على التوالي. أما هرمون البروجسترون تراوحت قيمه من 0.29 إلى 2.87، 1.40 إلى 6.45، 0.50 إلى 1.80 نانوجرام/مل في الحيوانات غير الحوامل، الحوامل، الحيوانات أثناء دورة الشياح على التوالي. و في حين لم تتجاوز قيم هرمون الأسترايول عن 13.42 بيكو جرام/مل في الحيوانات غير الحوامل الغير شائعة، بلغت قيمة الهرمون إلى 628.29 بيكو جرام/مل في الحيوانات أثناء دورة الشياح. كما أظهرت قيم هرمون الأسترايول في الإبل الحوامل زيادة مستمرة حتى بلغت 628.29 بيكو جرام/مل قبل الولادة مباشرة ثم تناقصت إلى 20.36 بيكو جرام/مل بعد الولادة، مما يشير إلى مساهمة المشيمة كمصدر إفرازي للإسترايول أثناء الحمل في الإبل. أظهرت النتائج زيادة مستوى هرمون البروجسترون خلال الحمل حتى بلغت 6.45 نانوجرام/مل ثم انخفضت حتى بلغت 1.19 إلى 2.47 نانوجرام/مل بعد الولادة.

كلمات مفتاحية: الدم، الإثريمت، أسترايول، بروجسترون، الإبل.

Introduction

Progesterone and estradiol hormonal profiles during different reproductive conditions have been characterized in

many domestic animals. However, only few reports have studied the hormonal profiles of progesterone and estradiol in camels. Skidmore *et al.* (1996a) studied the ovarian follicular wave patterns

ultrasonographically in camels and found that the follicular cycle was divided into a growth phase (10.5 ± 0.5 days), a mature phase (7.6 ± 0.8 days) and a regression phase (11.9 ± 0.8 days). They found that serum estradiol-17 β concentration reached a peak value of 39 pg/ml at estrus when the dominant follicle reached a mean diameter of 1.7 cm and, after ovulation, mean serum concentration of progesterone reached a peak value of 2.6 ng/ml on day 8.

Progesterone is high during pregnancy and falls just before parturition, while estradiol increases steeply before parturition in cattle, sheep, goats, and pigs (Bassett *et al.*, 1969, Thorburn *et al.*, 1972; Robertson and King, 1974, and Peterson *et al.*, 1975). Elias *et al.* (1984) measured estradiol-17 β concentrations at monthly intervals in pregnant camels and found that the concentrations remained constant at 50-100 pg/ml during the first 10 months of gestation before rising to a peak during the twelfth month. The same observation was reported by Skidmore *et al.* (1996b), where estradiol-17 β concentrations increased around day 50 to about 100 pg/ml, then remained relatively constant until day 300. The follicular wave duration in the dromedary camels was reported to range from 17.2 to 23.4 days in India (Joshi *et al.*, 1978), mean duration of 24.2 days in Egypt (Wilson, 1984) and 28 days in Sudan (Musa and Abusineina, 1978).

The objectives of the present study were to determine reference ranges for some hematological and serum biochemical values and hormonal levels of estradiol-17 β and progesterone in female camels at various ages and different physiological conditions under United Arab Emirates (UAE) climate.

Materials and Methods

Eleven female camels were used in this study. They were housed in open yards at

the College of Food Systems Experimental Farm, UAE University, during the breeding season from October to April 98/99. Each camel was offered 2-2.5 kg concentrate mixture (12% CP), 250 grams of dates, and hay *ad libitum*. All animals were regularly checked for any clinical diseases. Blood samples for the determination of hematological and biochemical parameters were collected (jugular vein) from four animals each of late pregnant (6-10 years of age and over 10 months of pregnancy) and non-pregnant (3-4 years of age) camels every 72 hrs for 10 consecutive times. The determined parameters in the whole blood were packed cell volume (PCV), hemoglobin (Hb), white blood cell (WBC), and white blood cell differential count percentages (N, neutrophils; L, lymphocytes; M, monocytes; and E, eosinophils). The following parameters were also determined in sera: glucose, total protein (TP), albumin (ALB), globulin (GLO), blood urea nitrogen (BUN), creatinine (Crea), creatinekinase (CK), alkaline phosphatase (Alph), alanine aminotransferase (ALT), aspartate aminotransferase (AST), gamma-glutamyl transferase (GGT), lactic dehydrogenase (LDH). Blood hematology and biochemical analyses were determined by using Dimension Clinical Chemistry System (Coulter Counter, T890) at the Veterinary Laboratory, Department of Agriculture and Livestock, Al-Ain, UAE. Blood samples for the determination of estradiol-17 β and progesterone concentrations were collected from four non-pregnant not cycling camels (3-4 years of age) once every other week for 10 weeks, and three camels (6-8 years of age) at standing estrus (7 samples) for 18 days during the estrous cycle. Estrus was detected every day by using a sexually mature male camel. In addition, blood samples were collected (every 72 hrs) from four late pregnant camels (6-10 years of age) for 10 consecutive times at the end of

pregnancy and continued for nine days after parturition. Sera were collected and kept at -20°C until hormonal determinations. Estradiol-17 β and progesterone hormones were determined in serum samples using solid phase fluoroimmunoassay (DELFLIA[®] kits, WALLAC oy, Turku, Finland).

The lower limit of detection for oestradiol-17 β (95% B/Bo) was 0.065 pg/ml serum, and the intra- and inter-assay coefficients of variation (CV) were 6.20% and 10.20%, respectively. The lower limit of detection for progesterone (95% B/Bo) was 0.039 ng/ml serum, and the intra- and inter-assay were 7.17% and 6.87%, respectively.

Statistical Analysis

Complete randomized design (CRD) according to Snedecor and Cochran (1980) was applied to analyze data by using Costat Statistical Program. The following model was used:

$$Y = u + A_i + T_j + A*T_{ij} + e_{ijk}$$

Where: u = overall mean, A_i = animal effect, T_j = time effect, $A*T_{ij}$ = animal X time interaction effect, e_{ijk} = random error. Duncan's (1955) multiple range test and

student T test were used to compare means at $P < 0.05$.

Results

Table 1 shows the levels of some hematological parameters determined in pregnant and non-pregnant camels. The levels of the determined hematological parameters fell within normal ranges, and no significant differences ($P > 0.05$) were found between pregnant and non-pregnant camels in the determined parameters except for neutrophils, lymphocytes and eosinophiles percentages. Pregnant camels showed higher ($P < 0.05$) values of neutrophils and eosinophiles and lower values for lymphocytes than those found in the non-pregnant animals. Table 2 shows the levels of some biochemical parameters in pregnant and non-pregnant camels. Pregnant camels showed higher ($P < 0.05$) values for serum total protein, albumin, blood urea nitrogen and creatinine, and lower ($P < 0.05$) values for serum CK, Alph, AST, GGT, LDH and glucose, ALT ($P > 0.05$) in non-pregnant camels.

Table 1. Levels of some hematological parameters in pregnant and non-pregnant camels (mean \pm S.E).

Parameter	Pregnant	Non-pregnant
PCV (%)	26.88 \pm 0.39	27.00 \pm 0.37
Hemoglobin (gm/100ml)	12.43 \pm 0.19	12.43 \pm 0.18
WBC (X103)	10.54 \pm 0.25	11.28 \pm 0.24
Neutrophils (%)	61.15 \pm 1.79 ^a	53.63 \pm 2.38 ^b
Lymphocytes (%)	30.50 \pm 1.95 ^a	40.43 \pm 2.48 ^b
Monocytes (%)	2.78 \pm 0.21	2.88 \pm 0.74
Eosinophils (%)	5.43 \pm 0.45 ^a	3.60 \pm 0.35 ^b

^{a, b} Denote differences between means in the same row ($P < 0.05$).

Table 2. Levels of some biochemical parameters in pregnant and non-pregnant camels (mean+S.E).

Parameter	Pregnant	Non-pregnant
Glucose (mg/100ml)	96.58±1.53	100.55±1.03
Total Protein (gm/100ml)	6.43±0.04 ^a	5.95±0.08 ^b
Albumin (gm/100ml)	2.70±0.05 ^a	2.49±0.02 ^b
Globulin (gm/100ml)	3.74±0.04	3.51±0.06
BUN (mg/100ml)	15.48±1.45 ^a	7.85±1.45 ^b
Creatinine (mg/100ml)	1.42±0.04 ^a	1.20±0.06 ^b
CK (U/L)	23.25±2.21 ^a	55.96±4.54 ^b
Alkaline Phosphatase (U/L)	44.27±1.93 ^a	73.75±2.42 ^b
ALT (U/L)	13.13±0.36	18.56±0.24
AST (U/L)	53.88±0.88 ^a	77.15±1.41 ^b
GGT (U/L)	8.83±1.40 ^a	11.08±2.28 ^b
LDH (U/L)	297.00±9.24 ^a	428.58±13.0 ^b

^{a, b} Denote differences between means in the same row (P<0.05).

Table 3 and Figure 1 show levels of serum estradiol-17β and progesterone during 10 weeks in non-pregnant camels at 3-4 years of age. Estradiol-17β concentration ranged from 1.29 to 13.42 pg/ml, and progesterone concentration ranged from 0.29 to 2.87 ng/ml during 8 and 10 weeks of the study, respectively. Progesterone concentrations

remained below 1 ng/ml during the first 4 weeks, where estradiol-17β levels were low, then progesterone level increased (P<0.05) to 2.87 ng/ml at the 6th week and declined (P<0.05) to 1.52 and 1.57 ng/ml during the 8th and 10th weeks, respectively.

Table 3. Levels of serum estradiol and progesterone hormones in non-pregnant camels (mean ±S.D).

Weeks	Estradiol (pg/ml)	Progesterone (ng/ml)
0	2.66±1.98 ^b	0.39±0.44 ^c
2	1.29±1.41 ^b	0.29±0.26 ^c
4	3.20±4.15 ^b	0.77±1.18 ^{bc}
6	10.72±0.92 ^a	2.87±0.67 ^a
8	13.42±3.20 ^a	1.52±0.87 ^b
10	ND	1.57±0.19 ^b

^{a, b, c} Denote differences between means in the same column (P<0.05).

ND= Not determined

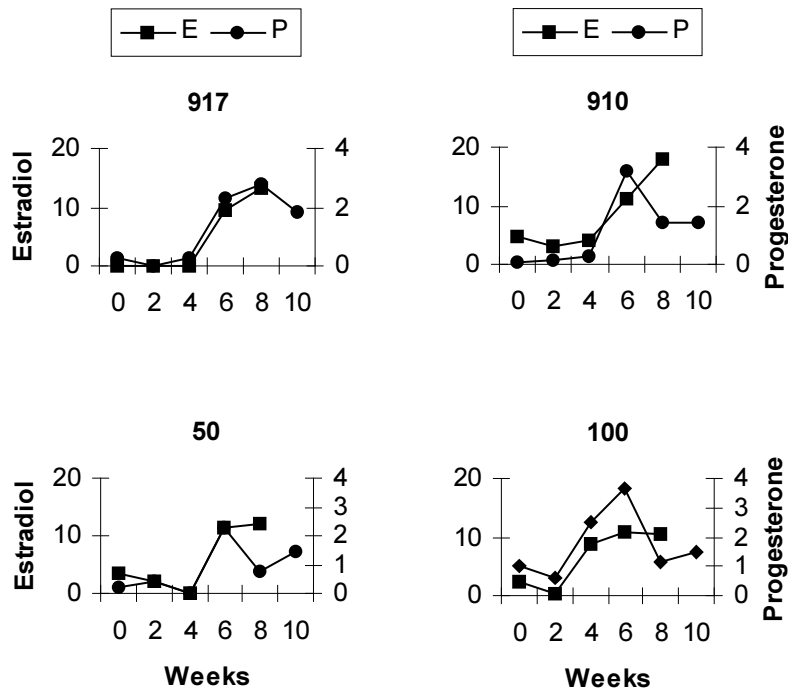


Figure 1. Serum levels of estradiol (pg/ml) and progesterone (ng/ml) during 10 weeks in 4 immature camels.

Estradiol-17 β reached the highest ($P<0.05$) concentration (29.7 pg/ml) at standing estrus, decreased gradually to 5.7 pg/ml at the 7th day, then increased insignificantly (10.6 to 12.7 pg/ml) during the rest of the cycle at the day 18 (Table 4 and Figure 2). On the other hand, progesterone levels remained below 1 ng/ml (0.5 to 0.7 ng/ml) during the first 3 days of the estrous cycle, and then increased insignificantly to above 1 ng/ml (1 to 1.8 ng/ml) during the rest of the cycle at the day 18. Table 5 and Figure 3 show serum levels of

estradiol-17 β and progesterone during the last 3 weeks of pregnancy and after parturition. Estradiol-17 β level increased gradually before parturition and reached the highest ($P<0.05$) concentration (628 pg/ml) at the 6th day before giving birth. On the day of parturition, estradiol-17 β decreased ($P<0.05$) sharply to 42.97 pg/ml. On the other hand, progesterone levels ranged from 4 to 6.5 ng/ml during the last two weeks before parturition, dropped to 2.5 ng/ml on the day of parturition, then ranged from 1.19 to 2.28 ng/ml after parturition.

Table 4. Concentrations of serum estradiol and progesterone hormones in estrous camels (mean \pm S.D).

Days	Estradiol (pg/ml)	Progesterone (ng/ml)
0 (Estrus)	29.69 \pm 7.31 ^a	0.56 \pm 0.59
1	13.89 \pm 8.74 ^b	0.50 \pm 0.21
3	6.90 \pm 1.59 ^b	0.69 \pm 0.50
7	5.72 \pm 4.55 ^b	1.14 \pm 0.79
11	12.44 \pm 3.72 ^b	1.80 \pm 1.85
15	12.71 \pm 6.13 ^b	1.18 \pm 0.59
18	10.63 \pm 2.36 ^b	1.03 \pm 0.82

^{a, b}Denote differences between means in the same column ($P<0.05$).

Table 5. Concentrations of serum estradiol and progesterone hormones in camels during the last month of pregnancy and after parturition (3 days intervals, mean \pm S.D).

Days	Estradiol (pg/ml)	Progesterone (ng/ml)
-18	240.95 \pm 161.34 _{bc}	1.40 \pm 0.58 _c
-15	393.96 \pm 159.46 _{ab}	4.96 \pm 3.08 _{ab}
-12	503.74 \pm 268.94 _{ab}	4.08 \pm 3.78 _{abc}
-9	553.72 \pm 146.10 _a	5.30 \pm 2.81 _{ab}
-6	628.29 \pm 222.37 _a	4.25 \pm 3.03 _{abc}
-3	488.55 \pm 411.65 _{ab}	6.45 \pm 0.64 _{bc}
Parturition	42.97 \pm 60.39 _c	2.47 \pm 0.46 _{bc}
3	16.04 \pm 7.45 _c	1.88 \pm 1.19 _{bc}
6	38.75 \pm 41.65 _c	2.28 \pm 1.69 _c
9	20.36 \pm 13.47 _c	1.19 \pm 0.38 _c

^{a, b, c} Denote differences between means in the same column ($P < 0.05$).

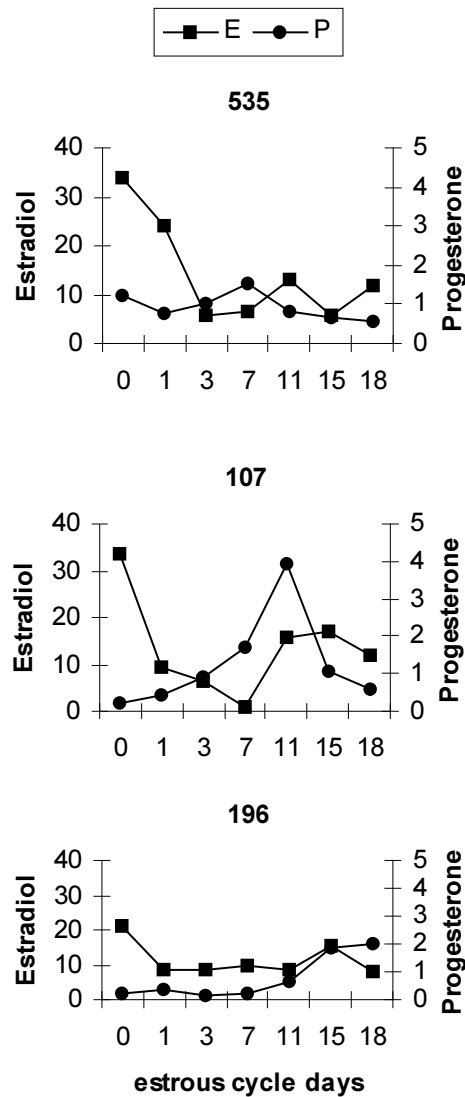


Figure 2. Serum levels of estradiol (pg/ml) and progesterone (ng/ml) in 3 camels during estrous cycle.

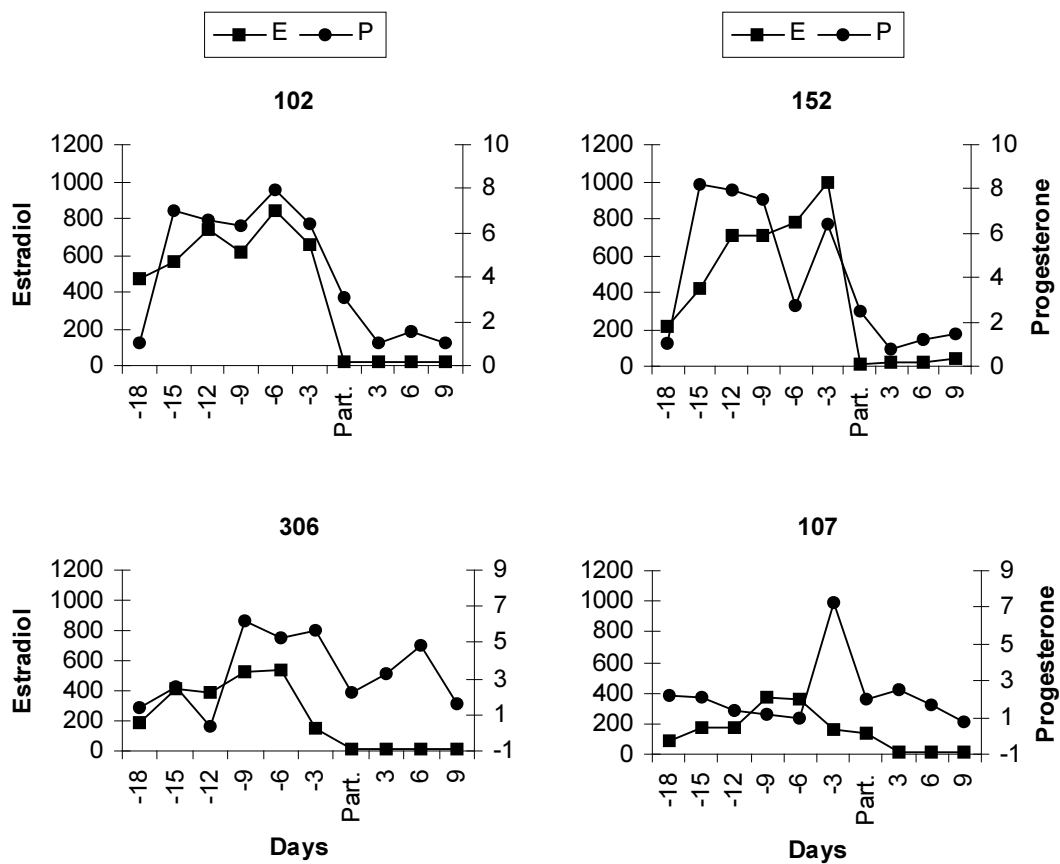


Figure 3. Serum levels of estradiol (pg/ml) and progesterone (ng/ml) in 4 camels near end of pregnancy and after parturition

Discussion

Blood is an important index for several metabolic processes in the body that may in one animal species vary due to age, sex, physiological condition, and environmental factors etc. The values for hematological and biochemical parameters determined in the present study (Table 1 and 2) were in the normal ranges and are in agreement with other studies by Abdel Gadir *et al.* (1984), Higgins and Kock (1985) and Nyang'ao *et al.* (1997). The total number of white blood cells (10.54 to 11.28×10^3 /ml) determined in the present study was higher than those reported (2.9 to 9.7×10^3 /ml) by Higgins and Kock (1985) and lower than those reported (8.8 to 30×10^3 /ml) by Nyang'ao *et al.* (1997). This could be due to breed differences. Ghodsian *et al.* (1978) reported that white blood cell

numbers in young camels are usually higher than those of adults which agrees with our findings. They attributed that to the higher number of band cells, neutrophils, monocytes, eosinophils and basophils in younger camels. The predominant white cells observed in the present study were neutrophils followed by lymphocytes and are in agreement with results reported by Ghodsian *et al.* (1978) and Higgins and Kock (1985). The higher values observed for neutrophils and eosinophils in pregnant than in non-pregnant camels could be due to age differences and to the stress of pregnancy. Most of the biochemical parameters obtained in the present study are in close agreement with previous results (Elias and Yagil, 1984; Al-Ali *et al.*, 1988 and Beaunoyer, 1992). However, higher levels in most of the determined biochemical

parameters were found in the non-pregnant than in pregnant camels. In the present study, values for total protein, albumin, blood urea nitrogen and creatinine were higher in pregnant than in non-pregnant camels. This could be due to differences in age and physiological conditions (pregnancy) between both groups of camels. Jain (1993) reported that plasma total protein concentrations were comparatively higher in old animals. In addition, Rezakhani *et al.* (1997) found that the concentration of urea nitrogen, total protein and globulin increased with age in Iranian camels. However, some authors reported opposite findings and attributed that to differences in breed and climatic conditions.

In the present study, the immature camels (3-4 years old) did not show estrus signs throughout the experiment as checked by the presence of a rutting male camel with females for two hrs every day. Iwema (1960) stated that a young she-camel may come in season at 3 years and first service is generally allowed at the age of 4 years, while Matharu (1966) reported that the female camel does not generally breed until she is 6 years old. In Saudi Arabia, Arthur *et al.* (1985) reported that she-camels reach puberty at the age of 2 years but are not mated until they are 3 years of age. The factors influencing the age at puberty in camels have not been studied, but investigations on other farm animals revealed that puberty is genetically determined and is conditioned by environmental factors (Joubert, 1963), which affect body weight, organ growth, and nutritional status (Hunter, 1980). Chatty (1972) suggested that the old age of puberty in camels could be due to slow rate of growth. Schwartz *et al.* (1983) reported that under traditional nomadic management in Kenya, camels reach their mature body weight between 7 and 8 years of age.

Levels of estradiol-17 β measured in the immature camels in the present study probably did not reach optimum concentrations to elicit estrus signs. The maximum level of estradiol-17 β was 13.4 pg/ml in those immature non-cycling camels (Table 3). However, estradiol-17 β concentration in camels at estrus was 29.69 pg/ml (Table 4). Skidmore *et al.* (1996a) reported in camels that estradiol-17 β reached a peak value of 39.0 pg/ml when the dominant follicle measured 1.7 cm diameter at estrus. Abdel-Rahim (1989) stated that the presence of progesterone is necessary for the manifestation of estrus and sexual receptivity in camels. It also seems that the proper ratio between the two steroids is necessary for showing estrus signs in camels. Abdel-Rahim and El-Nazier (1992) found in male camels that flehmen occurred for shorter periods of time with estrus, compared to non-estrus female camels, which could be due to the presence of the right pheromone in terms of quality and quantity in estrus urine. They suggested the presence of more than one pheromonal substances in camel urine, each of which could act independently or in combination, as is known to occur in sheep (Radford and Watson, 1957). In non-mated female camels the mature follicle becomes atretic and a new follicular wave soon initiates a new period of estrus and sexual receptivity (Skidmore *et al.*, 1996a). The source of progesterone hormone in the present study in the non-cycling animals could be from ovarian or adrenal sources. Arthur and Al-Rahim (1982) examined the genital organs of female camels from the abattoir and found that the numbers of corpora albicans exceeded the numbers expected from normal pregnancies. Marie and Anouassi (1987) observed that ovulation could occur in females exposed to the sight, sound, and smell of a male after a prolonged absence. However, plasma progesterone measurements in such animals indicate a

short life span of the resulting corpus luteum (CL), as is the case in females that ovulate after a sterile mating (Elias, 1990). These observations might suggest that spontaneous ovulation could take place in the she-camel. El-Wishy (1987) reported that the camel is an induced ovulator, and the estrous cycles are either ovulatory or non-ovulatory (follicular). Thus the present study suggests that the source of progesterone hormone in the non cycling camels could be due to silent ovulation.

In the present study estradiol-17 β and progesterone levels showed increases towards the end of pregnancy (Table 5). The steady increase in estradiol-17 β level was also found in the cow (Robertson, 1974), llama (Leon *et al.* 1990), one-humped camel (Skidmore *et al.* 1996b) and Bactrian camel (Zhao *et al.* 1998). The maternal estradiol-17 β dropped following parturition, indicating that the estradiol-17 β measured in pregnant camels was fetoplacental in origin. The level of progesterone did not change significantly during the last 15 days before giving birth, then decreased ($P < 0.05$) after parturition. In sheep, the placenta at term possesses an active steroid 17 α -hydroxylase system (Anderson *et al.* 1975) and is able to convert 17 α -hydroxyprogesterone to estrogens in vitro (Steele *et al.* 1976). A similar situation may exist in the camel during the final months of pregnancy as observed by Elias *et al.* (1984) who found very high concentrations of estradiol-17 β (241 to 390 ng/ml) in the allantoic fluid of camels at birth. In addition, the increased production of estrogens coincides with an increase in fetal growth and a substantial increase in the volume of fetal fluids observed between 9 and 12.5 months of gestation in the dromedary (El-Wishy *et al.* 1981). This also suggests that placental estrogens are important for fetal growth in camels.

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