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HAEMATOLOGICAL PROFILE VARIATIONS IN FEMALE DROMEDARY CAMELS DURING DRY PERIOD, EARLY PREGNANCY, LACTOGENESIS AND GALACTOPOIESIS IN ALGERIAN DROMEDARY CAMELS

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ABSTRACT

The present study investigated the effects of different reproductive stages on haematological parameters of mature local dairy female dromedary camels (n=52) in El Oued region in southeastern Algeria under a semi-intensive breeding system. The haematological parameters analysed included white blood cell count (WBC), lymphocyte count (LYM), lymphocyte percentage (LYM%), monocyte count (MON), monocyte percentage (MON%), granulocyte count (GRAN), granulocyte percentage (GRAN%), red blood cell count (RBC), haemoglobin (HGB), haematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), and platelet count (PLT). The study focused on four distinct stages: dry period, early pregnancy, lactogenesis, and galactopoiesis. Significant increases ($P<0.001$) were observed in MON% and GRAN% during the dry period and early pregnancy. MCV values were significantly higher ($P<0.05$) during the dry period than early pregnancy. However, GRAN during these stages was significantly lower ($P<0.001$) than during galactopoiesis. Lactogenesis and galactopoiesis stages were characterised by significant elevations ($P<0.001$) in WBC, LYM, and LYM%. Additionally, HGB, MCHC, and MCH values were significantly higher ($P<0.001$) during these stages. Conversely, RBC, HCT, and PLT were significantly lower ($P<0.001$) during lactogenesis and galactopoiesis. Interestingly, the MON during galactopoiesis was significantly lower ($P<0.001$) than during the dry period. These findings demonstrate that haematological parameters in female dromedary camels undergo significant alterations across different reproductive stages. This knowledge can contribute to improved reproductive management strategies and provide insights into the physiological adaptations of camels during various reproductive phases in semi-intensive breeding systems.

Key words: Camel, dry period, haematology, galactopoiesis, lactogenesis, pregnancy

Assessing the physiological, nutritional and pathological conditions of animals and their productivity, including camels, is often evaluated through haematologic profiles (Hafez, 2006; Tharwat *et al,* 2015). Various factors such as breed, sex, age, nutrition and seasonal changes have been observed affecting haematologic values (Tornquist, 2010; Farooq *et al,* 2011). The reproductive status of animals can also influence these parameters due to the effects of the endocrine system on multiple organs (Tharwat *et al,* 2015; Jalali *et al,* 2018). Dromedary camels exhibit seasonal breeding patterns, with breeding seasons during winter and spring, while summer and autumn are typically non-breeding seasons for females (Tibary and Anouassi, 1996). Additionally, they are induced ovulators (Eman, 2019) and their pregnancy lasts approximately 387 days (Wilson and Payne, 1999).

Some studies have investigate the impact of different reproduction periods on haematological parameters (Hafez, 2006; Muhammad *et al,* 2011; Tharwat *et al,* 2015; Jalali *et al,* 2018; Ebissy *et al,* 2019; Elkhair, 2019; Chikha *et al,* 2024). However, there

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remains a lack of documented data on the impact of various reproductive periods, including the dry period, early pregnancy, lactogenesis and galactopoiesis on haematological parameters in semi-intensive breeding system of camel population in the south east of Algeria. Therefore, this study aimed to evaluate the effects of different reproductive periods on haematological attributes in one-humped female camels (*Camelus dromedarius*) in the southeast of Algeria.

Materials and Methods

In this research, 52 adult female dromedary camels were used. The camels kept in a semi-intensive breeding system situated in El Oued region, southeastern Algeria. Throughout the study duration, the camels were found to be free of both internal and external parasites and with good health status.

Blood Collection and analysis

In this study, blood samples were collected from a total of 52 animals, out of which 15 samples were obtained during the dry period, 13 during early pregnancy (first month), 12 during lactogenesis (last month of pregnancy) and 12 during early galactopoiesis (first month of lactation). The samples were collected and transported to the laboratory for haematological analysis. Haematological parameters including white blood cell count (WBC), lymphocyte count (LYM), monocyte count (MON), granulocyte count (GRAN), lymphocyte percentage (LYM%), monocyte percentage (MON%), granulocyte percentage (GRAN%), red blood cell count (RBC), haemoglobin concentration (HGB), haematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), platelet count (PLT) and mean platelet volume (MPV) were determined using a MINDRAY haematology auto analyser (BC-3000Plus, China) as used in the study of Chikha *et al* (2024).

Statistical analysis

The haematological parameters data were analysed using IBM SPSS Statistics, version 25.0, based in Armonk, NY, USA. The findings were expressed as mean values ± standard deviation (SD). To assess group differences across various lactation stages, a one-way ANOVA test was applied, followed by Tamhane T2 test as a post hoc analysis. The significance level was established at $p < 0.05$.

Results and Discussion

The results of white blood cell (WBC), red blood cell (RBC) and platelet parameters are summarised in Table 1 and Table 2, respectively. As depicted in Table 1, there was no significant difference between the WBC count in early pregnancy and the dry period, which was notably lower compared to the values during lactogenesis and galactopoiesis. Consistent with these findings, previous work (Atta *et al,* 2021) reported lower values of these parameters during the dry period and early pregnancy. This alteration was linked to physiological adaptations associated with foetal growth and development throughout pregnancy (Muhammad *et al,* 2011). Conversely, other studies (Saeed *et al,* 2011); Ebissy *et al,* 2019) did not demonstrate any notable variance induced by pregnancy. Early pregnancy was associated with a significantly lower lymphocyte count than both the lactogenesis and galactopoiesis phases as well as the dry period. Similar results (Atta *et al,* 2021) were reported where the number of lymphocytes significantly increased in lactating camels and decreased significantly in dry and pregnant ones. While the monocyte (MON) count during galactopoiesis was significantly lower than during the dry phase, it was not statistically different from the counts during early pregnancy and lactogenesis. In addition, a significant increase was observed during lactation in MON (Atta *et al,* 2021). In the current study, the granulocyte count during dry period and early pregnancy was significantly lower than during galactopoiesis. Atta *et al* (2021) also reported higher significant values of granulocyte count during lactation. The current findings indicated that there was a considerable variation in LYM% between the various times; the value was low during early pregnancy and extremely significant during galactopoiesis in comparison to other periods. Parallel to the current findings, a significant decrease in lymphocyte percentage was noted during late pregnancy compared to early lactation (Elkhair, 2019). However, no significant difference was reported between the dry period and early pregnancy, but a high value was reported during lactation (Atta *et al,* 2021). Data of the current study indicated that, during the dry period MON% was significantly higher compared to the early period, lactogenesis and galactopoiesis, with the lowest value observed during galactopoiesis. Consistent to the current study, a significant increase in monocyte percentage was observed during early lactation compared to late pregnancy periods (Elkhair, 2019). In the current study, the percentage of granulocytes showed no significant difference between the different periods. A significant difference between the dry period, pregnancy and lactation was reported earlier (Atta *et al,* 2021). The significant

changes observed in the percentages of lymphocytes, monocytes and granulocytes could be linked to the release of cortisol and ACTH in response to the stresses of pregnancy and lactation (Ahmed, 2017; Jainudeen and Hafez, 2000).

In the current study, RBC and HCT were significantly lower during lactogenesis and galactopoiesis compared to the dry period and early pregnancy. A significant increase in the number of RBCs was reported in lactating camels compared to the dry period (Atta *et al,* 2021). The variation in erythrocyte parameters according to physiological status may be attributed to the heightened demand for oxygen consumption and the need for a higher metabolic rate to support growth, particularly during late pregnancy and early lactation (Elkhair and Minawy, 2018). The current study reported that, Haemoglobin (HGB) levels were significantly higher during lactogenesis and galactopoiesis compared to dry period and early pregnancy. Similar results (Tharwat *et al,* 2015; El Zahar *et al,* 2017), indicated that higher values of Hb were reported during late pregnancy and early lactation in camels. Contrarily, other study (Atta *et al,* 2021) reported a slight increase in HGB levels in dry camels compared to postpartum and lactating ones. The higher levels of haemoglobin during lactogenesis and galactopoiesis could be attributed to the combination of increased elevated metabolic rate and hormonal changes during these periods. In the current study, Mean Corpuscular Volume (MCV) values were significantly higher during dry period than early pregnancy and no significant difference was observed between lactogenesis and galactopoiesis. Similar results (Ebissy *et al,* 2019) were reported earlier. The low value of MCV during early pregnancy could be the result of hormonal changes that prioritise resources towards supporting foetal growth and development.

Table 1. White blood cell parameter values in female camels during different reproductive periods (Dry, Early Pregnancy, Lactogenesis, Galactopoiesis).

Parameters	Period				P value
	Dry period (n=15)	Early pregnancy (n=13)	Lactogenesis (n=12)	Galactopoiesis (n=12)	
WBC ($\times 10^9$/L)	12.50±2.87^a	11.65±2.30^a	27.06±8.95^b	65.77±19.17^c	0.000
LYM ($\times 10^9$/L)	3.60±1.40^a	1.23±0.35^b	35.30±13.45^c	47.38±15.59^c	0.000
MON ($\times 10^9$/L)	2.58±1.28^{ab}	1.71±1.03^b	2.22±0.77^b	2.64±1.44^a	0.000
GRAN($\times 10^9$/L)	6.34±3.12^a	8.76±1.71^a	9.54±3.44^{ab}	12.40±3.60^b	0.000
LYM%	29.06±8.60^a	12.16±2.54^b	63.60±8.009^c	73.041±7.38^d	0.000
MON%	15.16±3.31^a	10.80±3.03^b	9.17±2.38b^c	6.94±1.69^c	0.000
GRAN%	52.85±12.21^a	75.084±5.64^b	31.86±9.68^c	17.30±3.19^d	0.000

a,b,c; Values within a column that have different superscripts vary significantly from each other ($p<0.05$). WBC; Number of white blood cells, LYM; Lymphocyte, MON; Monocyte, GRAN; Granulocyte, LYM%; Per cent Ratio of Lymphocyte, MON%; Per cent Ratio of Monocyte, GRAN%; Per cent ratio of Granulocyte.

Table 2. Red blood cell and platelets parameter values in female camels during different reproductive periods (Dry, Early Pregnancy, Lactogenesis, Galactopoiesis).

Parameters	Stage of lactation				P value
	Dry period (n=15)	Early pregnancy (n=13)	Lactogenesis (n=12)	Galactopoiesis (n=12)	
HGB (g/dl)	11.06±1.39^a	14.23±1.34^b	124.38±9.44^c	121.41±6.27^c	0.000
RBC ($\times 10^{12}$/L)	5.38±0.62^a	5.34±0.54^a	4.60±0.43^b	4.23±0.58^b	0.000
HCT%	23.36±2.58^a	22.39±2.17^a	19.80±1.65^b	19.01±2.43^b	0.000
MCV fL	43.21±0.47^a	42±0.68^{bc}	43.15±1.43^{ac}	42.98±1.65^{ac}	0.029
MCH pg	23.34±1.85^a	26.05±1.97^b	28.25±4.19^b	28.72±3.82^b	0.000
MCHC g/dL	53.98±4.40^a	63.86±7.24^b	655.33±73.58^c	594±32.80^c	0.000
PLT ($\times 10^9$/L)	211.73±36.45^a	154.74±13.24^b	137.16±19.05b^c	139.91±12.38^c	0.000
MPV fL	6.62±0.56	6.33±0.84	6.47±0.75	7.058±0.83	0.110

a,b,c; Values within a column that have different superscripts vary significantly from each other ($p<0.05$). RBC; Number of red blood cells, HGB; Haemoglobin concentration, HCT; Haematocrit, MCV; Mean corpuscular volume, MCH; Mean corpuscular haemoglobin, MCHC; Mean corpuscular haemoglobin concentration, PLT; Number of Platelets, MPV; Mean Platelet Volume.

The current findings indicated that high significant values of Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC) were observed during lactogenesis and galactopoiesis. However, no significant difference was observed between lactogenesis and galactopoiesis in the current study. These results were in the contrary to the results that reported earlier (Ebissy *et al*, 2019), whereas, a significant difference was reported between antepartum and postpartum days. The high values of MCH and MCHC could be the result of adaptations to optimise oxygen transport and metabolism, including alterations in erythropoiesis and haemoglobin synthesis to meet the increased metabolic demands of milk production. In the current study, a low significant level of platelets (PLT) was observed during lactogenesis and galactopoiesis compared to dry period and early pregnancy. This low value could be attributed to the physiological stress associated with lactation and the demands of milk production, which can impact platelet levels. The current findings indicated that there was no significant difference in Mean Platelet Volume (MPV) values during the different periods.

In conclusion, the current data illustrates how several time periods such as the dry period, early pregnancy, lactogenesis and galactopoiesis affect the haematological parameters of dromedary camels and may serve as a useful guide for she-camels.

Conflict of interests

The authors have not declared any conflict of interests.

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