

Reference values of essential haematological parameters in Damascus does and bucks throughout the year

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ABSTRACT

This study was conducted on adult male and female Damascus goats to determine some blood components throughout the year. Twelve goats (4 males and 8 females), 2-3-year-old apparently healthy were used for one year. Jugular blood samples were collected once a week using vacutainers containing 18 mg K2E as an anticoagulant. Immediately after collection, samples were transferred to the lab to determine some blood components using Veterinary Hematology Analyzer. Overall means were: $17.09 \pm 5.16 \times 10^3/\text{mm}^3$ for White Blood Cells (WBC), $7.82 \pm 2.85\%$ for Lymphocytes (LYM), $0.98 \pm 0.39\%$ for Monocytes (MON), 11.16 ± 3.28 g/dL for Haemoglobin (HGB), $750 \pm 319 \times 10^3/\text{mm}^3$ for Platelet Counts (PLT) and 4.99 ± 0.38 fL for Mean Platelet Volume (MPV), with variations in the concentrations of the components among individuals. Results indicated statistical differences in the means of WBC, LYM, HGB, PLT and MPV between males and females, with no significant differences in the MON parameters. Results also showed statistical differences in the values of all parameters between winter and summer months in males and females, except for MON, where mean values of WBC, LYM and HGB with higher values in winter as compared to summer months.

Keywords: Blood components, white and red blood cells parameters, platelets parameters, male and female Damascus goats, months of the year.

INTRODUCTION

Goats are important animals and the major livestock of many countries including India, Pakistan and Bangladesh (Khanum et al. 2000) due to the uniqueness they have in terms of withstanding harsh conditions and the low cost of maintenance (Zarkawi et al. 1999), and the vital role they play in the socio-economic structure of rural poor (Pal et al. 2011).

Damascus (Shami) goat breed is originated from Damascus and was spread to other cities within Syria and then to some neighbouring countries to improve the local breeds (Khalil et al. 2010). This breed is seasonal and famous for its good characteristics especially for milk production. However, for some reasons, the number of Damascus goats has been decreasing. In 2010, for example, the number of Damascus goats was 63256 head (out of total goat number 2056627, 3.08%), decreased to only 35397 (out of 1844197, 1.92%) in 2019 (MAAR, 2021). There is a cause for concern about this great deterioration in their numbers, consequently this Syrian valuable Damascus goats breed could probably face an imminent wave of extinction, accordingly, the Syrian Ministry of Agriculture and Agrarian Reform has established the Dair Al-Hajar Damascus (Shami) Goats Research Station to improve their productivity and increase their numbers.

Determination of the haematological parameters is widely used to assess and monitor the nutritional and metabolic conditions of the animals (Pizetti et al. 2021); hence, measurement of such parameters can reflect the physiological and health status of animals (Zarkawi and Soukouti, 2022).

Values of haematological parameters are affected by several factors including breed, age, environment, reproductive status, husbandry and hormonal treatments (Arfuso et al. 2016; Habibu et al. 2017a; Ahmad et al. 2018).

Many laboratories in the world have no reference haematological parameters and need to establish their own ones for their use. In the literature, reference values of haematological parameters for some animals species were reported such as Italian Ariégeois, Bleu de Gascogne, Bracco italiano, Segugio italiano, and Briquet Griffon Vandeen hunting dogs (Miglio et al. 2020), Chinese water deer (Nie et al. 2020), Brazilian geese (Benarrós et al. 2020), Egyptian buffaloes (Abd Ellah et al. 2019), Pakistani camels (Farooq et al. 2011), Italian Piemontese and Blonde d'Aquitaine cattle (Tarantola et al. 2020) and Croatian Lika Pramenka sheep (Vugrovečki et al. 2017).

As for goats, Al-Bulushi et al. (2017) studied some haematological parameters (White Blood Cells: WBC, Neutrophils, Red Blood Cells: RBC, Haemoglobin: HGB, Haematocrit: HTC, urea and cholesterol) in four goat breeds in Oman to establish the reference values, while in Argentina, Pizetti et al. (2021) determined 12 haematological parameters in goats raised in three different regions differing environmentally and geographically, and indicated that HGB and HCT values were higher in high mountainous environment as compared to others. In Italy, 13 haematological parameters were analysed in female Verzaschese and Camosciata delle Alpi goats, (Agradi et al. 2022) and reported differences in values of 11 parameters. In a Turkish study, Karaşahin et al. (2022) determined eight blood components namely WBC, RBC, HGB, HCT, Mean Corpuscular Volume: MCV, Mean Corpuscular Haemoglobin: MCH, Mean Corpuscular Haemoglobin Concentration: MCHC and Red Cell

Distribution Width: RDW in male and female Hair goat breed at different age stages to establish the reference values of them.

In Syria, several studies were conducted on Damascus goats such as response of Damascus does to fluorogestone acetate (FGA) sponges and equine chorionic gonadotropin (eCG) treatments assessed by laparoscopy, progesterone and cortisol concentrations (Zarkawi and Soukouti, 2018). However, as for haematological parameters, very few studies and reports are available, including determination of WBC, RBC, HGB and HCT in female Damascus goats during pregnancy (Al-Ani et al. 2009) and assessment of RBC, Packed Cell Volume: PCV and HGB values in goats infected with soft foreign bodies in the rumen (Abdulrahman et al. 2022). Therefore, the aim of the current study was to define and establish haematological reference parameters for the adult male and female Damascus goats throughout the year and to assess the effect of the season on the studied parameters.

MATERIALS AND METHODS

Ethical approval

This study was approved by the Local Scientific and Ethical Committee of the Atomic Energy Commission of Syria (AECS), Damascus, Syria (Permit Number 36/Z/M1-02/09/2019).

Blood sampling and analysis

Jugular blood samples (10 mL) were collected weekly at the same time (10 am) from the experimental Damascus goats using vacutainers (BD, Plymouth, UK) containing K2E as an anticoagulant. Then, samples were immediately and directly transferred to the lab for determination of some blood components using a Veterinary Hematology Analyzer (Mythic™ Vet, Orphée, Geneva, Switzerland).

Parameters and statistical analysis

The following parameters were measured: White Blood Cells: WBC, Lymphocytes: LYM, Monocytes: MON, Haemoglobin: HGB, Platelet Counts: PLT and Mean Platelet Volume: MPV.

Results were statistically analyzed and the differences among the means were calculated by ANOVA using Statview-IV programme on IBM system.

RESULTS AND DISCUSSION

This work gives, for the first time, values of six essential haematological parameters in adults male and female Damascus goats throughout the year as reference intervals and is considered as a continuation to previous works to

characterize this locally, regionally and internationally important Damascus goats breed.

It is well known that blood tests and analyses are important diagnostic tools in animal diseases (Žaja et al. 2019). Blood contains three different types of cells namely red blood cells (RBC) or erythrocytes, white blood cells (WBC) or leukocytes or leucocytes and platelets or thrombocytes (Sahlol et al. 2020), and RBC form the majority of the blood cells (Aliyu et al. 2018).

Leukocyte parameters include WBC, LYM, MON and Granulocytes: GRA; Erythrocyte parameters contain RBC, HGB, HCT, MCH, MCHC, RDW and MCV, whereas Thrombocytes parameters consist of PLT and MPV.

Leukocyte parameters

WBC counts. The overall mean for WBC was $17.09 \pm 5.16 \times 10^3/\text{mm}^3$, ranging from 7.3 to $33.2 \times 10^3/\text{mm}^3$, which lies within the values of 12.88, 12.2 and 12.1 to $9.8 \times 10^3/\text{mm}^3$, reported by (Mohammed et al. 2016) in the blood of in Barbari, Black Adrdi, White Adrdi and Damascus goats, respectively in Kuwait, and $14.6 \times 10^3/\text{mm}^3$ in Sahrawi Musandam, Jabal Al-Akhdar, Sahrawi and Jabali goat breeds in Oman [17, and $8.66 \times 10^3/\text{mm}^3$ in Camosciata delle Alpi goat breed in Italy (Agradi et al. 2022).

In the current study, there was an influence of season and sex on WBC. Significant differences in the overall mean of WBC parameter between males and females were observed averaging: 16.10 ± 4.55 and $17.59 \pm 5.38 \times 10^3/\text{mm}^3$, respectively. WBC values were higher during winter months (January and February) as compared to the summer months (July and August) in both goat sexes (18.84 ± 4.25 and $14.11 \pm 3.12 \times 10^3/\text{mm}^3$ for males, and 20.68 ± 5.63 and $14.11 \pm 3.12 \times 10^3/\text{mm}^3$ for females, respectively (Figs. 1 and 2). This is in agreement with Agradi et al. (2022) who found a significant increase in WBC value during winter as compared to summer months in Verzascese and Camosciata delle Alpi goat breeds in Italy, whereas, in Kiko goat breed kept in the USA, Okere et al. (2022) did not find such difference in WBC values between Summer ($15.9 \pm 6.47 \times 10^3/\text{mm}^3$) and Winter ($14.8 \pm 6.59 \times 10^3/\text{mm}^3$).

Egbe-Nwiyi et al. (2000) reported an increase in WBC counts in male goats ($14.89 \times 10^3/\text{mm}^3$) as compared to the females ($12.38 \times 10^3/\text{mm}^3$) in Nigeria. There is an influence of the breed too on WBC values. Okonkwo et al. (2011) found significant differences in WBC counts among three goat breeds namely Sahel, Red Sokoto and West African Dwarf in Nigeria (11.9 , 11.3 and $9.23 \times 10^3/\text{mm}^3$, respectively).

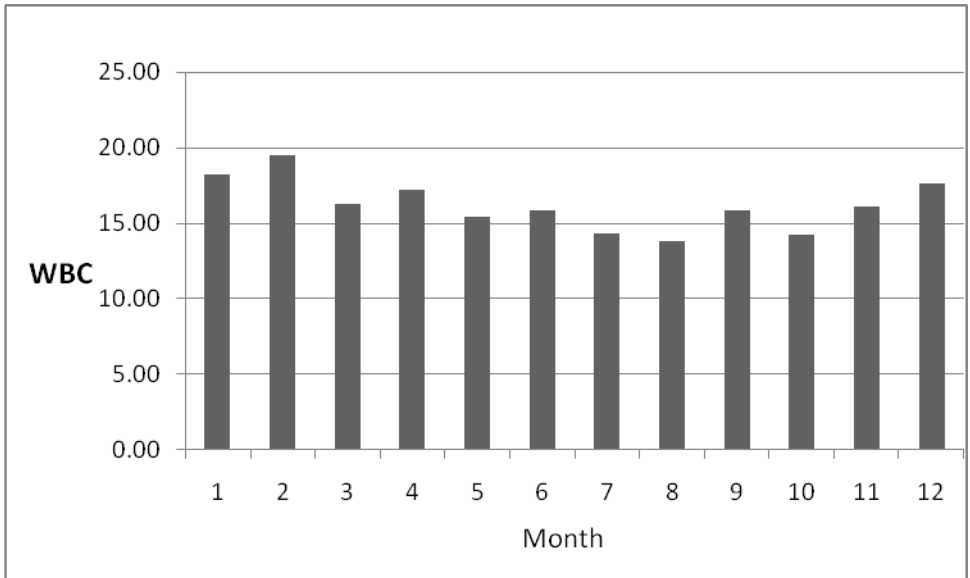


Figure 1. Mean white blood cell count (x10³/mm³) in male Damascus goats throughout the year

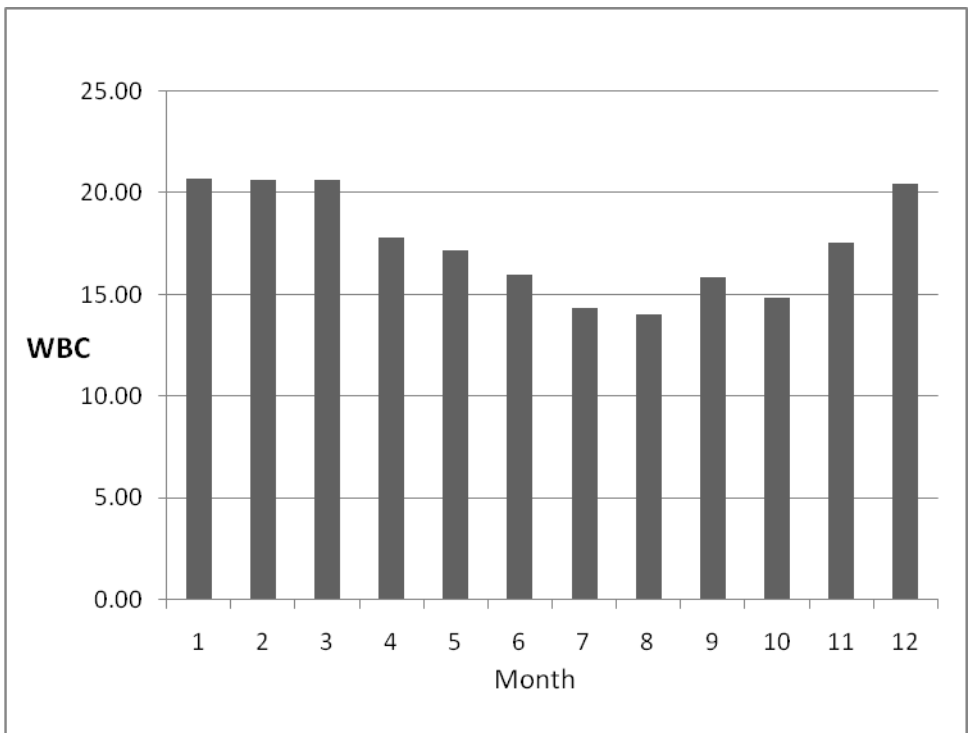


Figure 2. Mean white blood cell count (x10³/mm³) in female Damascus goats throughout the year

LYM. The overall mean for *LYM* was $7.82 \pm 2.85\%$ ranging from 2.2 to 18.9%, which was significantly higher in the females ($8.11 \pm 2.87\%$) as compared to the males ($7.25 \pm 2.73\%$). Moreover, a significant difference in the value was found between summer and winter in both sexes, it was high during January and February (males: $8.78 \pm 2.98\%$, females: $9.90 \pm 3.33\%$) as compared to July and August (males: $5.72 \pm 2.17\%$, females: $6.99 \pm 2.11\%$) (Figs. 3 and 4). The increase in *LYM* concentration in winter as compared to summer in this study is in agreement with Agradi et al. (2022) who reported similar results in Verzasca and Camosciata delle Alpi goat breeds in Italy. Dhuha et al. (2021) reported an influence of goat breeds (Saanena and Anglo-Nubian) raised in Malaysia on *LYM*%.

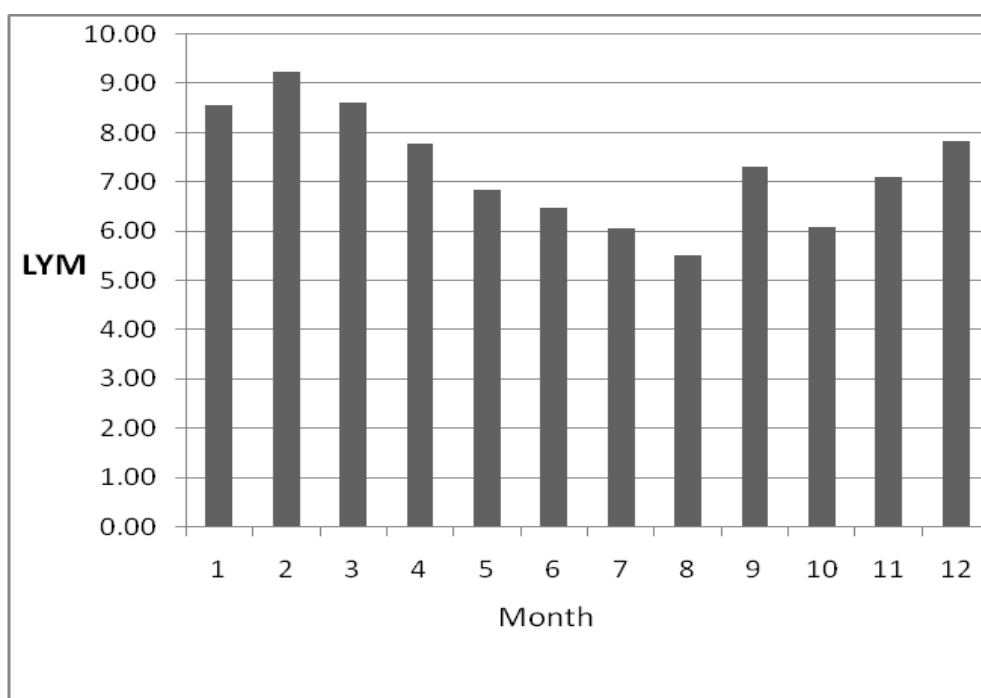


Figure 3. Mean concentration of lymphocytes (%) in male Damascus goats throughout the year

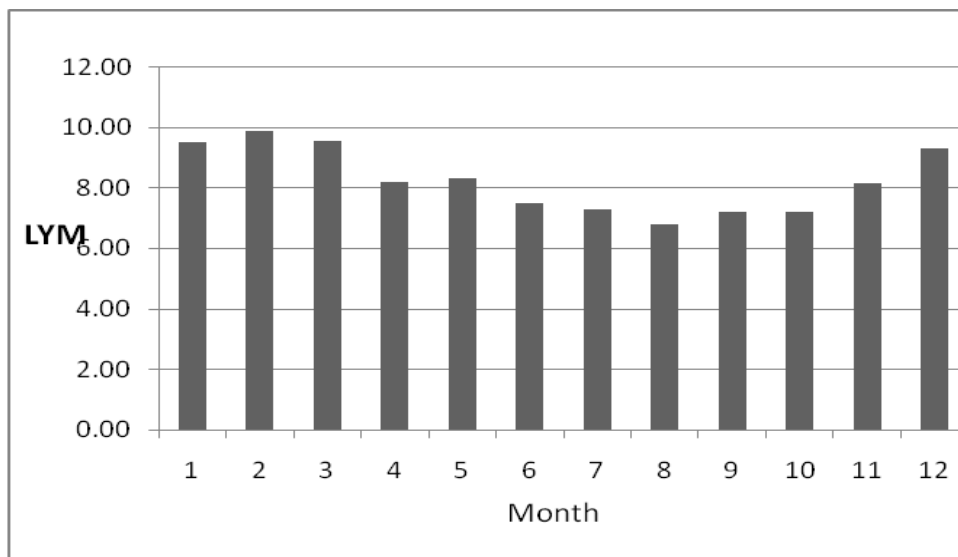


Figure 4. Mean concentration of lymphocytes (%) in female Damascus goats throughout the year

MON. The overall mean for MON was $0.98 \pm 0.39\%$, ranging from 0.3 to 2.2%, which is below 3% reported by (Oni et al. 2020) in Dwarf African goat in Nigeria, with a significant ($P < 0.05$) rise in winter (1.44 and 1.38% for January and February as compared to 0.72 and 0.65% for July and August). Figures 5 and 6 show means of the monthly variations in MON concentrations throughout the year in male and female Damascus goats, respectively. There was no significant difference in MON concentration between males ($0.93 \pm 0.35\%$) and females ($1.01 \pm 0.39\%$). Goat sex influence on MON values was also reported in adult Nigerian Sahel goats (Egbe-Nwiyi et al. 2015). However, as for the two seasons, no significant difference between summer and winter was detected (males: 0.95 and 1.01%, females: 1.05 and 1.16%). Similarly, Agradi et al. (2022) found no significant difference in MON concentration in Verzascese and Camosciata delle Alpi goat breeds in Italy.

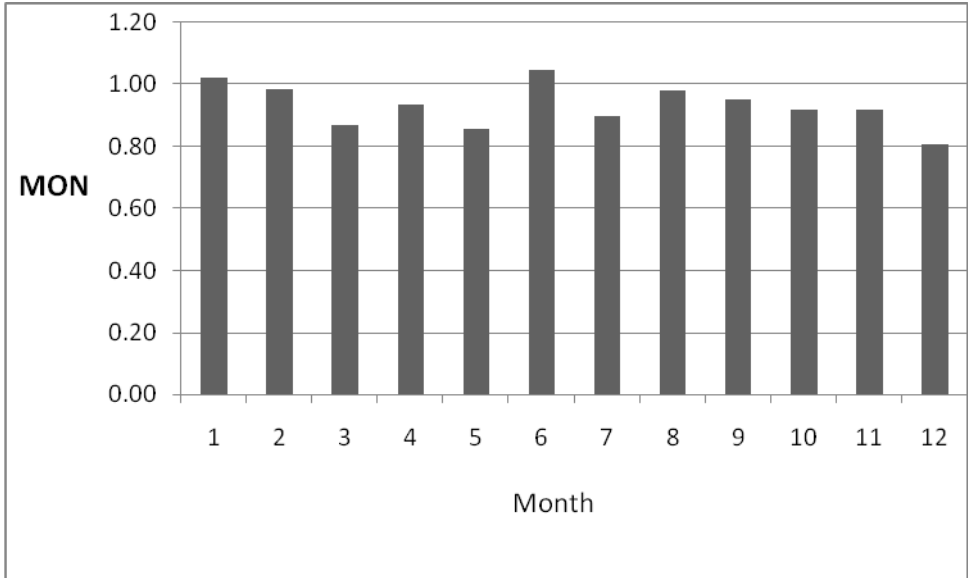


Figure 5. Mean concentration of monocytes (%) in male Damascus goats throughout the year

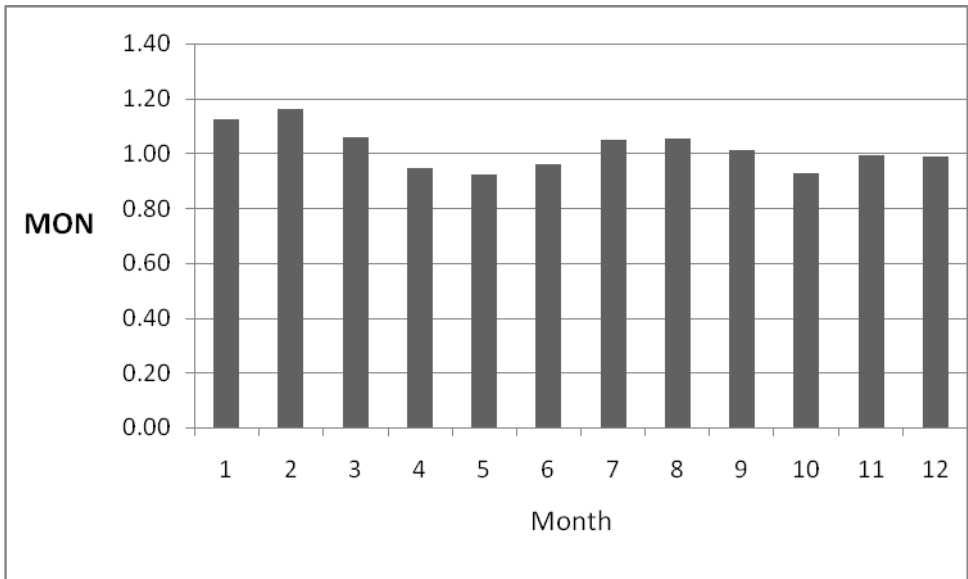


Figure 6. Mean concentration of monocytes (%) in female Damascus goats throughout the year

Erythrocytes parameters

HGB. The overall mean for HGB was 11.16 ± 3.28 g/dL, ranging from 5.6 to 22.3 g/dL, and in males 11.63 ± 3.15 g/dL, while in females was 10.92 ± 3.29 g/dL with a significant difference between them. In addition, there was a significant difference in the concentration between summer and winter seasons in both sexes (Figs. 7 and 8), with a significant rise in winter (males: 16.21 g/dL, females: 15.81 g/dL), as compared to July and August (males: 8.8 g/dL, females: 7.92 g/dL). Similarly, in Zarabi and Damascus male goats kept in Egypt, Abdel Rahman et al. (2019) reported that the highest HGB values were recorded in winter season, whereas, Okere et al. (2022) did not find differences in HGB values in Kiko goat breed in the USA between summer (9.23 ± 1.47 g/dL) and winter (9.99 ± 1.59 g/dL). HGB value reported in the current study is within the laboratory reference values in goats (8-12 g/dL) reported by Jackson and Cockcroft (2002), and also within 9.97, 8.43 and 10.65 g/dL reported by Mohammed et al. (2016) in Barbari, Black Adrdi and white Adrdi goats, respectively in Kuwait, and 12.46 and 12.38 g/dL in male and female Saanen goat in Turkey (Elitok, 2012), and 7.6 g/dL in male African Dwarf goats in Nigeria (Oni et al. 2020).

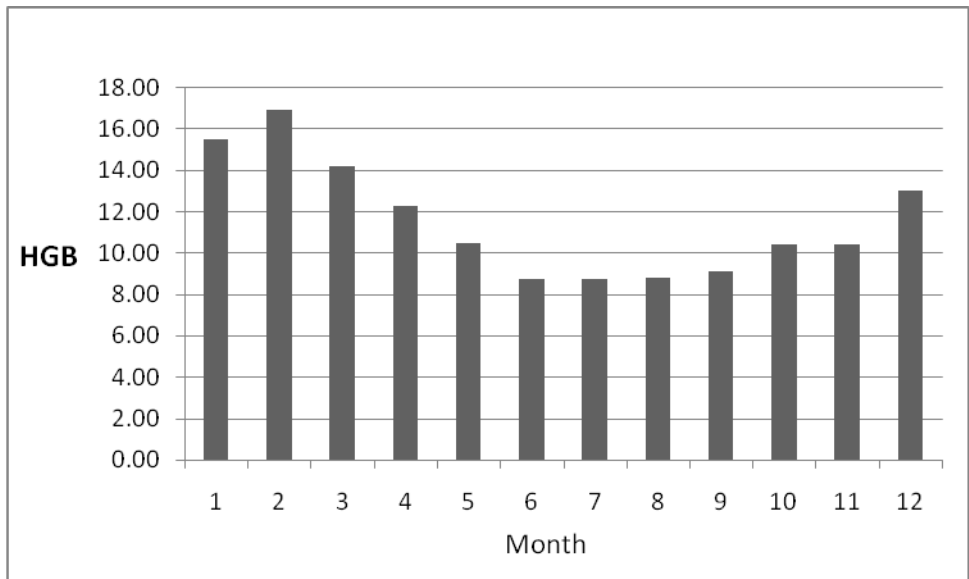


Figure 7. Mean concentration of haemoglobin (g/dL) in male Damascus goats throughout the year

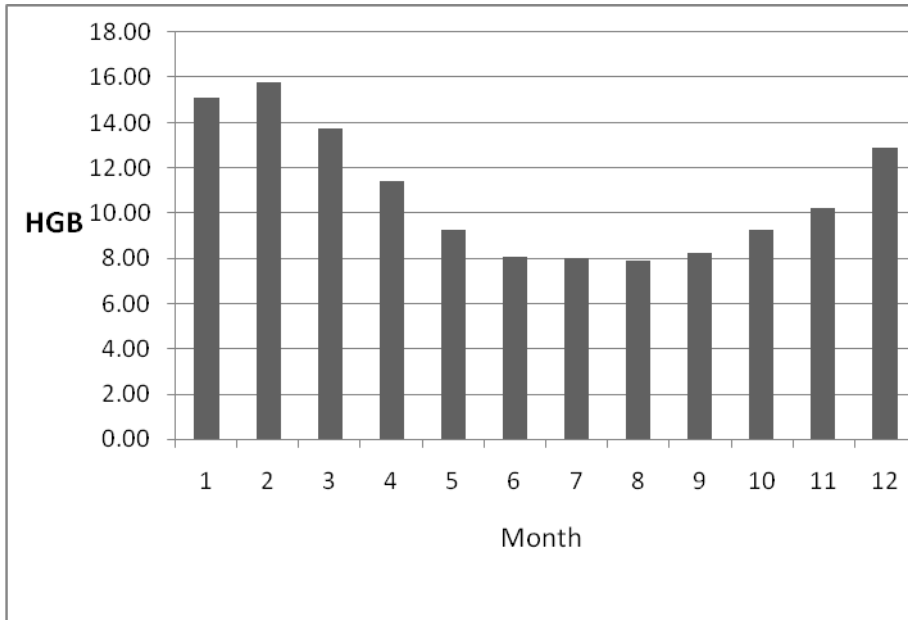


Figure 8. Mean concentration of haemoglobin (g/dL) in female Damascus goats throughout the year

Thrombocyte parameters

Platelets Counts. There was an effect of both sex and season on PLT counts. Overall mean for Platelets Counts reached $750 \pm 319.8 \times 10^3/\text{mm}^3$, ranging from 175 to $1766 \times 10^3/\text{mm}^3$, in males 820 ± 313 while in females $715 \pm 3.7 \times 10^3/\text{mm}^3$ with significant difference between them, which is in agreement with Habibu et al. (2017b) between males ($265.6 \times 10^3/\text{mm}^3$) and females ($190.4 \times 10^3/\text{mm}^3$) Red Sokoto and Sahel goat breeds in Nigeria. In addition, there was a significant difference in the PLT counts between winter (males 1159, females $1125 \times 10^3/\text{mm}^3$) and summer (males 584, females $418 \times 10^3/\text{mm}^3$) months (Figs. 9 and 10).

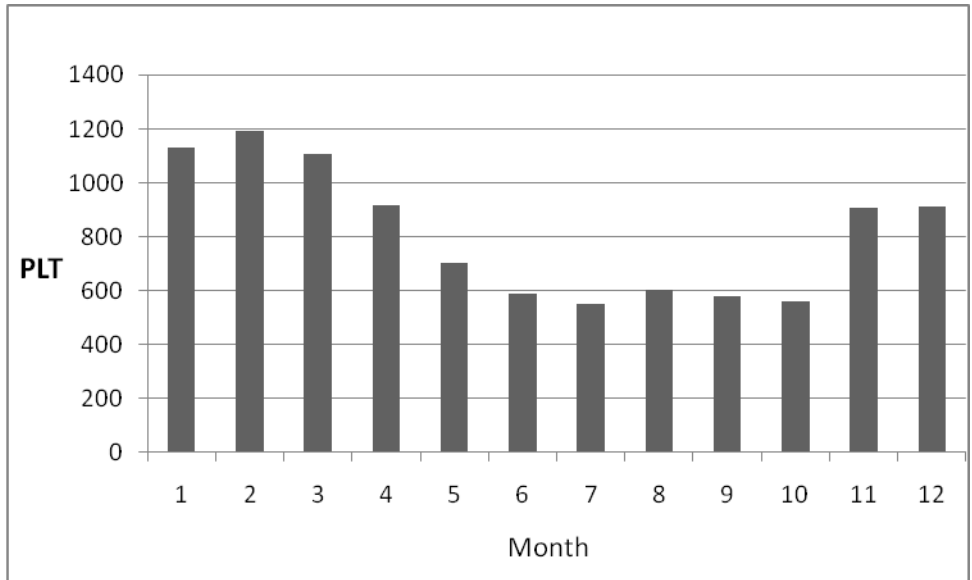


Figure 9. Mean concentration of platelets ($\times 10^3/\text{mm}^3$) in male Damascus goats throughout the year

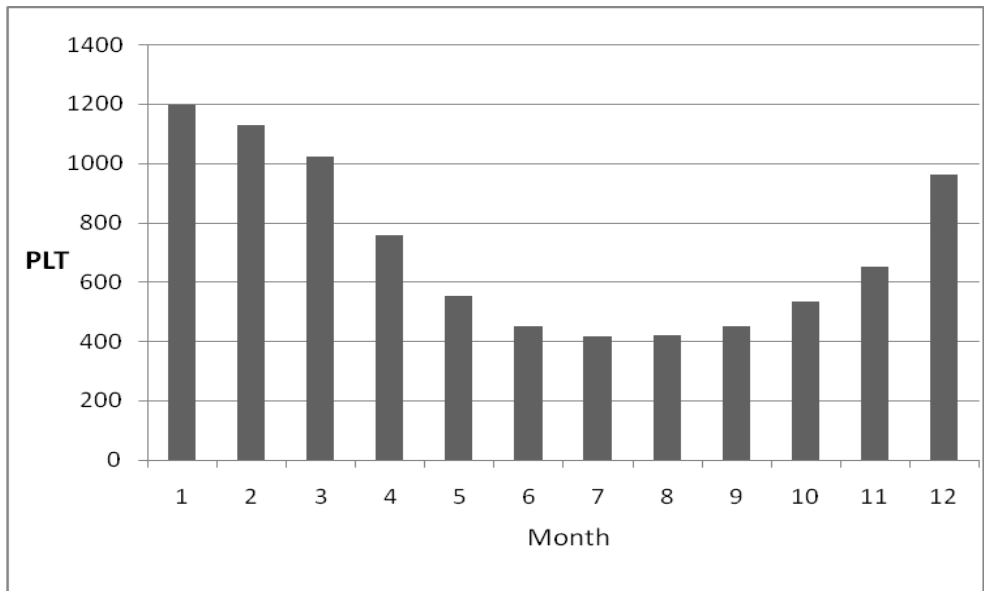


Figure 10. Mean concentration of platelets ($\times 10^3/\text{mm}^3$) in female Damascus goats throughout the year

MPV. Overall mean for *MPV* was 4.99 ± 0.38 fL, ranging from 3.9 to 5.9 fL, which is below 10.4, 10.6, 8.65 and 8.12 fL reported by Mohammed et al. (2016) in Barbari, Black Adrdi, White Adrdi and Damascus goats, respectively in Kuwait. Overall mean in males was 4.92 ± 0.40 and in females was 5.03 ± 0.37 fL with a significant difference between them. As for the months, mean values in January and February were significantly higher as compared to July and August in both sexes (males: 5.01 and 4.81, females 5.08 and 4.88 fL) (Figs. 11 and 12). Similarly, Okere et al. (2022) reported an influence of season on *MPV* values in Kiko goats in the USA, where *MPV* was higher in winter as compared with summer, which is in agreement with our current results.

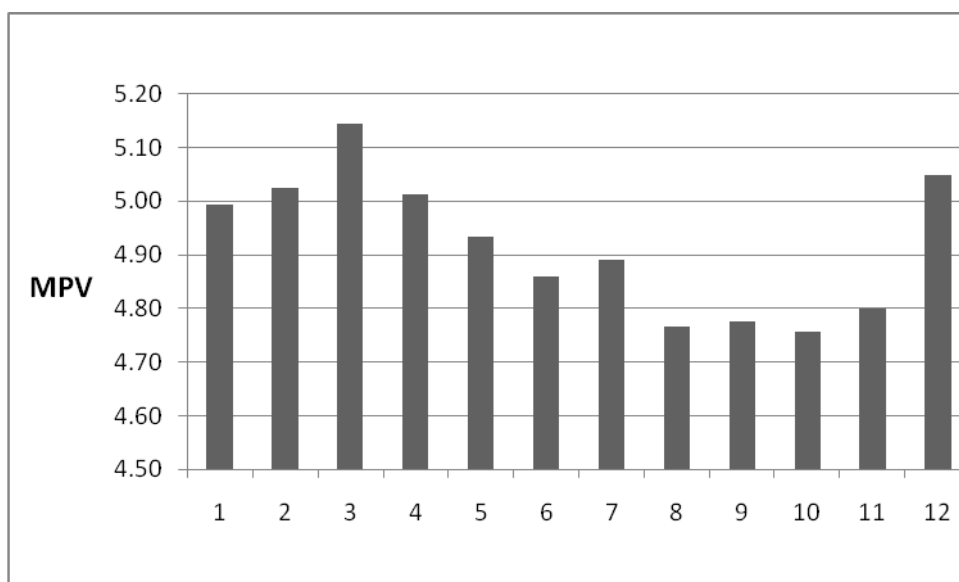


Figure 11. Mean concentration of mean platelet volume (fL) in male Damascus goats throughout the year

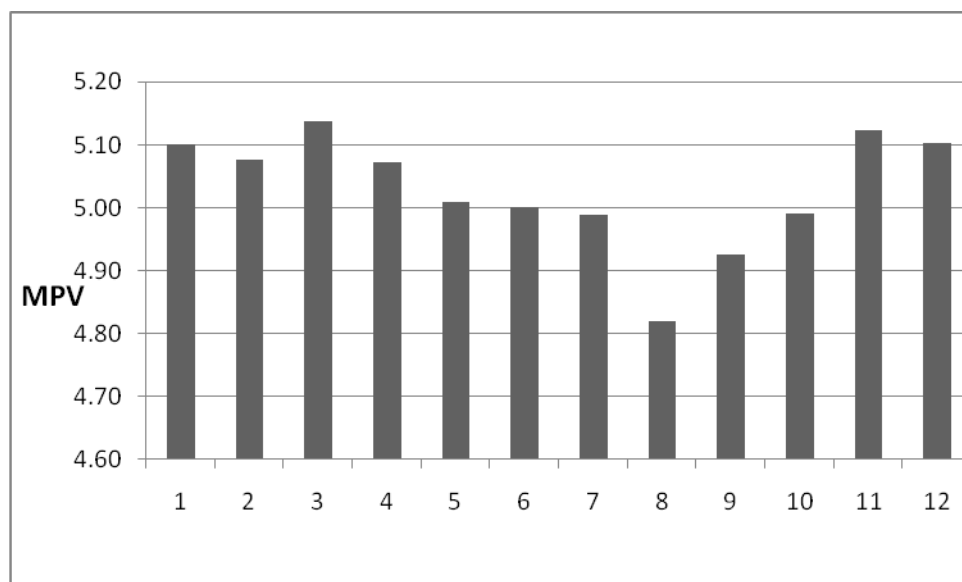


Figure 12. Mean concentration of mean platelet volume (fL) in female Damascus goats throughout the year

Finally, Table 1 gives overall means, maximum and minimum values of haematological parameters, and significance in male and female Damascus goats, and Table 2 summarizes the parameters values in summer and winter months, whereas Table 3 compares the overall mean values of some parameters between Awassi rams (Zarkawi and Soukouti, 2022) and Damascus bucks kept in the same environment throughout the year, illustrating the differences in haematological parameters in the two local animal species.

Table 1. Overall means for the studied haematological parameters in male and female Damascus goats

Parameter	Males	Females	Significance	Overall Mean	Maximum-Minimum Value
WBC ($\times 10^3/\text{mm}^3$)	16.10 \pm 4.55	17.59 \pm 5.38	P = 0008	17.09 \pm 5.16	33.2 - 7.3
LYM (%)	7.25 \pm 2.73	8.11 \pm 2.87	P = 0.0008	7.82 \pm 2.85	18.9 - 2.2
MON (%)	0.93 \pm 0.35	1.01 \pm 0.39	NS	0.98 \pm 0.39	2.2 - 0.3
HGB (g/dL)	11.63 \pm 3.15	10.92 \pm 3.29	P < 0001	11.16 \pm 3.28	22.3 - 5.6
PLT ($\times 10^3/\text{mm}^3$)	820 \pm 313	715 \pm 317	P < 0001	750 \pm 319	1766- 175
MPV (fL)	4.92 \pm 0.40	5.03 \pm 0.37	P = 0013	4.99 \pm 0.38	5.9 - 3.9

Table 2. Mean values of the studied haematological parameters and the significance between winter months (January and February) and summer months (July and August) in male and female Damascus goats

Parameter	Winter	Summer	Significance
WBC ($\times 10^3/\text{mm}^3$)	18.84 \pm 4.25	14.01 \pm 4.13	P < 0001
Males			
WBC ($\times 10^3/\text{mm}^3$)	20.67 \pm 5.63	14.11 \pm 3.12	P < 0001
Females			
LYM (%)	8.78 \pm 2.98	5.72 \pm 2.17	P < 0001
Males			
LYM (%)	9.90 \pm 3.33	6.99 \pm 2.11	P < 0001
Females			
MON (%)	1.01 \pm 0.33	0.95 \pm 0.37	NS
Males			
MON (%)	1.16 \pm 0.45	1.05 \pm 0.32	NS
Females			
HGB (g/dL)	16.21 \pm 2.33	8.80 \pm 1.47	P < 0001
Males			
HGB (g/dL)	15.81 \pm 2.17	7.92 \pm 1.08	P < 0001
Females			
PLT ($\times 10^3/\text{mm}^3$)	1159 \pm 260	584 \pm 133	P < 0001
Males			
PLT ($\times 10^3/\text{mm}^3$)	1125 \pm 238	418 \pm 107	P < 0001
Females			
MPV (fL)	5.01 \pm 0.12	4.81 \pm 0.47	P = 0.0223
Males			
MPV (fL)	5.08 \pm 0.12	4.88 \pm 0.47	P = 0.0017
Females			

Table 3. Overall means of some haematological parameters in Awassi rams* and Damascus bucks throughout the year

Parameter	Awassi Sheep	Damascus Goats
WBC ($\times 10^3/\text{mm}^3$)	8.92 \pm 5.05	17.09 \pm 5.16
LYM (%)	5.91 \pm 3.92	7.82 \pm 2.85
MON (%)	1.00 \pm 0.45	0.98 \pm 0.39
HGB (g/dL)	10.24 \pm 1.16	11.16 \pm 3.28
PLT ($\times 10^3/\text{mm}^3$)	577 \pm 180	750 \pm 319
MPVm(fL)	3.99 \pm 0.49	4.99 \pm 0.38

* Zarkawi and Soukouti (2022)

CONCLUSION

It was possible, for the first time in Syria, to successfully define and establish reference values for six essential haematological parameters in both male and female Damascus goats throughout the year.

This reported work is a continuation of other previous works aiming at characterization of this nationally, regionally and internationally important goat breed.

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