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Effects of Age, Breed and Sex on Haematological Parameters of Growing Omani Goat Breeds

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ABSTRACT: Sixty seven healthy growing goat kids of three Omani breeds, born and raised in Sultan Qaboos University Agricultural Experiment Station, were used to study the effects of age, breed and sex on haematological parameters. Blood samples were collected at several times from the first to 25 weeks to study the following parameters: Red Blood Cells (RBCs), White Blood Cells (WBCs), Packed Cell Volume (PCV), Haemoglobin (Hb), Mean Cell Volume (MCV), Mean Cell Haemoglobin Concentration (MCHC) and Mean Cell Haemoglobin (MCH). At birth, MCV and MCH levels were significantly higher in Batina (BAT) kids than both Jabal Akhdar (JA) and Dhofari (DOF), but there were no breed differences in the rest of the haematological values. There were significant breed differences in RBC, MCH, WBC, MCV at different ages, with Hb and PCV being highly significant at all ages. All blood parameters changed with time but showed different patterns in all breeds. There was no effect of sex on RBC, MCHC, PCV, Hb or WBC, but female kids had significantly higher MCH and MCV values at week 12. This study indicates that haematology parameters in Omani goat kids could be affected by age, breed and sex.

Keywords: Batina; Breeds; Dhofari Goats; Haematology; Jabal Akhdar; Oman.

تأثيرات العمر والسلالة والجنس على مكونات الدم في سلالات الماعز العمانية النامية

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مستخلص: تم استخدام عدد 67 من مواليد ماعز ثلاثة سلالات عمانية بصحة جيدة، ولدت وتربت في محطة التجارب الزراعية لجامعة السلطان قابوس، لدراسة تأثيرات العمر والسلالة والجنس في قياسات مكونات الدم. تم تجميع عينات من الدم عدة مرات من الاسبوع الأول حتى الاسبوع 25 بعد الميلاد لدراسة قياسات المكونات الآتية : عدد كريات الدم الحمراء (RBC)، عدد كريات الدم البيضاء (WBC)، قياس نسبة الهيماتوكريت (PCV)، تركيز الهيموجلوبين (Hb)، متوسط حجم كرية الدم الحمراء (MCV)، متوسط تركيز الهيموجلوبين في كرية الدم الحمراء (MCHC)، ومتوسط هيموجلوبين كريات الدم الحمراء (MCH). في الأسبوع الأول كان قياس (MCV) و (MCH) أعلى بدلالة إحصائية في مواليد ماعز سلالة الباطنة عن سلالتي الجبل الأخضر والظفارية، ولكن لم يكن هناك فرق بينهم في قياسات بقية المكونات. كانت هناك فروقات ذات دلالات احصائية بين السلالات في أعمار مختلفة في كل من قياسات (RBC)، (MCH)، و (WBC) و (MCV)، مع فروقات سلالة ذات دلالة احصائية عالية جداً في قياسات (Hb) و (PCV) في كل الأعمار. قياسات كل المكونات تغيرت مع العمر بأساليب مختلفة في كل السلالات. لم يكن هناك تأثير للجنس على قياسات (RBC)، (MCHC)، (PCV)، (Hb) أو (WBC)، ولكن قياسات كل من (MCH) و (MCV) في الإناث كانت اعلى من الذكور بدرجة إحصائية عالية في الأسبوع 12. هذه الدراسة اشارت إلى أن قياسات مكونات الدم في سلالات الماعز العمانية النامية قد تتأثر بالعمر والسلالة والجنس.

كلمات مفتاحية: الباطنة ، السلالات ، ظفاري ، ماعز ، مكونات الدم ، الجبل الأخضر ، عمان.

1. Introduction

There are over two million heads of livestock in Oman including 1.56 m goats [1], with three major breeds of goats, Jabal Akhdar (JA), Batina (BAT) and Dhofari (DOF). The JA breed is the largest in size among all goat breeds and mostly located in the interior of Oman especially Al Jabal Al-Akhdar Mountains (green mountains). They have back twisted-horns, long pendulous ears, long hair and are predominantly golden to brown in colour [2]. Batina breed goats have long hair, pendulous ears and a larger mature body size than the DOF goat, which resembles the short haired, prick-eared East African goat. The adult BAT goat, found mostly in the Batina coastal plain of North Oman, Batina may weigh 10–15 kg more than the DOF goat. The home of DOF goats is in the mountains of South Oman, Dhofar [3]. Local breeds have shown good potential for production when subjected to improved management [2]. Goats are mainly kept for meat in Oman. Their meat is preferred by Omanis to that of imported breeds. Local goats are sold for very high prices, and slaughtered at different social occasions. Haematological values are important parameters for the health status assessment of individual animals. Normal values can be altered by an animal's exposure to abnormal conditions including environmental hazards, e.g. crude oil pollution [4], season [5], bacterial

infections such as mastitis [6], Mycoplasma [7] or parasitic infestation [8]. They can also vary due to physiological status, breed and sex, or with age [9-11]. To our knowledge there is no detailed published record on the normal haematological values in Omani goat breeds. This is necessary for health assessment of goats by veterinarians in Oman. Therefore, the current study was conducted to provide reference values for haematology in healthy growing Omani goats, as well as to study the effects of age, breed and sex on these values.

2. Materials and Methods

In this study, a total of sixty seven apparently healthy kids were used, 19 of JA, 19 of BAT and 29 of DOF goat breeds, which had been raised in Sultan Qaboos University Agricultural Experiment Station (AES). The animals were kept in clean partially shaded open yards equipped with feed and water troughs. Kids were weaned at age 12–14 weeks and were provided with either a general ruminant concentrate, prepared in the AES feed mill, or a commercial concentrate (Dairy 18; Oman Flour Mill Co., Oman) at a rate of 250-300 g/head/day. They were fed regularly at 9:00 am. Rhodes grass hay, either produced at AES or purchased through a local dealer, was offered *ad libitum*. The protein and some of the mineral concentrations in the various feeds are presented in Table 1. The animals were allowed free access to salt licks (Writex copper block, Frank Wright Feeds International LTD, Ashbourne, UK, Table 1) and water. All animals were routinely subjected to anthelmintics and they were internal and external parasite free.

Table 1. Protein and mineral contents of feeds and salt licks offered to growing kids of Jabal Akhdar, Batina and Dhofari Omani goat breeds.

Feed	Trace elements (mg/kg DM)			Protein (%)
	Copper	Zinc	Iron	
General ruminant concentrate	19.7	67.2	422	13.05
Dairy 18	27.0	79.3	524	16.96
Purchased hay	5.7	7.5	48	4.94
Farm hay	4.5	9.5	58	9.62
Salt lick (mg/kg)	400	2500	120	

Blood samples were collected at 8:00 am from the jugular vein in vacutainer tubes containing the anticoagulant EDTA for haematology determination. Blood samples were collected at 1, 3, 8, 12, 16, 19 and 25 weeks. Haematological parameters were obtained in fresh samples using a Cell-Dyn 3700 automated blood analyzer (Abbott Laboratory, Diagnostic Division, Abbott Park, IL 60064, USA). The following parameters were analyzed: red blood cells (RBC), white blood cells (WBC), packed cell volume (PCV), haemoglobin concentration (Hb), mean cell volume (MCV), mean cell haemoglobin concentration (MCHC) and mean cell haemoglobin (MCH).

2.1 Statistical analysis

General linear model statistical analysis was used to study the effects of age, breed and sex. The Type III method for sum of squares was used with the unbalanced model factorial design. The Duncan Multiple Range Test was used to compare the means. All analyses were carried out using SPSS 19 for Windows personal computer package [13].

3. Results

The means and ranges of haematological parameters in growing kids of the three Omani goat breeds are shown in Table 2. All haematological parameters changed during the experimental period. However, the trends in these changes were not similar across all the parameters. While WBC, RBC and MCHC gradually increased, MCV and MCH levels decreased from the first to the twelfth week (weaning age), then stabilised. However, haemoglobin was low at the first week, then increased at age 8 weeks. On the other hand, PCV dropped slightly from birth values in the second sampling at age 3 weeks, then returned to previous values and stabilised until the end of the experimental period.

Table 2. Mean (± SE) and range of haematological values in kids of three Omani goat breeds at various ages.

Age (weeks)	RBC (10^{12}/l)	Hb (g%)	PCV (%)	MCV (fl)	MCH (pg)	MCHC (gm%)	WBC (10^3/µl)
Birth	8.2 ± 0.33	9.0 ± 0.16	28.3 ± 0.66	37.2 ± 1.48	11.9 ± 0.46	32.2± 0.33	9.93 ± 0.39
	(7.6-8.9)	(8.7-9.3)	(26.9-29.4)	(34.3-39.9)	(11.0-12.8)	(31.5-32.8)	(9.16-10.7)

3	11.6 ± 0.36	8.9 ± 0.14	26.6 ± 0.41	24.7 ± 1.0	8.3 ± 0.35	33.4 ± 0.21	13.24 ± 0.44
	(10.9-12.3)	(8.6-9.1)	(25.8-24.4)	(22.7-26.7)	(7.6-9.0)	(33.0-33.8)	(12.36-14.12)
8	19.6 ± 0.49	10.4 ± 0.13	28.4 ± 0.33	15.1 ± 0.65	5.6± 0.22	36.5 ± 0.18	19.06 ± 0.54
	(18.7-20.6)	(10.1-10.6)	(27.7-29.0)	(13.8-16.4)	(5.1-6.0)	(36.1-36.8)	(17.97-12.14)
12	23.2 ± 0.47	10.1 ± 0.18	27.3 ± 0.31	12.1 ± 0.27	4.5 ± 0.11	36.9 ± 0.53	23.51 ± 0.56
	(22.3-23.2)	(9.7-10.4)	(26.7-27.9)	(11.5-12.6)	(4.2-4.7)	(36.0-38.0)	(22.39-24.64)
16	25.2 ± 0.87	10.4 ± 0.13	27.4 ± 0.36	11.4 ± 0.37	4.3 ± 0.13	37.8 ± 0.19	22.95 ± 0.68
	(23.5-26.9)	(10.1-10.6)	(26.7-28.1)	(10.7-12.2)	(4.0-4.6)	(37.4-38.2)	(21.58-24.32)
19	19.5 ± 0.96	10.4 ± 0.13	27.9 ± 0.34	15.7 ± 0.58	5.9 ± 0.20	37.5 ± 0.33	24.42 ± 0.73
	(17.6-21.4)	(10.1-10.7)	(27.2-28.5)	(14.5-16.9)	(4.5-6.4)	(36.8-38.1)	(22.96-25.87)
25	20.0 ± 0.73	9.1 ± 0.12	25.2 ± 0.37	13.6 ± 0.57	4.9 ± 0.21	37.7 ± 0.33	24.56 ± 0.70
	(18.5-21.4)	(8.9-9.3)	(24.5-25.9)	(12.5-14.8)	(4.5-5.3)	(36.0-37.3)	(23.16-25.94)

Table 2. Contd.

There were significant breed differences in RBC, MCH, WBC, MCV, Hb and PCV, but there was no breed effect on MCHC (P>0.05).

Means of RBC values in different breeds are presented in Table 3. Significant breed differences were observed at week 3 (P<0.05) with the highest values for JA, and week 8 (P<0.05) and week 12 (P<0.001) with the highest values for BAT. Despite these differences all breeds followed similar trends of change during the study period.

Table 3. Means (± SE) of RBC (1012/l), Hb (g%), and PCV (%) haematological blood parameter values in growing kids of Jabal Akhdar, Batina and Dhofari Omani goat breads. (Means followed by the same letters, or with no letter, are not significantly different (P>0.05)).

Breed		**Jabal Akhdar**		**Batina**		**Dhofari**		**Breed effect**
	Age	Mean	SE	Mean	SE	Mean	SE	
RBC (10^{12}/l)	Birth	8.6	0.59	7.3	0.60	8.7	0.49	NS
	3	13.0a	0.64	11.2b	0.70	10.5b	0.51	P<0.05
	8	21.3b	0.90	19.6a	0.93	18.0b	0.72	P<0.05
	12	22.4b	0.88	26.1a	0.88	21.2b	0.66	P<0.001
	16	26.4	1.67	25.6	1.62	23.7	1.18	NS
	19	18.3	1.86	21.1	1.75	19.1	1.34	NS
	25	19.4	1.42	21.7	1.33	18.8	1.00	NS
Hb (g%)	Birth	9.1	0.3	9.2a	0.3	8.6	0.24	NS
	3	9.4a	0.25	9.3a	0.27	7.9b	0.2	P<0.001
	8	10.7a	0.23	10.6a	0.24	9.9b	0.19	P<0.05
	12	10.9a	0.33	10.1a	0.34	9.2b	0.25	P<0.001
	16	11.2a	0.18	10.7a	0.67	9.3b	0.23	P<0.001
	19	11.2a	0.25	10.9a	0.25	9.3b	0.19	P<0.001
	25	9.6a	0.22	9.3a	0.22	8.5b	0.17	P<0.001
PCV (%)	Birth	27.9	1.1	29.4	1.1	27.1	0.91	NS
	3	27.8 a	0.73	27.9 a	0.8	24b	0.58	P<0.001
	8	29a	0.6	29.1 a	0.6	27.1b	0.47	P<0.05
	12	28.7a	0.56	28.7 a	0.6	24.6b	0.44	P<0.001
	16	29.2a	0.66	28.4 a	0.7	24.6b	0.5	P<0.001
	19	29.6a	0.63	28.8 a	0.6	25.2b	0.48	P<0.001
	25	26.6a	0.68	26.2 a	0.7	22.8b	0.52	P<0.001

There were no significant (P>0.05) breed differences in either Hb or PCV (Table 3) at birth. Thereafter, DOF kids recorded consistently significant (P<0.001) but only at age 8 weeks, (P<0.05) lower values of Hb and PCV throughout the experimental period than both JA and BAT, which had similar values at all ages. There were significant breed differences for MCV (Table 4) at birth (P<0.05) due to the highest mean value in BAT, at week

12 (P<0.05) where the JA mean value was higher than BAT, and week 19 (P<0.05), where the JA mean value was higher than both BAT and DOF.

Table 4. Means (± SE) of MCV (fl) MCH (pg) and WBC haematological blood parameter values (10^3/µl) in growing kids of Jabal Akhdar, Batina and Dhofari Omani goat breads. (Means followed by the same letters, or with no letter, are not significantly different (P>0.05))

Breed		**Jabal Akhdar**		**Batina**		**Dhofari**		**Breed effect**
	Age	Mean	SE	Mean	SE	Mean	SE	
MCV (fl)	Birth	34.4a	2.5	43.1b	2.6	33.9a	2.1	P<0.05
	3	22.6	1.79	27.6	1.95	23.9	1.42	NS
	8	14.2	1.19	15.7	1.22	15.5	0.95	NS
	12	13.0a	0.49	11.2b	0.49	11.9ab	0.37	P<0.05
	16	11.7	0.71	11.6	0.69	11.0	0.5	NS
	19	18.4a	1.13	14.3b	1.06	11.4b	0.81	P<0.05
	25	14.8	1.1	12.7	1	13.5	0.78	NS
MCH (pg)	Birth	11.3b	0.84	13.6a	0.84	10.8b	0.68	P<0.05
	3	7.7	0.61	9.3	0.68	7.8	0.49	NS
	8	5.2	0.4	5.7	0.41	5.8	0.33	NS
	12	5.0a	0.21	4.0b	0.21	4.4ab	0.16	**
	16	4.5	0.26	4.4	0.25	4.1	0.18	NS
	19	7.0a	0.34	5.4b	0.36	5.2b	0.27	P<0.001
	25	5.3	0.4	4.5	0.4	5.0	0.28	NS
WBC	Birth	9476	712	10079	712	10229	576	NS
(10^3/µl)	3.56	12905b	442	11131b	86b	15683a	629	P<0.001
	8.27	18994b	542	17294b	1029b	20882a	801	P<0.05
	12.44	24167	564	22505	1068	23870	804	NS
	16.3	24046	684	21094	1305	23717	953	NS
	20.3	24918b	729	21947 b	1359	26386	1041a	P<0.05
	25.15	25847	700	23669	1301	24167	950	NS

At birth BAT kids had significantly higher values for MCH (P<0.05) than both JA and DOF (Table 4). After weaning, JA goats had the highest values but thereafter the only significant differences were at week 12, when JA MCH values were higher than those for BAT (P<0.01), and at week 19, when they were higher (P<0.001) than those for both BAT and DOF kids. Dhofari kids had higher WBC count pre-weaning, than both JA and BAT in week 3 (P<0.001) and week 8 (P<0.05) (Table 4). Post weaning, BAT consistently recorded the lowest values but these were significantly lower than DOF (0<0.05), which was the highest, only at week 20.

There was no significant (P>0.05) effect of sex, or a clear tendency, on PCV, MCHC or WBC during the experimental period, nor was there any significant (P>0.05) effect of sex on RBC at any time. However, there was a tendency (P=0.053) of higher values in females (8.9±0.49) compared with males (7.7±0.49) at birth. Similarly, there was no significant (P>0.05) effect of sex on Hb at any time. However, there was a tendency (P=0.084) of higher values in females (10.2±0.26) compared to males (9.6±0.28) at 12 week. Male kids had a tendency (P=0.064) of higher MCV mean value at birth than females (38.5 ± 1.97 *vs* 35.9 ± 2.2, respectively). This tendency (P=0.062) in males continued in the next bleeding at age 3 weeks (26.3 ± 1.43 *vs* 22.7 ± 1.34, respectively). Thereafter, female kids' values exceeded those of males but this was significant (P<0.05) only at age 12 weeks (12.8 ± 0.36 *vs* 11.4 ± 0.37, respectively). A similar trend was in observed in MCH, with a tendency (P=0.06) of higher values of MCH in male kids (12.6 ± 0.64) than in females (10.8 ± 0.65) at birth, and at 3 weeks (P=0.075) (8.8 ± 0.5 and 7.7 ± 0.47, respectively). Thereafter, female kids had higher values but the difference was significant (P<0.05) only at age 12 weeks (4.7 ± 0.16 and 4.2 ± 0.16, respectively).

4. Discussion

The haematological blood parameters, such as RBCs, Hb, WBCs, can reflect physical changes occurring in an animal's body. These changes could be due to diseases or normal physiological changes. Haemoglobin is the substance responsible for transporting oxygen to body tissues and removing waste carbon dioxide. It also plays an important role in maintaining the pH of the blood. RBCs transport Hb. Reduction of Hb or of RBCs results in low O_2 in tissues, causing short breath, a symptom of anaemia. WBCs, or leukocytes, defend the body against invasions of foreign particles. Their number can be used to detect the presence of pathogens in the blood of sick animals.

The change of values with age of all the haematological parameters in the growing kids in this study is in line with other reports that either compared groups of young and adult goats [13-14], goats of many age groups [15-21] and sheep [10,11,15] or studied changes in growing animals as in calves [22,23] and swine [24]. The drop in Hb and PCV values from birth to three weeks of age and the subsequent increase to previous values reported in this study is comparable to that in neonatal Dwarf and Landrace kids reported by Mbassa and Poulsen [17]. At early age the mean values of all parameters in Omani kids were comparable to those reported by Gutierrez, *et al.* [25] in 1 week old Canary goat kids.

At about three months of age, however, only PCV values were comparable to that of white German and Coloured German Noble breeds [26]. Values of RBCs, Hb, MCH and MCHC were higher while MCV and WBC were lower in Omani kids than in German breeds. Comparing Omani kid's values at the end of study period i.e. at age 25 weeks, with other goats, Hb was comparable to that of Barbari male goats at 9-12 months of age [28] lower than the mean value of adult West African Dwarf goats [13] and within the goat range provided by the Merck Veterinary Manual [29]. On the other hand RBCs, MCHC and WBCs were higher while PCV, MCV and MCH were lower in 25 weeks old Omani kids than the values reported by Sharma, *et al*., Daramola *et al*., and the Merck Veterinary Manual [13,27,28].

The differences between values obtained in the current study and other reports can be attributed to many factors including differences in climate [5], diet [29], management system [30-33] and breed. The latter cause is confirmed in the current study, as goats of all breeds were raised under the same conditions. Breed difference in haematological values was also established in other goats in Ethiopia [21], Bangladesh [20], in Northern Nigeria [34] and Mubi Adamawa State of Nigeria [35].

The DOF breed had the lowest values for both Hb and PCV and, mostly, the highest values of WBCs. That may indicate a lower health status of DOF goat. That suggestion is supported also by the lower Hb and PCV mean values in DOF than those reported elsewhere [13,25-27] and below the range of the Merck Veterinary Manual (2009)[25]. However, this difference could be due to difference in breed *per se* or to low acclimatization of DOF to the different habitat of the study area (Muscat) compared to Dhofar, the original habitat of this breed. No record is available on the haematological values of this breed in its natural habitat. However, this supports the statement of Daramola *et al*. [13] that it is difficult to establish a universal haematological profile.

There was a significant sex difference only at age 12, the weaning age, where females had higher MCV and MCH, although there were tendencies of higher values for females than male at early age on RBC, and on Hb (at 12 week). There were higher MCVs in 0-3 m and 3-6 m old groups of female goats in Borno State of Nigeria [18]. In the latter report, sex also influenced RBC, Hb and PCV. This was in contrast to the report of Tibbo *et al*. [21] who found significantly higher PCV and RBC values in males than females in Ethiopian native goats but no significant sex effect on MCHC or WBC and reports of Egbe-nwiyi *et al*. [18] with higher RBCs, PCV and MCV values in male goats between birth and 7 years. Similarly, Ramprabhu *et al*. [19] reported that males had higher values of Hb, PCV, RBC and WBC in Kanni Indian goats. On the other hand, sex did not affect haematological parameters in neonatal Dwarf and Danish Landrace kids [17] and West African Dwarf goats [13,30]. However, another study by Opara *et al.* [36] on the same West African Dwarf goats of different age groups reported higher WBC in male than in females.

5. Conclusion

It has been presented that the values of haematological parameters, in healthy growing kids of JA, BAT and DOF goat breeds, raised under extensive systems were generally within the reference range reported for other goat breeds. These findings provide the reference values in these breeds and may be helpful for diagnosis purposes in these breeds.

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