

# Effect of Management System on Serum Copper Level and Haematology of Jabal Akhdar Breed Goats in two Sites in Al Jabal Al Akhdar Region of Oman

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**ABSTRACT:** Blood samples were collected from randomly selected healthy Jabal Akhdar breed goats reared in two sites in the Jabal Akhdar region of Oman. Seven males and 65 female goats, age range 2 months to 4 years, raised in Shnoot Al-Dar village were kept under a semi-intensive system (SIS) and 2 males and 18 females, age range 4 months to 5 years, raised in Al-Ala'lana village and kept the under free range system (FRS) were studied. Serum Cu and haematological values were measured. There were no significant ( $p>0.05$ ) effects of age, sex or serum copper levels on the haematology of goats, so data was pooled and only the effects of the management system on serum Cu and haematology were analysed. There were highly significant ( $p<0.001$ ) differences between the two systems in all parameters studied. FRS goats were higher than SIS goats in mean values ( $\pm$  SE) of serum Cu (mg/l)  $0.60 \pm 0.07$  vs  $0.48 \pm 0.33$ , red blood cells (RBC) ( $\times 10^{12}/L$ ) value  $15.03 \pm 0.42$  vs  $14.97 \pm 0.25$ , mean cell volume (MCV) (fl)  $21 \pm 21$  vs  $19.57 \pm 0.19$ , and haematocrit (HCT) (%) value  $31.84 \pm 0.59$  vs  $29.6 \pm 0.35$ . SIS values were higher than FRS in haemoglobin (Hb) (g/dl)  $9.34 \pm 0.16$  vs  $9.26 \pm 0.27$ , mean cell haemoglobin (MCH) (pg)  $6.21 \pm 0.05$  vs  $6.16 \pm 0.08$  and mean cell haemoglobin concentration (MCHC) (g/dl)  $31.96 \pm 0.38$  vs  $29.05 \pm 0.64$ . Therefore, it is evident that the management system can affect the serum copper levels and haematology of the Jabal Akhdar breed of goats in the Jabal Akhdar region of Oman.

**Keywords:** Haematology; Serum copper; Copper deficiency; Oman; Jabal Akhdar; Goats

أثر نظام الرعاية على مستوى عنصر النحاس في مصل ومكونات الدم في نوع ماعز الجبل الأخضر في موقعين بمنطقة الجبل الأخضر بسلطنة عمان

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**الملخص:** جمعت عينات من الدم من نوع ماعز الجبل الأخضر تبدو بصحة جيدة، تم اختيارها عشوائياً، من موقعين في منطقة الجبل الأخضر بسلطنة عمان. تضمنت الدراسة عدد 7 ذكور و35 أنثى بأعمار تراوحت ما بين شهرين و4 سنوات ولدت وتربت في قرية شنوت الدار بالنظام شبه المغلق (SIS)، وعدد 2 ذكور و18 أنثى بأعمار تراوحت بين 4 أشهر و5 سنوات في قرية العلانا تربت على نظام الرعي المفتوح (FRS). تم قياس كل من نسبة عنصر النحاس في مصل وقيم مكونات الدم. لم تكن هناك تأثيرات ذات دلالات إحصائية لكل من العمر، الجنس، أو مستوى عنصر النحاس في المصل على قيم مكونات الدم، ولذلك ضمت البيانات وانحصرت التحليل على أثر نظام التربية فقط. كانت هناك فروق بين النظامين ذات دلالات إحصائية عالية جداً ( $p<0.001$ ) في كل القيم التي تمت دراستها. كان نظام FRS أعلى من نظام SIS في كل من متوسط قيم النحاس (مغ/ل)  $0.60 \pm 0.07$  مقابل  $0.48 \pm 0.33$ ، عدد كرات الدم الحمراء ( $\times 10^{12}$ )  $15.03 \pm 0.42$  مقابل  $14.97 \pm 0.25$ ، متوسط حجم الخلية (مغ/ل)  $21 \pm 21$  مقابل  $19.57 \pm 0.19$ ، والهيماتوكريت (%)  $31.84 \pm 0.59$  مقابل  $29.6 \pm 0.35$ . كان نظام SIS أعلى من نظام FRS في قيم كل من الهيموجلوبين (ج/دس ل)  $9.34 \pm 0.16$  مقابل  $9.26 \pm 0.27$ ، ومتوسط تركيز هيموجلوبين الخلية (ج/دس ل)  $6.21 \pm 0.05$  مقابل  $6.16 \pm 0.08$ ، ومتوسط تركيز هيموجلوبين الخلية (ج/دس ل)  $31.96 \pm 0.38$  مقابل  $29.05 \pm 0.64$ . استنتج من نتائج البحث أن نظام الرعاية يمكن أن يؤثر على مستويات النحاس في مصل وقيم مكونات الدم في نوع ماعز الجبل الأخضر بمنطقة الجبل الأخضر بسلطنة عمان، وأن نظام الرعي المفتوح ربما يكون جزءاً من حل مشكلة نقص عنصر النحاس في أمصال الماعز العمانيّة.

**الكلمات المفتاحية:** مكونات الدم، نحاس مصل الدم، نقص عنصر النحاس، عمان، الجبل الأخضر، ماعز الجبل الأخضر.



## 1. Introduction

Haematological values are useful in assessing animal health and provide vital information on the physiological, nutritional and pathological status of an animal. These values are affected by several factors such as age, breed, sex, management systems [1-3], diet [4], rumen impaction [5] and parasitism [6].

Copper is an essential trace element which is associated with clinical and biochemical disorders. Copper deficiency is an endemic problem in Oman where low tissue, plasma or serum values have been reported in livestock by many workers [7-9].

Goats comprise a very important source of meat and income to villagers in Oman. Jabal Akhdar goats, a large body size goat, comprise 20% of the total goat population of 854,060 in Oman, as reported by Mahgoub *et al* [10]. They are named after the region they inhabit, the Jabal Akhdar. The Jabal Akhdar, Jebel Akhdar or Al Jabal Al Akhdar, is a part of the Al Hajar Mountain range in Oman, which extends about 300 km northwest to southeast, between 50 – 100 km inland from the Gulf of Oman coast. The range is mostly desert, with the higher altitudes receiving around 300 mm (12 in) of precipitation annually, which is moist enough to allow the growth of shrubs and trees and to support agriculture. This gives the mountains their 'green' name [11]. Goats are generally kept in medium to large herds of about 1-50 [10]. Villagers either leave their goats to graze all day on a free range management system, in which they browse on *Acacia* shrubs and other trees, or they feed them on seasonal indigenous range grass, Rhodes grass hay, by-products and household leftovers [10]. This work was intended to investigate the effect of the management system on the haematology and serum copper of goats in the Jabal Akhdar region of Oman.

## 2. Materials and Methods.

Blood samples were collected from the jugular vein from randomly selected, apparently healthy, Jabal Ahkdar breed goats, reared in two different sites in the Jabal Akhdar region of Oman. A total of 72 goats, 7 males and 65 females, age range 2 months to 4 years, raised in Shnoot Al Dar village (GPS: N 23' 06.930 E 057' 39.507 Elevation: 2289 meters above sea level (masl)) kept under the semi-intensive system (SIS) and 20 goats, 2 males and 18 females, age range 4 months to 5 years, raised in Al Ala'lana village (GPS: N 23' 06.903 E 057' 34.647 Elevation: 2172 masl) kept under the free range system (FRS) were included in the study. Serum was collected from blood in situ, separated in vials and kept at a cool temperature, moved to the lab and then frozen. Serum copper values were detected using Atomic Absorption Spectrophotometry. For haematology, blood was collected in EDTA vacuum tubes, kept at a cool temperature, moved to the lab and then analyzed immediately. Haematological parameters were obtained from these fresh samples using a CELL-DYN 3700 automated blood analyzer (Abbott Laboratory, Diagnostic Division, Abbott Park, IL 60064, USA). Parameters studied included the following: Red blood cells (RBC), Packed cell volume (PCV), Haemoglobin concentration (Hb), Mean cell volume (MCV), Mean cell haemoglobin concentration (MCHC) and Mean cell haemoglobin (MCH).

## 3. Statistical Analysis

Means were compared to study the effects of the management systems, age, sex and serum copper levels on these values using Type III general linear model statistical analysis using the SPSS computer package. There were no effects of age, sex or serum copper levels on haematological values; so data were pooled and only the effect of the management system on serum copper (mg/l) and haematological values were studied. A serum copper concentration  $\leq 0.59$  mg/l was considered as low and  $\geq 0.60$  mg/l was considered as normal.

## 4. Results and Discussion

### 4.1 Serum copper

The effect of the management system on serum copper level is presented in Table 1. FRS mean serum copper (mg/l) was significantly ( $p < 0/001$ ) higher than mean values for SIS.

**Table 1.** Serum copper and haematological values ( $\pm$ SE) of Jabal Akhdar goats under two management systems.

Parameter	Free range System	Semi-intensive System	Significance
Serum copper (mg/l)	0.60 $\pm$ 0.07	0.48 $\pm$ 0.33	0.000
RBC ( $\times 10^{12}$ /l)	15.03 $\pm$ 0.48	14.97 $\pm$ 0.25	0.000
MCV (fl)	21.00 $\pm$ 0.21	19.57 $\pm$ 0.19	0.000
PCV (%)	31.84 $\pm$ 0.59	29.6 $\pm$ 0.35	0.000
Hb (g/dl)	9.26 $\pm$ 0.27	9.34 $\pm$ 0.17	0.000
MCH (pg)	6.16 $\pm$ 0.08	6.21 $\pm$ 0.05	0.000
MCHC (g/dl)	29.07 $\pm$ 0.06	31.96 $\pm$ 0.38	0.000

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**Table 2.** Numbers and (%) of goats with normal or low serum Cu and mean values (mg/l  $\pm$  SE) in Semi-intensive and Free range management systems.

Serum Cu level	Semi-intensive system		Free range system	
	Goats number (%)	Serum Cu (mg/l)	Goats number (%)	Serum Cu (mg/l)
Normal	20(27.8%)	0.87 $\pm$ 0.04	11(57.9%)	0.72 $\pm$ 0.05
Low	52(72.2%)	0.33 $\pm$ 0.02	8(42.2%)	0.45 $\pm$ 0.06
Total	72		19	
Significance of management system		0.005		
X serum Cu interaction				
MCHC (g/dl)	29.07 $\pm$ 0.06	31.96 $\pm$ 0.38		0.000

The mean of serum Cu in FRS goats was at the bottom of the normal range, while that of the SIS goats was within the low or deficient range. At the same time the numbers and proportions of goats with normal or low serum Cu and mean values of each group, presented in Table 2, show that there was a higher proportion of goats with normal serum Cu than of those of low serum Cu in FRS, while there was a lower proportion of normal goats than of low serum Cu goats under SIS. Copper deficiency can be caused by low dietary Cu intake (simple Cu deficiency) or dietary intake of interfering elements, particularly molybdenum and sulphur [12] or iron (secondary Cu deficiency). Previous reports indicate that the prevalence of Cu deficiency in many Omani regions could be related to low Cu, high iron, sulphur and elevated molybdenum contents in different feeds [7,13]. In this study the goats in FRS presented better serum Cu status than the SIS goats. This may indicate that the FRS grazing goats, having the opportunity to select feeds [14], could have possibly selected either higher Cu or lower interfering element contents than the SIS goats, which mostly take feeds provided by owners, and which may be of low Cu content or contain causative agents of Cu deficiency. Although the results still show a low Cu status in some goats in the FRS, it may be a management system of higher potentiality to reduce the Cu deficiency problem in this area of Oman. However, the high stocking rate and overgrazing in this region [15] could have led to low availability of feeds to support the grazing goats, and thus get their Cu and other nutrient requirements fulfilled.

### 4.2 Haematological Values

The results of the effect of the management system on haematological values are presented in Table 1. There were highly significant differences ( $p < 0.001$ ) between the two systems on all haematological parameters studied. FRS were higher than SIS in mean values of RBC ( $\times 10^{12}/L$ ), MCV (fl) and PCV (%). SIS values were higher than FRS in Hb (g/dl) MCH (pg) and MCHC (g/dl). Similar results to these current ones were observed in West African Dwarf (WAD) Goats by Imasuen [16], West African Dwarf sheep in Nigeria [17] and in cattle (summarized by Etim *et al* [1]. On the other hand, Ifut *et al* [18] reported no significant effect of management system on the haematology of WAD goats.

Red blood cells function as carriers of haemoglobin. The latter contains iron and is responsible for the transportation of  $O_2$  to body cells and  $CO_2$  from cells to the lungs for excretion through respiration [19]. Therefore, their number reflects the availability of  $O_2$  to tissues, for them to perform their normal functions of excretion of  $CO_2$ . In this work, the FRS goats had higher RBC, MCV and, hence, PCV%. Packed Cell Volume value indicates either an increase in number of RBCs or a reduction in plasma volume [20]. It is involved in the transport of  $O_2$  and the absorption of nutrients [19]. A higher value of PCV indicates better transportation and thus results in an increased primary and secondary polycythemia [1]. PCV and RBC can be affected by nutritional status [21] and environmental temperature [22]. Therefore, it appears that FRS goats were in better condition than SIS goats. Contrary to the present results, Imasuen [16] reported higher PCV%, and RBC in SIS than in FRS goats while Hb and MCHC were similarly higher in SIS than FRS goats. Another study which compared WAD goats reared in the intensive and semi-intensive systems showed that the SIS goats had higher PCV than intensive system goats [18]. Packed Cell Volume, Hb and MCH values are significant indices for diagnosis of anaemia. The indices' values and their differences between different management systems may reflect the differences in nutritional status and/or possible parasitic infestations [23].

On the other hand, compared to some other published normal haematological values, both SIS and FRS goats had mean Hb and MCHC values lower, but RBCs and PCV values higher, than in WAD [24] and Red Sokoto [25] goats. These observations support other reports of breed differences [26].

## 5. Conclusion

Jabal Akhdar goats presented different serum Cu and haematology values when reared in FRS rather than in SIS in the Jabal Akhdar region of Oman. The goats of the FRS generally showed a better performance compared to those in

the SIS, especially on the serum Cu levels and RBC, MCV and PCV values. Although a proportion of goats had serum Cu levels within the subclinical and deficient range, it can be concluded that the FRS has the potential to provide for a reduction in Cu deficiency as well as higher haematological values of RBC, MCV and PCV. Further studies are needed to support these findings and to find proper supplementation methods to help to totally alleviate Cu deficiency and to improve the haematology and health status of Jabal Akhdar grazing goats in Oman.

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