



Hematological and Metabolic Profiles in Sheep at Al-Qadisiyah province, Iraq

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Submitted: April 12 2026

Revised: May 13, 2026

Accepted: May 18, 2026

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Abstract Aims: This study aimed to investigate the hematological indices [complete blood picture (CBC)] as well as serum minerals (calcium (Ca), copper (Cu), magnesium (Mg), selenium (Se), and zinc (Zn) and Vitamin E (Vit E) in sheep in various areas at Al-Qadisiyah province (Iraq).

Methodology: Totally, 50 sheep were selected from Afak, Al-Sanyea, Al-Daghara, Nuffer, and Al-Diwaniyah during August 2025. Post clinical examination, venous blood samples were collected from all study animals, divided into without- and with- anticoagulant tubes, and used to measurement of CBC by automatic blood analyzer, and serologically to determine the minerals and vitamin using the Colorimetric Assay.

Results: The findings revealed that there was a significant reduction in values of Ca, Cu, Mg, Vit E, and Zinc with normal range in selenium. Hematologically, the findings of red blood cells (RBC) and white blood cells (WBC) were normal.

Conclusion: Sheep has obvious metabolic deficiency in Calcium, Copper, Magnesium, Zinc and Vitamin E. Selenium was within normal range. Consequently, sheep were more susceptible to infection with deficit in blood content.

Keywords; Minerals, Vitamins. Serum, calcium, selenium

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Introduction Vitamins and minerals are necessary for the typical functioning of all metabolic processes in livestock. Dietary deficiencies can effect in significant economic losses in animal productivity. Mineral and vitamin needs were last reported by the National Research Council NRC during 2000 and 2001. From that time, substantial research has been published dealing with minerals and vitamins (1). Tocopherol ratio in the serum of lower than 2 mg/L in cattle and sheep are regarded as critical levels lower which deficiency diseases may occur (2). Green plants and cereal grains represent best sources of vitamin E barley, wheat bran, soybean meal, yellow corn are good sources also (3). Inorganic substances observed in the tissues and fluids of the body. They are classified into macro minerals (Ca, Mg, K, Na,

Cl, P, and S) and micro minerals (I, Zn, Si, Fe, Mn, Cu, Co, Mo, F, Cr, and B), which are crucial for health and must be taken according to the required of the animal. Specific minerals contain good-characterized physiological functions with the body. The capability of the body to preserve the minerals content within a certain rate in spite varying consumes, include the processes of absorption, storage, and excretion (4).

Radostits *et al.* (2007) reported that the normal range of serum Ca in sheep is 11.5-13mg/dl. Ca is presented in alfalfa, green leafy crops, especially legumes, and sugar beet pulp is better sources of calcium. Cereals, root, alfalfa hay, grass hay and corn silage are low sources (5). Clinical symptoms of hypomagnesemic tetany in sheep happens when the total magnesium in

plasma become less than 0.5 mg/dl occurs with hypocalcemia (plasma total calcium [tCa] become less than 8.0 mg/dl. Total magnesium range in sheep is 2.2–2.8 mg/dl (6). The normal copper ratio in sheep ranges 0.7-1.3ug/ml, while at primary deficiency 0.1-0.2 ug/ml, secondary deficiency 0.4-0.7ug/ml (2). In all forage types copper ratio were below their respective reference range through all regions. In barley grass (reference: 6–25 ppm), In alfalfa grass (reference: 11–30 ppm while in fresh rice straw(0.06-0.1ppm) composed of soybeans, wheat, and barley.

The diagnosis of Zn decline in sheep can be done using a lower limit of normality of 0.6 mg/l in serum (7). Barley is the main source of zinc in diet as well as corn, soybean, and wheat (8). The normal serum Se level in sheep is 0.08-0.50 ug/ml (2). selenium species characterization in food and supplementation is important. So, chemical species of Se in the bio fortified alfalfa are also studied for better understanding. Selenium existence in ruminant diets in other plants like legumes clover and grasses also participate to selenium intake (9). A complete blood count is indicated to the count for total number of cells in a specific amount of blood including WBC, RBC and platelets (thrombocytes). It also gives information about plasma proteins and hemoglobin. Mean corpuscular hemoglobin (MCH) value mention to the mean quantity of hemoglobin in each RBC (10).

Materials and Methods

Ethical approval statement

The study design was authorized from the committee of ethics in the College of Veterinary Medicine at the University of Al-Qadisiyah with the documented order 4291 in 13/10/2025.

Choosing the Elements

A selection of critical elements was made for evaluation to analyze their metabolic profile in both and *Theileria*-infected sheep. Lots of elements are present in blood, some are essential, little are important and trace have found to do basic role in metabolism. An online questionnaire has published to exclude the most important elements that have clinical significance. Wide diverse of veterinarians

responded to the question “What are the most popular and important cases you’ve ever seen to consider as metabolic deficiency in Iraq?”.

Animals

The study included herds of sheep that were visited in the sub-districts of Afak, Al-Sanyea, Al-Daghara, Nuffer, and Al-Diwaniyah as disclosed in table (1). Sum of observed sheep was 963. The animals, which included both males and females. ranged in age from six months to four years. Our work was during 1st august to 1st November of 2025.

Table (1) Count of sheep in Al-Diwaniyah province and sub-districts

Animal s	Addiwan iyah		AL- Daghar a		AL- Saniyah		Nuffer		Afak		
	Observed	Examined	Observed	Examined	Observed	Examined	Observed	Examined	Observed	Examined	
No.	53	3	35	2	55	3	34	2	52	3	
	29	2	57	3	66	2	48	3	29	1	
	74	4	37	2	51	2	37	2	38	2	
	36	1	75	3	85	3	43	3	29	4	
Sum	192	10	204	10	257	10	162	10	148	10	50 / 963

Physical examination

A physical examination was conducted on fifty sheep observed in the study. Along with the clinical assessment, owners provided information about conditions history and any changes in behavior and appetite that they had noticed. The clinical examination encompassed the evaluation of mucous membrane coloration, measurement of rectal temperature, and assessment of heart and respiratory rates. Lymph nodes were carefully felt to see if they enlarged. Also looked for ticks, signs of anemia, dehydration, and animals’ overall health.

Blood samples

Blood samples were taken from the jugular vein of sheep. Samples of blood six milliliters were taken from the jugular vein of healthy animals. One milliliter was put in EDTA for the CBC. Five milliliter blood was put in serum separated tubes to be spun around in a centrifuge, which separated the serum. The serum was stored at a temperature of -20°C. Serum would then be used for inductively coupled plasma mass spectrometry (ICP-MS) to measure Ca, Mg, Cu, Se, and Zn, and Vit. E using Colorimetric Assay kit to measure VE.

Complete Blood Count CBC

CBC is fundamental hematological assessment utilized in veterinary medicine to assess the health of sheep and other animals. It quantifies Hemoglobin “HGB” white blood cells “RBC” and platelets to evaluate anemia infection, inflammation, parasite disease and overall physiology. The sample was gently mixed and positioned in an automated veterinary hematology analyzer at Addewaniyah veterinary hospital. Contemporary analyzer utilize electrical impedance optical scattering and flow cytometry enumerate and categorize cells.

Results

Metabolic Profile

A questionnaire was established to know what are the most common cases of deficiency around. Result has found that Ca is the most important one. Copper has the second grade with less significance to other elements. In regard to age and gender; there was no obvious significance about the deficiency of elements as illustrated in table (2).

Table (2) Count of sheep with relation to age and gender

Sum	(IS)		Gender (IS)*		Location
	1-4 year	<1 year	F	M	
10	10		9	1	Afak
10	8	2	5	5	Nuffer
10	3	7	7	3	Al-Saniyah
10	4	6	2	8	Al-Daghara
10	4	6	7	3	Al-Diwaniyah
50	29	21	30	20	Total

* IS: Insignificant difference at P<0.05

Complete Blood Count

Forty-seven percent of tested sheep had normal white blood cells as shown in table (3). White blood cells were highly significant with in normal.

Table (3) Statistical Measures of WBC (cell/μl)

Ref, range	Above normal	Normal	Under normal	P value	Mean ±SE
5-14.5 *10 ³	11(22%)	37(74%)	2(4%)	<0.0001 (HS)*	11.56±0.57

*HS: Highly significant difference at P<0.01

In table (4); red blood cells were highly significant under normal range in examined sheep presenting 74%.

Table (4) Statistical Measures of RBC (cell / μl)

Ref, range	Above normal	Normal	Under normal	P value	Mean ±SE
8.9-12.3 *10 ⁶	0(0)	13(26 %)	37(74%)	<0.0001 (HS)*	7.96±0.21

*HS: Highly significant difference at P<0.01

As presented in table (5); hemoglobin was highly significant within under normal in group of hale sheep presenting 98%.

Table (5) Statistical Measures of HGB (g/dL)

Reference	Above normal	Normal	Under normal	P value	Mean ±SE
9-14	0(0)	1(2%)	49(98%)	<0.001 (HS)*	6.64±0.17

*HS: Highly significant difference at P<0.01

As outlined in table (6), Mean Corpuscular Volume was highly significant in normal range in tested sheep presenting 82%.

Table (6) Statistical Measures MCV (fl)

Ref, range	Above normal	Normal	Under normal	P value	Mean ±SE
27-37	0(0)	41(82%)	9(18%)	<0.001 (HS)*	29.85±0.38

*HS: Highly significant difference at P<0.01

Regarding to table (7), Red Cell Distribution Width–Coefficient Variation was highly significant above normal in tested sheep presenting 98%.

Table (7) Statistical Measures RDW-CV (%)

*HS: Highly significant difference at P<0.01

Ref, range	Above normal	Normal	Under normal	P value	Mean ±SE
14-19%	49(98%)	1(2%)	0(0)	<0.0001 (HS)*	21.95 ±0.42

Profile Elements

As illustrated in table (8), Calcium deficiency was highly significant in tested sheep because there were 80% deficient animals.

Table (8) Statistical Measures of Calcium Deficiency (mg/dl)

Ref range	Above normal	Normal	Under normal	P value	Mean ±SE
11.5-13	5(10%)	5(10%)	40(80%)	<0.0001 (HS)*	11.30±0.45

* HS: Highly Significant difference at P<0.01

As indicated in table (9), copper deficiency was highly significant in tested sheep they were 100% deficient.

Table (9) Statistical Measures of Copper deficiency (mg/dl)

Ref, range	above normal	Normal	under normal	P value	Mean ±SE
0.7-1.3	0(0)	0(0)	50(100%)	<0.001 (HS)*	0.079±0.003

*HS: Highly significant difference at P<0.01.

As reflected in table (10), Magnesium deficiency was highly significant in tested sheep because there were 72% deficient animals.

Table (10) Statistical Measures of Magnesium deficiency (mg/dl)

Ref, range	above normal	Normal	under normal	P value	Mean ±SE
0.10-0.12	7(14%)	8(16%)	35(70%)	<0.001 (HS)*	0.094±0.003

*HS: Highly significant at P<0.01.

As presented in table (11), Selenium was highly significant in good level in tested sheep because they present 54% sufficient animals.

Table (11) Statistical Measures of Selenium deficiency (mg/dl)

Ref, range	above normal	Normal	under normal	P value	Mean ±SE
2.2-2.8	0(0)	14(28%)	36(72%)	<0.0001 (HS)*	2.07±0.04

*HS: Highly significant at P<0.01

As noted in table (12), Zinc deficiency was highly significant in tested sheep they were 70% deficient animals.

Table (12) Statistical Measures of Zinc deficiency (mg/dl)

Ref, range	above normal	Normal	under normal	P value	Mean ±SE
0.270-0.280	0(0)	0(0)	50(100%)	<0.0001 (HS)*	0.049±0.002

*HS: Highly significant at P<0.01

As evidenced in table (13), Vitamin E deficiency was highly significant in tested sheep because they were 100% deficient animals.

Table (13) Statistical Measures of Vitamin E deficiency (mg/dl)

Ref, range	above normal	Normal	under normal	P value	Mean ±SE
0.012-0.015	24(48%)	3(6%)	23(46%)	<0.0001 (HS)*	0.016±0.001

*HS: Highly significant difference at P<0.01

Discussion

The results of the questionnaire about significant elements to include in this study had revealed the calcium as the most important one. Cu, Mg, Vit E, Zn and Se were also important elements in sheep. These elements established great significance in clinical biochemistry and their common application as indicators of

metabolic alterations, physiological conditions, and disease-related changes in ruminants.

Decreased rain through the last decade made the diet so expensive and owners depended on rough diet without any supplements. Metabolic deficiency in this study was compatible with the results of Mohammed *et.al.* (2024) in Diyala-Iraq (11). Many clinical signs indicated sheep health; light pink mucous membrane, regular breath, normal appetite, normal posture and gait. These outside signs are often used in routine clinical exam to check on the general health of sheep as recorded by Zufferey *et.al.* (12) in 2021 in Switzerland.

There was highly significant ($p>0.0001$) decrease in calcium, magnesium, zinc, copper and VE agreed with Saleh, (2019) (13) from Iraq indicated that decrease ($p>0.05$) in mean values of some elements of ewes tested. In conclusion, a notable correlation between the reduced mineral concentration in the blood of ewes and the overall health condition leading to decrease the production and subsequently economic losses was established. Approved with Jin *et.al.* (2023) (14) from China referred that sheep grazing on pasture commonly suffer from inadequate minerals levels sheep will show mineral, Ca, Cu, Co, Mn, and Zn due diet deficiencies.

This study has found normal level of selenium agreed with Al-Sammarraie *et.al.* (2011) (15) from Iraq who exposed selenium with normal range in awassy sheep. In Pakistan; a study by Khan *et.al.* (2010) (16) indicated the Se level in forage and animals at the livestock farm was found to be adequate. Other study from Pakistan found significant diversity in levels of trace elements in pasture (17). In Brazil; a study found that mineral levels of forages are influenced by soil type, species of and age of plant, usage of fertilizer and season (18). Highly significant ($p>0.0001$) decrease with VE agreed with Ahmed *et.al.* (2022) (19) from Iraq who revealed significant changes and decrease of VE and glutathion peroxidase in animals and this lead to indices clotting factors.

Sheep showed highly significant ($p>0.0001$) decrease in RBC and HGB due to anemia result from mineral deficiency agreed with Oubeid

et.al. (2023) (20) from Iraq who mentioned the effect of some trace minerals deficiency result as significant decreased in RBC and HGB. A research by Kerr in 2019 (21) referred that anemia was classified in to three group; vitamin deficiency, mineral deficiency, and nutritional deficiency. As much as appropriate with Saxena and Srivastava (2021) (10) who showed anemia was the reduced oxygen-carrying capacity of the blood that may originate from oligocythemia (a decrease in RBC), decrease in total blood volume, reduced hemoglobin concentration frequently observed in mineral deficiency, hemorrhage, blood loss due to injury and dehydration.

Heamatochrit (HCT) observed variable changes normal in some and decrease in other. This depends on deficient severity and period. MCH, MCHC decreased because anemia type microcytic hypochromic agreed with Kerr, (2019) (21). The anemia of minerals deficiency and protein is usually microcytic hypochromic. Highly significant ($p>0.0001$) decrease of RDW because minerals' deficiency causes microcytic hypochromic anemia result from gradual change in MCV agreed with Kerr, (2019) (21).

WBC showed highly significant ($p>0.0001$) with normal range in sheep agreed with Saleh, (2019) (13) from Iraq who referred that sheep have no defect in WBC count. Besides, he recorded that pack cell volume, hemoglobin and RBC which were markedly low. White blood cells showed no significant changes in most cases in several studies that appear deficient in some minerals like copper and selenium which effect function of immune cells. An author showed that Cu deficiency in ruminant changes specific immune response but not the count of cells (22). In present study show, few cases with decrease level of some minerals like zinc impact lymphocyte proportion as Fouda *et.al.* (2011) (23) revealed lymphocytopenia with reduced activity of superoxide dismutase enzyme attribute to zinc deficiency in Pakistan.

Conclusion

Sheep is the most important source of mutton for Iraqis had been identified with metabolic deficiency in Calcium, Copper, Magnesium,

Zinc and Vitamin E. Selenium was within normal range. Consequently, sheep were more susceptible to infection with deficit in blood content especially red blood cells and HGB which lead to microcytic hypochromic anemia.

Conflict of interest

There was no conflict of interest in this study as stated by the researchers.

Acknowledgement:

We would like to thank the medical staff in the teaching hospital of Addewaniyah. A special grateful appreciation presented to the staff of college of veterinary medicine in the university of Al-Qadisiyah.

Funding source

The study was self-funded.

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