International Journal of Fauna and Biological Studies
Available online at www.faunajournal.com

ISSN 2347-2677
IJFBS 2019; 6(2): 01-06
Received: 01-01-2019
Accepted: 04-02-2019

F Abraham
College of Veterinary Medicine and Agriculture, Addis Ababa University, Ethiopia, East Africa

L Kibeb
Addis Ababa University, College of Veterinary Medicine and Agriculture, Department of Biomedical Sciences, Bishoftu, Ethiopia, East Africa.

R Fikru
College of Veterinary Medicine and Agriculture, Addis Ababa University, Ethiopia, East Africa.

M Gezahegne
College of Veterinary Medicine and Agriculture, Addis Ababa University, Ethiopia, East Africa.

Correspondence
L Kibeb
Addis Ababa University, College of Veterinary Medicine and Agriculture, Department of Biomedical Sciences, Bishoftu, Ethiopia, East Africa

Analysis of red blood cell indices and electrolyte profile in diarrheic and apparent healthy non-diarrheic Sheep in and around Debre Zeit, East Shoa zone of Oromiya regional state, Ethiopia

F Abraham, L Kibeb, R Fikru and M Gezahegne

Abstract
A study was made on Red blood cell (RBC) indices and serum electrolyte profiles of 127 sheep that shows clinical manifestation of diarrhea and non-diarrheic, between December 2006 and June 2007, in and around Bishoftu/Debre Zeit area.

The mean values of red blood cell (RBC) count, Haemoglobin (Hb) concentration, packed cell volume (PCV) and egg per gram of feaces (epg) for non-diarrheic sheep were 10.6± 0.21 million μL^{-1}, 10.5± 0.25 $gdL^{-1,}$ 36.7± 13.53% and 69.8± 13.53, respectively. The average mean corpuscular volume (MCV), Mean corpuscular Hemoglobin (MCH), Mean corpuscular Hemoglobin concentration (MCHC) were 34.5± 0.63 fl, 10.0± 0.27 pg, 28.8 ± 0.58 g dL^{-1}, respectively. The mean serum electrolyte values showed 141.5 ± 0.64 mmol $L^{-1,}$ 4.7± 0.12 mmo1 L^{-1} and 110.7± 0.56 mmol L^{-1} for sodium (Na+), Potassium (K^+) and chloride (Cl^-), respectively.

The mean values of RBC count, Hb concentration, PCV and epg of diarrheic sheep were 9.5±0.18 million $\mu L^{-1,}$ 9.6±0.16 gdL^{-1}, 33.1±0.57% and 923.8±77.59, respectively. The mean MCV, MCH, and MCHC were 35.3±0.6 fl, 10.2± 0.16 pg and 29.3± 0.48 gdL^-, respectively. The average electrolyte values (Na+, K+, Cl^-) were 132.4 ± 0.41 mmol L^{-1}, 4.6 ± mmol L^{-1} and, 105.8± 0.48 mmol L^{-1} respectively. Diarrheic sheep show significantly (P<0.05) higher mean value of epg, whereas, non-diarrheic sheep show significantly (P<0.05) higher mean values of RBC count, Hb concentration and PCV value than non-diarrheic sheep. Generally, it could be seen that the RBC indices and serum electrolyte profile of diarrheic sheep observed in this study is lower than that of diarrheic sheep. In interpretation of these results the effect of breed, sex, age, nutrition, physiological state, presence of other disease condition with or without diarrhea must be considered besides clinical manifestation of diarrhea. Further study for our indigenous breeds with different clinical manifestation recommended.

Keywords: RBC indices, diarrheic sheep, electrolyte profile, Debre Zeit/Bishoftu

Introduction
Ethiopia is basically an agrarian country and the socio-economic activities of about 85% of the population are based on farming and animal husbandry. The country has the largest livestock population with an estimated 44.3 million heads of cattle, 23.6 million sheep, 23.3 million goats, 6.1 equines, 2.3 million camels [4]. The diversity of the ecology of the country has rendered it the capacity to support livestock production of all kinds. Livestock and their products provide direct cash income, export earnings, and animals are a living-bank for many farmers. They are closely linked to the social and cultural lives of millions of resource-poor farmers for whom livestock ensures varying degree of sustainable farming and economic stability [17].

Small ruminants among other domestic animals have a great potential to support the socioeconomic development of the majority of African rural communities and constitute an integral part of livestock sector of the economy. The Ethiopian highlands in general, are known for their sheep production accounting for 75% of the national flock and 20% of the total sheep population of tropical Africa and generate 89% of farmers' cash income. In these areas where farm size decreases with population pressure, increases in sheep population are assuming a greater importance than cattle in livestock production [7].

However, several factors constrains the full utilization of this potential, diseases are among one of the most common constraints. Sheep diseases can be of bacterial, viral, parasitic, and protozoal origin and be manifested by different clinical signs.

Diarrhea is one of the clinical sign of most diseases which affect the gastro-intestinal system. It is the increased frequency of defecation accompanied by feces which contain an increased concentration of water and electrolytes. The consistency varies from being soft to liquid. Therefore diarrhea is associated with loss of fluid and electrolyte that can in turn affect the hematology/RBC-indices [14].

For the appropriate intervention of the effects of diarrhea either by treatment, control or prevention, proper diagnostic is essential. Thus haematological and serum biochemical tests have been widely used to indicate the degree of hemoconcentraion and electrolyte lost. The information gained from the blood parameters would substantiate the physical examination coupled with medical history to provide excellent basis for judgment with respect to the nature of the disease, the extent of tissue and organ damage, the response of the defense mechanism of the patient, in diagnosing the type of anemia, in evaluating patients before commencing any surgical intervention and to select appropriate treatment [15].

It has been emphasized that the hematological and biochemical parameters have widely been used for the diagnosis of various animal diseases. Total erythrocyte count is particularly helpful in the diagnosis of hemoparasites, in determination of the type of anemia and to tell the prognosis of the patient. However, this count reflects only the total number of red blood cells in circulation and does not indicated the oxygen carrying capacity or amount of haemoglobin. Thus other hematological parameters such as haemoglobin concentration and PCV determination would help in doing so. Estimation of haemoglobin concentration can also be used in the detection of haemolytic diseases such as babesiosis, anaplasmosis, leptospirosis, etc, which cause significant drop of the value [3].

The percentage of blood volume occupied by the packed red corpuscles, (PCV) is used in clinical medicine as an index of anemia. Since the more anemic the patient is the lower PCV, or in a subject who is not anemic, it becomes higher. The PCV is an index of the relative amount of fluid in the plasma (dehydration). It is also the most valuable technique in detection of low level of parasitaemia in case of trypanosomosis and degree of hemoconcetration [9]. The blood parameters are subjected to significant variation and the interpretation vastly depending on mainly species, breed, age, sex, season, and pathological conditions [8; 9; 13; 16].

The physiological role of electrolytes in the animal body is diverse, as there are almost no metabolic processes that are not affected by or dependent upon electrolytes. A number of instruments and techniques are available that permit accurate, reproductive analytical measurements of electrolytes with increasing knowledge about electrolyte balance in various animal diseases. The use of electrolyte replacement therapy has become routine practice in veterinary medicine. In order that therapy can be most efficacious, it is essential for the clinician to have an understanding of the basic mechanisms involved in electrolyte alterations and an ability to interpret results of laboratory estimation for electrolytes [3].

Approximately half of the total body concentration of sodium (Na^+) is found in extra cellular fluid (ECF) where sodium has its primary function; most of the rest present in bone in a form not readily available to ECF. It can also be lost in urine, sweat and in secretion of digestive tract. In herbivores with large quantities of fluid in the feces, there may be a considerable faecal loss of sodium. In contrast, potassium (K^+) concentration is low in ECF and high in most cells of the body. Considerable excretion of K^+ is through the kidneys however, sweating through secretion of digestive tract and loss through high faecal water plays an important role in its excretion. Furthermore, chloride (Cl^-) which is one of the most important electrolyte in osomotic balance present in highest concentration in ECF. It is adequate in the diet if major cations are present in the feed stuffs consumed, as it usually occurs in combination with these cations. Excretion, absorption and distribution of chloride are passive, as chloride usually accompanies sodium, which is actively transported [3].

Although hematology and serum electrolyte profiles are potentially important for diagnostic aid and in establishing appropriate therapy, the interpretations of sick animals are often difficult. Any physiological and pathological changes can be evaluated if the normal values are available for comparison. Even though considerable information available on the normal blood parameters and serum electrolytes, these values are that of exotic breeds kept under different environmental and management conditions from our local animals, this result in a quantifiable variation in blood parameters [20].

In Ethiopia few works have been attempted on the haematology of some breeds of animals; blood values of Black Head Ogaden sheep [2], hematological values of local Menz sheep in central highlands of Ethiopia [6] and haematolgoical and serum biochemical values of long-eared Somali and Arsi-bale goat breeds [20]. However, there are no investigations so far made on haematology and serum electrolyte profile of small ruminants of Ethiopia particularly comparison has not been made on hematological and electrolyte profiles in diarrheic and non-diarrheic sheep. Therefore, this study was designed to determine the haematological (RBC indices) and electrolyte profiles of diarrheic sheep, to determine the hematological and serum electrolyte value in apparently normal non-diarrheic sheep, to assess the change in RBC indices and electrolyte profile due to diarrhea.

Materials and methods

Study area

The study was conducted from December 2006 to June 2007 in and around Debre-Zeit town of East Shoa zone of Oromiya, located South East of Addis Ababa at a distance of 45 km. The area is located at 9^0N latitude and 4^0E longitudes at an altitude of 1850 meter above sea level. It has an annual rainfall of 866mm of which 84% is in the long rainy season (June to September) and the dry season extends from October to February. The mean annual maximum and minimum temperatures are 26 ºC and 14 ºC, respectively, with mean relative humidity of 61.3% [12]. Farmers in the district practice a mixed crop-livestock farming system. The two major soil types are heavy black clay (Koticha) and light soil (gomborie) on which teff, wheat and highland pulses are commonly cultivated. Moreover, Debre Zeit and its surrounding (with in 50km radius) have variable and yet representative agro-ecologies of the country [21].

Study animals

The study was conducted on 127 sheep brought to the Faculty of Veterinary Medicine (FVM) open-air clinic from Debre Zeit town and its surrounding rural areas. In the study all age group with the clinical signs of diarrhea and apparently

healthy non-diarrheic sheep were included after general clinical examination and egg per gram of feaces have been conducted. The general clinical examination was done by inspecting the physical appearance and presence of visible pathological condition, assessing heart rate, pulse rate, respiratory rate and sound. Furthermore body temperature was recorded. Those animals with abnormal range of these parameters were excluded as described by Kelly [10]. Thus total of 84 diarrheic (42 male and 42 female) and 43 apparently health sheep, 22 male and 21 female, were included in the study.

Sampling strategy and study design

Sheep coming to the Faculty of veterinary Open-air clinic were rested for some time then thorough general clinical examination was conducted to rule out any clinical disease. Then sheep with clinical diarrhea was considered as one of the study group whereas sheep which do not manifest diarrhea and apparent clinical sign of any disease was included as a control group. In both groups egg per gram of feces (EPG) was determined. For EPG determination faecal sample was taken directly from the rectum of the animal and sent to FVM, parasitology laboratory. Similarly whole blood sample from both groups were collected from the jagular vein in to Ethylene Diamine Tetra Acetic acid (EDTA) vacutainer tube for hematology and in a sterile plane vacutainer tube for electrolyte analysis. The site of blood collection was first washed and shaved then disinfected with 70% alcohol and the puncture site was treated with 2.0% iodine for one minute before blood collection [9]. The EDTA vial was tightly toppered and immediately tipped back and forth a dozen times to dissolve the anticoagulants. Mixing of blood was done gently to avoid rupture of erythrocytes. The blood for electrolyte analysis was kept in a slant position at room temperature until serum starts to separate. The samples were identified by code, date of sampling, sex then immediately transported to biomedical science laboratory of faculty of veterinary medicine. The blood for electrolyte analysis was centrifuged and serum decanted in to sterile vials and it was preserved in a fridge at -20 ºC as described by Coles [3] until analysis.

Laboratory procedure

Haematological values were determined by Automated haematology analyzer whereas the serum electrolyte profile were determined by electrolyte analyzer. Determination of egg per gram of feaces was made by modified Mac master egg counting technique as described by Urqhuart, *et al.* [19].

Data analysis

The hematological and serum electrolytes values recorded during the analysis were total red blood cell count, PCV, Hb, MCV, MCHC, MCH, Na^+, K^+ and Cl^-. The results then obtained were analyzed using SPSS software version 11.5. ANOVA, pearson's correlation and mean were the statistical tools applied in the analysis where 95% confidence interval level and $P<0.05$ set for level of significance were used.

Result

The mean values of RBC count, Hb concentration, PCV value for non-diarrheic sheep were 10.6±0.21 million μL^{-1}, 10.5±0.25 g/dl and 36.7±0.70%, respectively. The mean MCV, MCH, MCHC and EPG values were 34.5±0.63 fl, 10.0±0.27 pg, 28.8±0.58 gdL^{-1} and 69.8±13.53. While the average electrolyte values were 141.5±0.64 $mmolL^{-1}$, 4.7±0.12mmol L^{-1}, and 110.7±0.56 mmol L^{-1} for Na^+, K^+ and Cl^-, respectively for the same group as indicated in tables 1 and 2 below. The average values for RBC count, Hb concentration, and PCV for diarrheic sheep were 9.5±0.18 million μL^{-1}, 9.6±0.16 g/dl and 33.1±0.57%, respectively. The average MCV, MCH, MCHC and EPG values were 35.3±0.65 fl, 10.2±0.16 pg, 29.3±0.48 gdL^{-1} and 923.8±77.59, respectively. The average electrolyte values were 132.4±0.41 mmol L^{-1}, 4.6±0.10 mmol L^{-1}, and 105±0.48 mmol L^{-1}, respectively as indicated in tables 1 and 2.

Table 1: Mean ± SE of red blood cell indices and egg per gram of feaces in diarrheic and non-diarrheic sheep

Health status	Sex	EPG	RBC ($x10^6$ μL^{-1})	HB (g/dl)	PCV (%)	MCV (fl)	MCH (pg)	MCHC (g/dl)
Diarrheic	Female (42)	857.0 ±104.05	9.6±0.25	9.6±0.23	32.5±0.87	34.3±0.74	10.2± 0.21	30.0±0.67
	Male (42)	990.4±115.46	9.5±0.25	9.5±0.21	33.7±0.74	36.3±1.05	10.2±0.26	28.6±0.67
	Total (84)	923.8± 77.59	9.5±0.18	9.6± 0.16	33.1 ± 0.57	35.3± 0.65	10.2± 0.16	29.3±0.48
Non-diarrheic	Female (21)	80.9 ± 20.26	10.9±0.30	11.2± 0.36	37.6 ± 1.01	34.8 ± 0.92	10.4 ± 0.40	29.9± 0.79
	Male (22)	59.1 ± 18.21	10.4±0.30	9.9 ± 0.30	35.8 ± 0.94	34.2 ± 0.88	9.6 ± 0.36	27.7± 0.81
	Total (43)	69.8 ± 13.53	10.6±0.21	10.5± 0.25	36.7 ± 0.70	34.5 ± 0.63	10.0 ± 0.27	28.8± 0.58
Total	Female (63)	598.4 ± 83.52	10.0±0.21	10.2± 0.22	34.2 ± 0.73	34.4 ± 0.58	10.2 ± 0.20	30.0± 0.52
	Male (64)	670.3± 94.01	9.8± 0.20	9.6± 0.17	34.4± 0.60	35.6± 0.76	10.0± 0.21	28.3± 0.52
	Total (127)	634.7± 62.77	9.9± 0.15	9.9± 0.14	34.3± 0.47	35.0± 0.48	10.1± 0.14	29.1± 0.37

Table 2: Mean ±SE of electrolyte profile in diarrheic and non-diarrheic sheep.

Health status	Sex	Na^+(mmol L^{-1})	K+(mmol L^{-1})	Cl^-(mmol L^{-1})
Diarrheic	Female (42)	132.6±0.60	4.6±0.15	105.9±0.67
	Male(42)	132.2±0.57	4.6±0.14	105.76±0.71
	Total (84)	132.4 ± 0.41	4.6±0.10	105.8 ± 0.48
Non-diarrheic	Female (21)	140.4 ± 1.0	4.8±0.16	109.6 ± 1.0
	Male (22)	142.5 ± 0.76	4.7±0.17	111.7 ± 0.41
	Total (43)	141.5 ± 0.64	4.7±0.12	110.7 ± 0.56
Total	Female (63)	135.2 ± 0.70	4.7±0.12	107.1 ± 0.60
	Male (64)	135.8± 0.76	4.6±0.11	107.8± 0.60
	Total (127)	135.5± 0.52	4.6±0.08	107.5± 0.42

Pearson's correlation coefficients of RBC indices with EPG for both non-diarrheic and diarrheic sheep were given in table 3 and 4 respectively. Significantly strong positive correlation were found between RBC and PCV (r=0.66), Hb and PCV (r=0.54) and Hb and MCHC (r=0.643) in non-diarrheic sheep. There was also positive correlation between RBC and Hb (r=0.36) and, RBC and EPG (r=0.12) However, strong negative correlation was observed between RBC and MCV (r=0.55), RBC and MCH (r=0.50).

Table 3: Pearson's Correlations of red blood cell parameters in non-diarrheic sheep

	RBC	HB	PCV	EPG	MCV	MCH	MCHC
RBC	1	0.36 [a]	0.66 [b]	0.17	-0.55 [b]	-0.51 [b]	-0.20
HB	0.36[a]	1	0.54 [b]	0.06	0.13	0.61 [b]	0.64 [b]
HCT	0.66 [b]	0.54 [b]	1	0.23	0.15	-0.05	-0.30
EPG	0.17	0.06	0.23	1	-0.05	-0.08	-0.13
MCV	-0.55 [b]	0.13	0.15	-0.05	1	0.60 [b]	0.01
MCH	-0.51 [b]	0.61 [b]	-0.05	-0.08	0.60 [b]	1	0.74 [b]
MCHC	-0.20	0.64 [b]	-0.30	-0.13	0.01	0.74 [b]	1

[a]Correlation is significant at the 0.05 level (2-tailed).
[b]Correlation is significant at the 0.01 level (2-tailed).

In diarrheic sheep was strong positive correlation between RBC and Hb (r = 0.53), RBC and PCV (r = 0.53), PCV and Hb (r=0.55), and Hb and MCHC (r=0.35).EPG and RBC have negative correlation (r=0.03) though not significant. However, there was a strong negative correlation between RBC and MCV (r=0.62) indicated in table 4.

Table 4: Pearson's correlations of red blood indices in diarrheic sheep

	RBC	HB	PCV	EPG	MCV	MCH	MCHC
RBC	1	0.53[a]	0.53 [a]	-0.03	-0.54 [a]	-0.62 [a]	-0.06
HB	0.53 [a]	1	0.55 [a]	0.07	-0.04	0.33 [a]	0.35 [a]
HCT	0.53 [a]	0.55 [a]	1	0.08	0.42 [a]	-0.06	-0.57 [a]
EPG	-0.03	0.07	0.08	1	0.10	0.10	-0.01
MCV	-0.54 [a]	-0.04	0.42 [a]	0.10	1	0.59 [a]	-0.52 [a]
MCH	-0.62 [a]	0.33 [a]	-0.06	0.10	0.59 [a]	1	0.36 [a]
MCHC	-0.06	0.35 [a]	-0.57 [a]	-0.01	-0.52 [a]	0.36 [a]	1

[a]Correlation is significant at the 0.01 level.

The study further showed significantly (P<0.05) higher mean RBC count, Hb concentration, PCV, Na^+, and Cl^- in non-diarrheic sheep but significantly (P<0.05) low mean EPG values. Furthermore, there was no significant association between clinical manifestation of diarrhea and MCV, MCH, MCHC, and K^+ (Table 5).

Table 5: Mean square from the analysis of variance for the effect of diarrhea on the red blood cell indices and serum electrolyte profile

	Df	Ms	Sig.
RBC	1	35.34	0.000
HB	1	25.71	0.001
PCV	1	371.42	0.000
EPG	1	20744480.42	0.000
Na^+	1	2334.72	0.000
K^+	1	0.63	0.375
Cl^-	1	663.42	0.000
MCV	1	18.99	0.425
MCH	1	1.19	0.499
MCHC	1	7.261	0.524

Df = Degree of freedom
Ms = Mean square
Sig = Significance level

Discussion

Hematological and serum electrolyte profiles of small ruminants in Ethiopia have not yet extensively been conducted except for long-eared and Arsi-Bale goat breed in the mid-rift valley [20], hematological studies on local Menz sheep [6] in highland area, and on Black head Ogaden sheep [2] in low land area. In this study attempts have been made to assess the hematology and serum electrolyte profiles of diarrheic and apparently health sheep in and around Debre Zeit which can represent the mid altitude area.

The study indicated mean RBC count (10.6 ± 0.21 million μL^{-1}) of non-diarrheic sheep is higher than the value of black head Ogaden sheep that inhabit the Ogaden low land at altitude of 1600 masl [2]. Similarly it is significantly higher than the values reported by Dutta *et al.* [5] and Alonso *et al.* [1] for exotic sheep breeds. This might be either due to the effect of altitude where it is well documented that reduced oxygen tension of mountainous regions leads to increased production and release of erythropoietin there by stimulating erythropoiesis Schalm *et al*. [15]; Coles [3] and Jain [9]. However the present study gave lower mean RBC value than the mean values reported by Fufa [6] which might be attributed to the difference in altitude. It is also lower mean RBC value than values reported by Schalm *et al.* [15], Coles [3], Jain [9] which might be as a result of difference in breed and age of animals, management, season and altitude as described by Jain [9] and Coles [3]. The mean RBC count (9.5±0.18 million μL^{-1}) for diarrheic was lower than the mean RBC values of non-diarrheic sheep in this study which might be attributed to presence of blood sucking parasites, parasites that might cause mucosal damage so that blood is lost along with diarrhea as most of diarrheic sheep showed high EPG which is described by Coles [3] and Urquhart *et al.* [19].

Mean Hb concentration values for non-diarrheic sheep (10.5 ± 0.25 g/dl) agrees with the findings of Bekele [17]. However, it is lower than the value reported by Schalm *et al*. [15], Coles [3], Jain [9], Dutta *et al*. [5] which studied on exotic breeds and Fufa [6] on local sheep breed from Menz sheep. The mean Hb value in diarrheic sheep (9.6±0.16 g/dl) is lower than that of the non-diarrheic sheep. The reduction in mean Hb value in diarrheic sheep could also be attributed to the loss of blood by gastrointestinal parasites as the study indicated significantly higher EPG in diarrheic sheep than non-diarrheic ones.

Mean PCV value in non-diarrheic sheep (36.7±0.7%) is slightly higher than with the findings of Fufa [6], but it is significantly lower than the values reported by Schalm *et al.* [15], Coles [3], Bekele [2] and Jain [9]. This difference might be attributed to the effects of environment (altitude and water availability), breed, nutrition as described by Coles [3]. The mean PCV percentage in diarrheic sheep (33.1±0.57%) is significantly (P<0.05) lower than the value in non-diarrheic sheep. This could indicate that the level of fluid loss in the diarrheic sheep had no significant effect on hemoconcentration, but the lower PCV could be as a result of the effect of blood sucking parasites and parasites that might cause mucosal damage as indicated in Schalm *et al.* [15].

The mean value of MCV in non- diarrheic sheep in this study is agreement with report of Jain [17] but higher than the values reported by Schalm *et al*. [15]; Coles [3]; Bekele [2]; Fufa [6]. The mean value of MCH is similar to the findings of Schalm *et al.* [15], Coles [3] and Jain [9] but it is lower than the values reported by Bekele [2], Fufa [6]. The average MCHC value is lower than the reporting of Schalm *et al.* [15], Coles [3], Bekele [2], Jain [9],

and Fufa [6]. The same factors that affect RBC, PCV, and Hb can also cause variation in these RBC indices. But there was no significant difference in mean MCV (35.3±0.65 fl), MCH (10.2±0.16 pg) and MCHC (29.3±0.48 g/dl) values in diarrheic and non-diarrheic sheep. This might be due to the effect of blood sucking parasites and parasites that cause mucosal damage on red blood cells which indirectly affects Hb concentration, and PCV value thus the MCH, MCV and MCHC might not be significantly affected as described in Schalm *et al.* [15].

The mean EPG value in diarrheic sheep (923.8±77.59) is significantly (P<0.05) higher than that of the non-diarrheic sheep (69.8±13.53) which might be suggestive of the presence of relative high number of female gastrointestinal nematode parasites that are of high fecundity. These could also be suggestive of the cause of the diarrhea could be associated with parasitic infestation as they penetrate the epithelial surface of small intestine and cause disruption which leads to villous atrophy and reduction in the area available for absorption, which then results in diarrhea [19]. But this cannot exclude other cause of diarrhea like viral or bacterial diseases. As higher EPG values might also be observed in non-diarrheic sheep interpretation of results must be undertaken carefully as clearly described by Soulsby [18].

The mean Na^+ concentration for non-diarrheic sheep (141.5 ± 0.64 mmol L^{-1}) was lower than the mean value reported by Coles [3]; Meyer and Harvey [11]. The mean Cl^- concentration for non-diarrheic sheep (110.7 ± 0.56mmol L^{-1}) was higher than the values indicated by Coles [3], Meyer and Harvey [11], whereas the mean K^+ concentration (4.7±0.12 mmol L^{-1}) was in agreement to the values reported by Coles [3] but slightly lower than the values indicated by Meyer and Harvey [11]. The variation in these electrolyte concentrations might be attributed to the difference in environment, diet and/or management as described by Meyer and Harvey [11]. The mean Na^+ and Cl^- concentration (132.4 ± 0.41 mmol L^{-1} and 105.8 ± 0.48 mmol L^{-1}, respectively) in diarrheic sheep was significantly (P<0.05) lower than the mean value in non-diarrheic sheep. It was also slightly lower than the values reported by Coles [3], Meyer and Harvey [11]. The difference in the mean values of Na^+ and Cl^-concentrations might be due to faecal loss of Na+ during diarrhea as a result Cl^- could also follow the loss of Na^+ whereas there was no significant difference in K^+ concentration between diarrheic and non-diarrheic sheep as K^+ is usually found in intra-cellular and associated with cellular injury or necrosis [3].

Conclusion and recommendations

In this study RBC indices and serum electrolyte values (Na^+, K^+, Cl^-) were determined in diarrheic and non-diarrheic sheep. It was shown that considerable variation in RBC indices and serum electrolyte values was noted in the study sheep and previously done works both in local and exotic sheep breeds. Similarly significant difference in these parameters in diarrheic and non-diarrheic sheep was noted. The hematological (RBC indices) and serum electrolyte values obtained for the non-diarrheic sheep in this study were different from the values reported by other authors. Non-diarrheic sheep had significantly (P<0.05) higher mean values in RBC-indices (Hb concentration and RBC count) as well as electrolyte profiles (Na^+, Cl^-). The mean PCV and EPG values in diarrheic sheep were lower than that of the non-diarrheic sheep. However, there were no significant difference in K^+ concentration, MCV, MCH and MCHC values between diarrheic and non-diarrheic sheep. Likewise the study indicated strong positive correlation between PCV, Hb concentration, RBC count and strong negative correlation between RBC count, MCV and MCHC were observed. Thus the study provided a base line data of the parameters in apparently health sheep and the effect of diarrhea on the parameters in the study area. Based on the study results the following points are recommended**:**

- In the diagnosis and effective treatment of livestock disease hematological (RBC - indices) and electrolyte should also be integrated.
- In the interpretation of RBC-indices and electrolyte values of animals' different factors such as geographical, breed and pathological condition should be considered,
- Haematological studies (RBC-indices) and assessment of electrolyte profiles for different breeds and species of indigenous animals of this country, Ethiopia, should be conducted.

References

1. Alonso AJ, Teresa RDE, Garci M, Gonzalez JR, Valleio M. The effect of age and reproductive status on serum and blood parameters in Merino breed sheep. Journal of Veterinary Medical Association. 1997; 44:223-231.
2. Bekele T. A study on Blood values of Black Head ogaden sheep in Jijiga (Hararge). DVM Thesis, FVM, Debre Zeit, 1987, 24.
3. Coles HE. Veterinary clinical pathology, 4th edition, W.B. Saunders company, 1986, 10-19, 114-151.
4. Central Statistics Authority, CSA. The 2001/02 Ethiopian Agricultural Sample Enumeration (ESAE), Executive summary, May, Addis Ababa, Ethiopia, 2004.
5. Dutta A, Smarman S, Rajkowa NK. Hematological and biochemical study in sheep of Assam. Indian Veterinary Journal. 1996; 73:402-405.
6. Fufa AK. Haematological values of local Menz sheep in central highlands of Ethiopia. DVM thesis, FVM, Debre Zeit, Ethiopia, 1999, 30.
7. Gryseels G, Anderson FM. Studies on traditional agricultural system. Initial results 1977-1980. Research on farm and Livestock productiviety in the central Ethiopian highlands, ILCA-Addis Ababa, 1983, 7-22.
8. Howkey CM, Fitzger AK, Hart MG. Age related hematological changes in captive Barbery sheep (*Ammotragus larvia*). Research in Veterianry Science. 1983; 35(1):118-119.
9. Jain NC. Essentials of veterinary haematology. Lea and Febiger, Philadelphia, 1993, 417.
10. Kelly WR. Veterinary clinical diagnosis. New York. The macmalian publishing company inc., 1977, 1-32.
11. Meyer DJ, Harvey JW. Veterinary laboratory medicine, interpretation and diagnosis, WB saunders, Philadelphia, 1998, 237-24.
12. NMSA: Rainfall and temperature data of Debre Zeit, National Metrological service Agency, Addis Ababa, Ethiopia, 1999.
13. Oyewale JO, Olayemi FO, Samson AF. Haematology changes after haemorrhage in the domestic fowl Veterinariski, ARHIV. 1997; 67(5):193-201.
14. Radostits OM, Blood DC, Gay CC. Diarrhea, Constipation and Scant feaces. In Veterinary Medicine :A text book of the diseases of cattle, sheep, pigs, goats, and

horses, 1993, 160.
15. Schalm OW, Jain NC, Carroll EJ. Veterinary Haematology 3rd ed. Lea and Febiger, Pulbisher, Philadelphia, USA, 1975, 807.
16. Sherman DM, Mary CS. Blood, Lymph and immune systems. Goat Medicien. Lea and Febiger, USA, 1994.
17. Solomon B. PARC privatization of Animal health services subprogramme. Ethiopian Veterinary Association. Proceedings of the 8th conference. Addis Ababa, 1994, 35.
18. Soulsby EJL. Helminths, arthropods and protozoa of Domestic animals, Seventh edition, 1986, 771-773.
19. Urquhart GM, Armour J, Duncan JL, Dunn AM, Jennings FW. Veterinary Parasitology, 2nd edition. Longman scientific and technical, 1996, 261-264.
20. Yasmin JY. Haematological and serum biochemical values of long eared Somali and Arsi-Bale goat breeds in the Mid-rift valley of Ethiopia. DVM thesis, FVM, Debre Zeit, Ethiopia, 2000, 1-32.
21. Zeleke A, Bizuneh T, Tesema T. Historical milestones of Debre Zeit Agricultural Research center, DARC in half a centure (1995-2005) Bulletin of Golden Jubilee, 2005, 5.