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Research Article

Anaplasma Infection in Goats in El Daein, East Darfur State, Sudan: An Epidemiological Study

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Abstract

Small ruminants, particularly goats, are essential to the livelihoods of rural communities in Sudan; however, their productivity is threatened by tick-borne diseases such as anaplasmosis. This study aimed to determine the prevalence of anaplasmosis in goats slaughtered in El Daein city, East Darfur State, Sudan, and to assess associated epidemiological and clinical risk factors. A cross-sectional study was conducted from November 2022 to February 2023 in three slaughterhouses. Blood samples (n = 175) were collected from randomly selected goats and examined for *Anaplasma* spp. using Giemsa-stained blood smears. Ante-mortem and post-mortem examinations were performed to identify clinical and pathological abnormalities. Data were analyzed using chi-square and logistic regression tests. The overall prevalence of anaplasmosis was 62.3%. No statistically significant association ($P > 0.05$) was observed between infection and sex, age, breed, or post-mortem pathological lesions including splenomegaly, gallbladder enlargement, or jaundice. However, a significant association was detected between infection and pale mucous membranes ($P = 0.031$), indicating anemia as a likely consequence of erythrocytic infection. Most infections appeared subclinical, suggesting endemic stability in the study area. The high prevalence indicates widespread circulation of *Anaplasma* among goats in East Darfur, likely driven by favorable ecological conditions for tick proliferation. Strengthening tick control strategies and routine diagnostic surveillance is recommended to reduce disease burden and improve small ruminant productivity in the region.

Keywords

Anaplasmosis, Goat, Prevalence, Risk Factor

1. Introduction

Small ruminants, particularly goats, play a vital role in the livelihood of rural communities across Sudan that possesses one of the largest livestock populations among African countries They are a major source of meat, milk, skins, manure, and serve as an easily marketable Source of income for household and contributes significantly to food security, and resilience during droughts and economic hardship [1-3]. In East Darfur State, small ruminant production forms an essen-

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tial component of mixed farming systems, supporting pastoral and agropastoral families and serving as a source of capital, social prestige, and insurance against crop failure [1]. The main goat breeds in Sudan are Nubian, Desert, Nilotic, and Taggar goats [4]. These breeds together with the cross bred ones are known for their capability of surviving in arid and semi-arid environments, utilizing shrubs and trees less palatable to other livestock, which makes them a vital species for sustainable livestock production in marginal areas.

Despite their importance, goat production in Sudan is constrained by infectious diseases, of which tick-borne diseases, such as anaplasmosis are of major concern [5]. Anaplasmosis is a blood-borne parasitic disease caused by obligate intracellular bacteria belonging to the genus *Anaplasma*. The infection is naturally transmitted through various species of ticks and biting flies [6, 7]. Twenty species of ticks have been shown to transmit. Transovarial transmission occurs and insects (blood sucking flies e. g deer flies, stable flies) play a significant role in mechanical transmission [8]. Primarily transmitted by ticks of the genus Rhipicephalus and Hyalomma. *Anaplasma* infects erythrocytes leading to anemia, fever, jaundice, weight loss, and sometimes death [9] The disease results in significant economic losses [10].

The disease is widely distributed in tropical and subtropical regions, with many African countries reporting high prevalence rates. In Sudan, several studies have documented infection in goats in various states; however, limited data are available from East Darfur, particularly in El Daein locality. Understanding its occurrence and associated risk factors is crucial for designing appropriate control strategies and improving livestock health and productivity considering the importance of small ruminant production in East Darfur State.

Therefore, this study was conducted to determine the prevalence of anaplasmosis in goats slaughtered in El Daein Locality, East Darfur State, Sudan, and to investigate its possible association with different epidemiological and clinical risk factors.

2. Materials and Method

2.1. Study Area

A cross sectional study was carried out to determine the prevalence of anaplasmosis in goats as well as to investigate the potential risk factors associated with the disease.

The study was carried out in is the capital of East Darfur State, El Daein, A convenient non-probability sampling method to select the study area, a systemic systematic method used in slaughterhouse to select individual animal. The study was conducted between November 2022 up to February 2023 in three slaughter houses in eastern Darfur.

2.2. Sample Size

The sample size was calculated using [11]. Considering the

$$n= \frac{z^2 * PQ}{L^2}$$

Where: n = Sample size; Z $(1,96)^2$ = constant; p= estimated prevalence= 61.8; Q = (1-P)= 0.05; L^2 =desired accuracy level at 95% confidence interval= 7.2^2. n was calculated to be 175 goats.

During ante-mortem, animal mucous membrane and hair coat of each animal were examined for abnormality. Blood samples from jugular veins of animals were collected in EDTA. K3 tubes, labeled, stored in container and transported to laboratory for diagnosis of blood *Anaplasma*. Air dried blood smears were fixed in absolute methyl alcohol and stained with 10% Giemsa stain as described by [12]. Slides were examined under oil immersion objective lens (100x) for detection and identification of *Anaplasma* in red blood cells.

Animals were subjected to Post-mortem examination to detect Jaundice, and abnormalities of gallbladder and spleen. Chi. Square (x^2) test and Logistic Regression were used to assess the statistical association for potential risk factors association Anaplasmosis. Data were analyzed using Microsoft of Excel and IBM SPSS (Statistical Package for the Social Sciences) version 20.

3. Results

Examination of 175 blood samples collected from goats, revealed a prevalence of 62.3%. The examined animals from three slaughter- houses in Eldaein were found to be of different ages (less than one year, 1-3 years, more than three years) that are classified as described in Table 1. No significant association is found between age and anaplasmosis ($P<0.05$).

Regarding sex, 38(64.4%) out of 59 males and 71 (61.2%) out of 116 females were infected with *Anaplasma*. The chi-square test ($\chi^2 = 0.170$, $P = 0.404$) showed no significant association between infection and sex.

For clinical findings, six showed pale mucous membrane and two showed congested mucous membrane the rest of the goats examined were of normal mucous membrane. The condition of the mucous membrane was found to have significant association (P= 0.031) with anaplasmosis,

Hair condition was also assessed, six goats had brittle hair, and four of them were infected. There was no statistically significant association between hair condition and infection ($P > 0.05$) (Table 1).

Post-mortem examination of 175 goats revealed 160 enlarged (Figure 1A and 1B), however two empty and 13 normal gallbladders out of which 100 (62.5%), 1 (50.0%) and 8 (61.5%) respectively, were infected with *Anaplasma* no significant association between *anaplasma* infection and changes of gallbladder is found. 32 Spleen were hypertrophied with 18 (56.3) infected with *Anaplasma* while 91(63.6) normal spleen out of 143 were also infected. No jaundice was observed in the 175 goat slaughtered (Table 1) No significant

association was found between post-mortem findings and anaplasmosis.

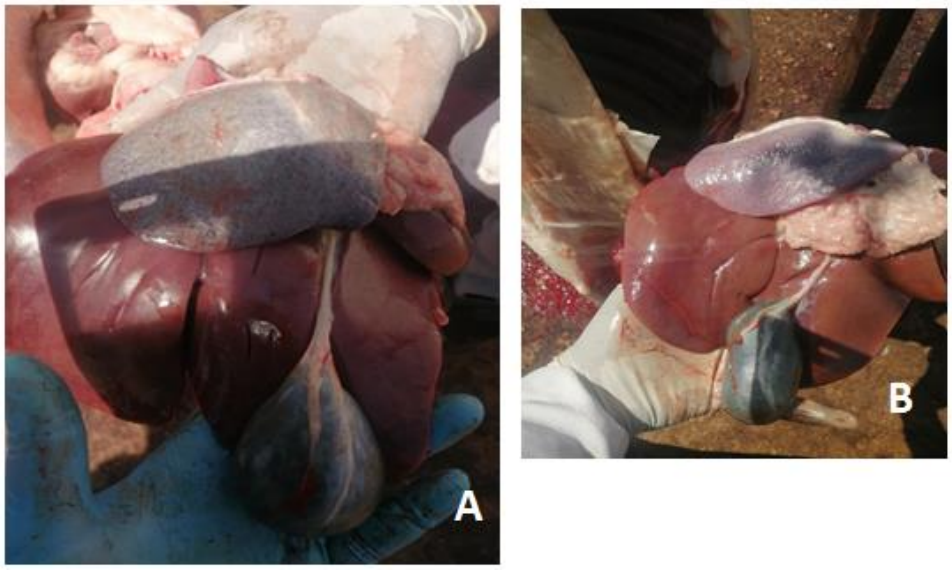

Figure 1. *A. Hypertrophied Spleen and Enlarged Gallbladder in Carcass of Goat Infected with Anaplasma. B. Normal Spleen and Enlarged Gallbladder in Carcass of Goat Infected with Anaplasma.*

Table 1. *Univariate Analysis of Risk Factors Associated with Anaplasma Infection in Goats Using Chi-Square Test in East Darfur State, Sudan.*

Risk factor		Total no. of goats	Goats positive for *Anaplasma*	Percentages of goats positive for *Anaplasma*	Df	X^2	P-value
Sex	Male	59	38	64.4%			
	Female	116	71	61.2%	1	0.170	0.404
Age	less than year	108	66	61.1%			
	1-3 years	15	9	65.4%	2	0.309	0.857
	over 3 years	52	34	60.0%			
Gallbladder	Enlargement	160	100	62.5%			
	Normal	13	8	61.5%	2	0.135	0.935
	Empty	2	1	50.0%			
Spleen	Splenomegaly	32	18	56.3%			
	Normal	143	91	63.6%	1	0.607	0.280
Mucous membrane	Pale	6	6	100%			
	Congested	2	0	0.00%			
	Normal	167	103	61.7%	2	6.962	0.031*
Hair condition	Brittle	6	4	66.7%			
	Normal	169	105	62.1%	1	.051	0.592

4. Discussion

This study carried out to investigate the prevalence of anaplasmosis in goats and to determine the association between the disease and the risk factors in east Darfur State. This study represents the first epidemiological investigation of anaplasmosis in goats in East Darfur State, Sudan. Blood samples from 175 goats were collected from El Daein, slaughter houses to identify prevalence of anaplasmosis. The prevalence was found to be 62.3% in goats. It is considerably higher than those reported by [13], who reported 12.9% prevalence in goats in other parts of Sudan, and by [14], who reported 8.33% in goats in Pakistan and [15] in Iran. The high infection rate found in East Darfur could be attributed to favorable ecological conditions for tick proliferation, such as the savanna climate, vegetation cover, and the presence of multiple animal hosts in the area. The disease is typically kept alive in endemic areas by the prevalence of both vectors and reservoir hosts, as well as a high rate of tick infection. The effective reservoirs for vector transmission are asymptomatic carrier animals [16]. However, all continents are affected by anaplasmosis, which is widespread and disseminated via a variety of biological and mechanical vectors [17]. In West Kordofan, [18] reported that PCR detection of tick-borne pathogens in small ruminants demonstrated a prevalence of 61.8% (110/178) in sheep and goats, including *Anaplasma ovis*. Because PCR is more sensitive and reliable than blood smear examination, their findings support the current study's results and suggest that the observed prevalence likely reflects the true infection status. This also implies that underestimation due to subclinical or non-acute infection stages-often characterized by minimal clinical signs-was unlikely. The results showed no significant association between anaplasmosis and host-related factors such as age and sex. This finding is consistent with the observations of [14] who found no significant association with sex and [13], who found that *Anaplasma* infection was not significantly affected by animal age or sex. The absence of association suggests that all age groups and both sexes are equally exposed to tick infestation in the study area, possibly due to communal grazing systems and shared water sources that facilitate disease transmission.

Postmortem examination revealed that most infected animals had normal spleen and gallbladder size, with no significant association between infection and organ enlargement. However, hypertrophy of spleen and gallbladder enlargement were occasionally observed, which may be attributed to hemolytic effects of *Anaplasma* infection as described by [10]. All examined carcasses were free from jaundice, indicating that infections either subclinical or chronic infection or adaptation of the animal to the infection.

A significant association ($P < 0.05$) was found between mucous membrane color and *Anaplasma* infection in goats. Animals with pale mucous membranes were more likely to be positive, reflecting anemia resulting from erythrocyte destruction by *Anaplasma* organisms. Similar findings were reported by [9], confirming that pale mucous membranes are a useful clinical indicator of anaplasmosis in small ruminants.

Overall, the findings highlight the widespread nature of *Anaplasma* infection in East Darfur and emphasize the need for improved tick control measures and diagnostic surveillance. The high prevalence suggests endemic stability, where animals are frequently exposed and maintain subclinical infections. However, stress, poor nutrition, or concurrent infections could precipitate clinical disease outbreaks, leading to economic losses among livestock producers.

In this study, there is no association between the anaplasmosis and the studied risk factors Namely age sex, breed and no significant association between the disease and the studied pathological changes expected, namely: brittle hair coat, enlargement of gallbladder, hyperplasia of spleen, jaundice, where as there is significant association between the disease and changes in mucous membrane. Once *Anaplasma* enters the bloodstream, the organism invades red blood cells by invaginating their membranes, forming a vacuole within which it multiplies to produce an inclusion body that may contain up to eight initial bodies. These inclusion bodies are most abundant during the acute stage of infection, although some may persist for several years afterward [19]. This persistence explains the presence of infection even in the absence of distinct or severe pathological changes.

Limitation: The relatively small sample size may have limited the power of the statistical analysis, particularly in detecting significant associations between potential risk factors and anaplasmosis infection. Therefore, the findings should be interpreted with caution, and further studies with larger sample numbers are recommended to strengthen the reliability of the conclusions.

Abbreviations

EDTA	Ethylenediaminetetraacetic Acid
Df	Degree of Freedom
CI	Confidence Interval
RBCs	Red Blood Cells

Author Contributions

Khalda Abdelgadire Mohammed Jibreel: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Visualization, Writing – original draft

Mohamed Abdelsalam Abdalla: Conceptualization, Data curation, Methodology, Resources, Supervision, Validation, Visualization, Writing – review & editing

Hind Osman Elrayah: Methodology, Validation, Visualization, Writing – review & editing

Sarra Elnaeim: Formal Analysis, Writing – review & editing

Mohamed Tajeldin Ibrahim: Formal Analysis, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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