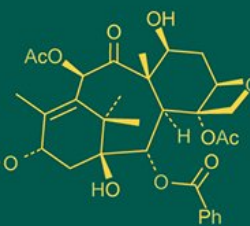
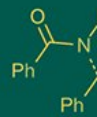
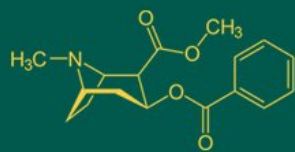


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Hematological and serum biochemical alterations in cattle associated with varying intensities of ixodid tick infestation in the Adamawa Region of Cameroon

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Abstract

Ixodid tick infestations cause significant physiological disturbances in parasitized cattle through blood loss, toxin injection, and immunological reactions. This research evaluated the hematological and serum biochemical alterations in cattle associated with varying intensities of ixodid tick infestation in the Adamawa Region of Cameroon. A comparative cross-sectional investigation was conducted on 180 cattle categorized into three groups: non-infested (n=60), lightly infested (1-20 ticks, n=60), and heavily infested (>20 ticks, n=60). Blood samples were collected for complete blood count and serum biochemistry analysis. Heavily infested cattle showed significantly reduced packed cell volume ($22.8 \pm 4.2\%$ vs $32.4 \pm 3.2\%$ in controls, $p < 0.001$), hemoglobin concentration (7.4 ± 1.6 g/dL vs 11.2 ± 1.4 g/dL, $p < 0.001$), and red blood cell counts ($4.2 \pm 0.8 \times 10^6/\mu\text{L}$ vs $6.8 \pm 1.0 \times 10^6/\mu\text{L}$, $p < 0.001$). Significant elevations in white blood cell counts and serum total protein were observed in heavily parasitized animals. A strong negative correlation ($r = -0.72$, $p < 0.001$) was established between tick burden and packed cell volume. These findings demonstrate that heavy tick infestations induce clinically significant anemia and inflammatory responses in cattle, supporting the need for prompt tick control interventions.

Keywords: Hematological parameters, serum biochemistry, tick infestation, packed cell volume, anemia, cattle, *Rhipicephalus*, blood loss, Cameroon, pathophysiology

Introduction

The problem of tick-induced blood loss in tropical cattle populations extends far beyond the direct consumption of host blood by feeding ticks. Each engorged female ixodid tick can consume 0.5-3 mL of blood depending on the species, and heavy infestations involving hundreds of simultaneously feeding ticks can result in daily blood losses exceeding 200 mL [1]. This chronic hemorrhagic insult triggers a cascade of pathophysiological responses including compensatory erythropoiesis, alterations in iron metabolism, activation of inflammatory pathways, and redistribution of metabolic resources away from productive functions toward immune defense [2].

Hematological and biochemical profiling provides objective, quantifiable indicators of the physiological impact of tick parasitism that complement clinical assessments [3]. Previous investigations have documented varying degrees of anemia, leukocytosis, hypoalbuminemia, and elevated acute-phase proteins in tick-infested cattle [4]. However, dose-response relationships between tick burden intensity and specific hematological or biochemical parameters have been insufficiently characterized, particularly in tropical African cattle breeds [5]. Yusuf AY, Aliyi MB reported high tick prevalence in bovine populations that likely contributes to subclinical production losses through chronic blood depletion [6]. This research evaluated the hematological and serum biochemical profiles of cattle with different levels of tick infestation in the Adamawa Region of Cameroon.

Material and Methods

Material

This research was conducted in the Adamawa Region of Cameroon, situated between latitudes 6°N and 8°N. The region has a tropical highland climate with annual rainfall of 1,500-1,800 mm. Ethical clearance was obtained from the Ngaoundéré Institute of Sciences

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Research Ethics Board (NIS/REB/2023/037). Materials included vacutainer tubes (EDTA and plain), an automated hematology analyzer (Sysmex KX-21N), a chemistry analyzer (Mindray BS-200), and standard reagent kits.

Methods

A comparative cross-sectional design was employed on 180 cattle: non-infested controls (n=60), lightly infested with 1-20 ticks (n=60), and heavily infested with >20 ticks (n=60). Whole-body tick counts were performed and 10 mL of blood collected from each animal via jugular venipuncture into EDTA and plain tubes. Hematological parameters (PCV, Hb, RBC, WBC, platelets, differential counts) were

determined using the automated analyzer. Serum biochemistry (total protein, albumin, globulin, ALT, AST, BUN, creatinine) was analyzed using standard kits. Pearson correlation analysis and one-way ANOVA with post-hoc Tukey tests were used for statistical analysis.

Results

Significant differences were observed across all three infestation groups for key hematological parameters. Heavily infested cattle demonstrated the most pronounced alterations, with PCV values 29.6% lower than non-infested controls.

Table 1: Hematological parameters of cattle across three tick infestation categories

Parameter	Non-infested (n=60)	Light (n=60)	Heavy (n=60)	p-value
PCV (%)	32.4 ± 3.2	28.6 ± 3.8	22.8 ± 4.2	<0.001
Hb (g/dL)	11.2 ± 1.4	9.8 ± 1.6	7.4 ± 1.6	<0.001
RBC (×10 ⁶ /μL)	6.8 ± 1.0	5.9 ± 1.2	4.2 ± 0.8	<0.001
WBC (×10 ³ /μL)	8.4 ± 1.6	9.6 ± 1.8	12.4 ± 2.2	<0.001
Platelets (×10 ³ /μL)	286 ± 42	248 ± 38	198 ± 34	<0.001

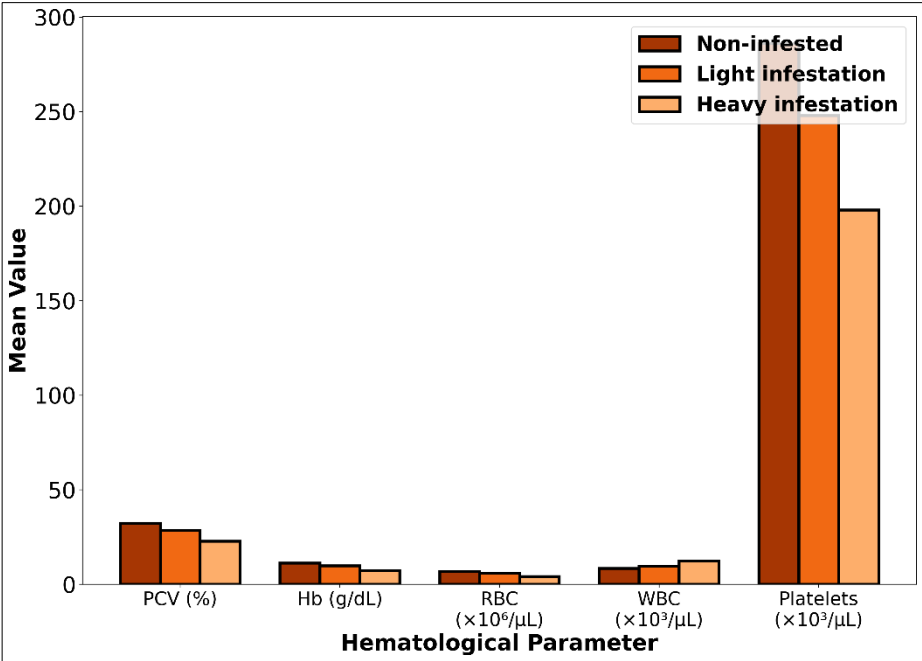


Fig 1: Comparison of key hematological parameters across three tick infestation categories in cattle from Cameroon

Table 2: Serum biochemical parameters across tick infestation categories

Parameter	Non-infested	Light	Heavy	p-value
Total protein (g/dL)	6.8 ± 0.6	7.2 ± 0.8	8.4 ± 1.0	<0.001
Albumin (g/dL)	3.4 ± 0.4	3.0 ± 0.4	2.4 ± 0.6	<0.001
Globulin (g/dL)	3.4 ± 0.6	4.2 ± 0.8	6.0 ± 1.2	<0.001
ALT (U/L)	24.6 ± 4.2	28.4 ± 5.6	36.8 ± 7.4	<0.001
AST (U/L)	42.8 ± 8.4	52.6 ± 10.2	68.4 ± 14.6	<0.001

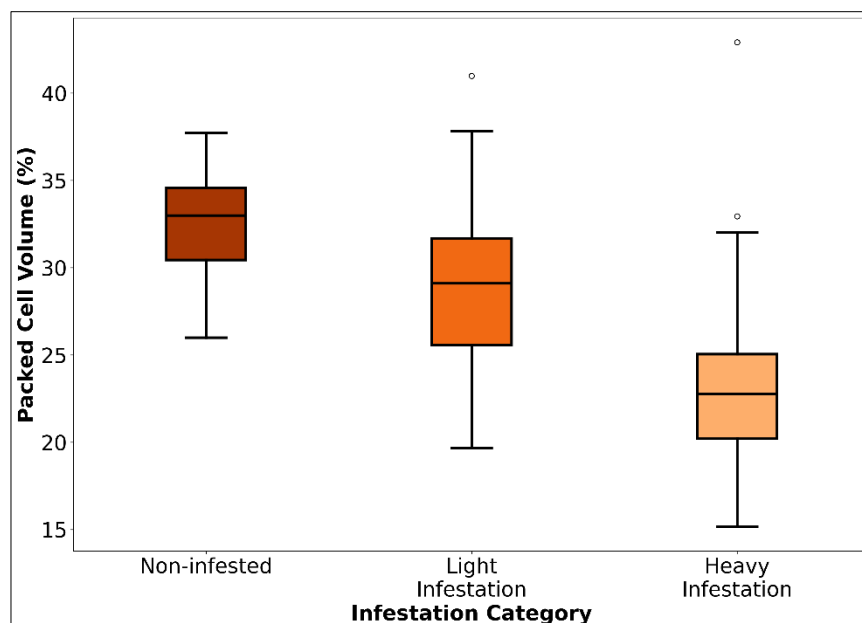


Fig 2: Box plot showing packed cell volume distribution across tick infestation categories

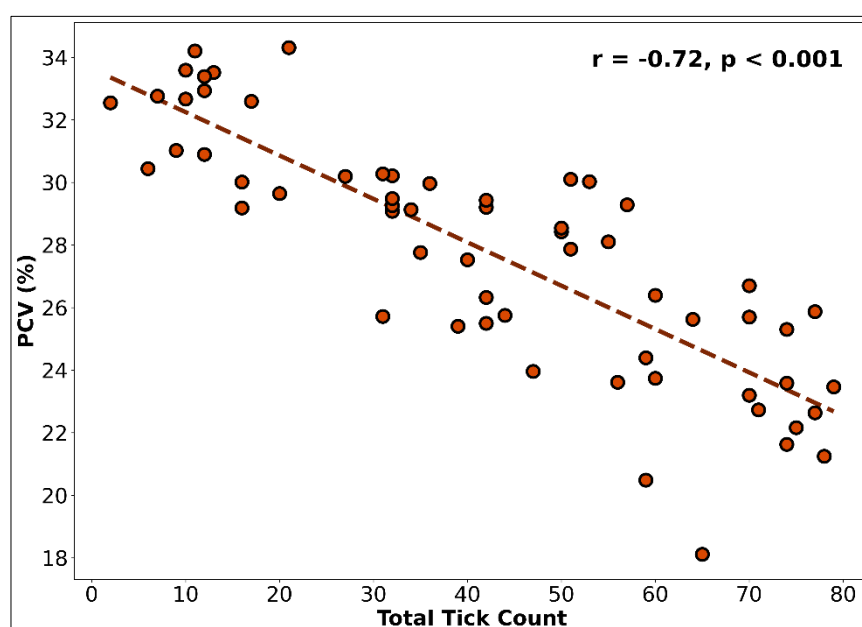


Fig 3: Correlation between tick burden and packed cell volume in cattle from the Adamawa Region

A strong negative correlation was established between total tick count and PCV ($r = -0.72$, $p < 0.001$), confirming the dose-dependent relationship between tick infestation intensity and anemia severity.

Discussion

The significant reductions in PCV, hemoglobin, and RBC counts observed in heavily infested cattle are consistent with the expected hematological consequences of chronic blood loss due to tick feeding [7]. The finding that PCV values in heavily infested animals (22.8%) fell below the clinical anemia threshold of 24% for tropical cattle breeds indicates that heavy tick infestations induce clinically relevant anemia requiring therapeutic intervention [1]. In comparison with previous reports, the magnitude of hematological alterations observed in this research is comparable to findings from East African investigations involving similar tick burdens [8]. The elevated WBC counts and serum globulin levels in heavily infested cattle reflect the activation of inflammatory

and immune responses to tick salivary antigens and potential concurrent tick-borne pathogen exposure [9]. These immunological responses, while protective, divert metabolic resources from productive functions, contributing to the reduced weight gain and milk production commonly observed in tick-infested herds [10]. The practical implication is that economic threshold analyses should incorporate subclinical production losses alongside clinical disease costs when evaluating the cost-effectiveness of tick control interventions.

Clinical significance of findings

The dose-response relationship established in this research ($r = -0.72$) provides a quantitative basis for defining action thresholds for tick control interventions based on hematological monitoring. Animals with PCV values approaching 24% should receive priority treatment to prevent progression to clinically significant anemia [1].

Pathophysiological mechanisms

The observed hyperglobulinemia combined with hypoalbuminemia in heavily infested cattle suggests a shift from hepatic albumin synthesis toward immunoglobulin production in response to chronic antigenic stimulation by tick salivary proteins^[9]. This protein metabolism disruption contributes to reduced growth performance and productive efficiency in parasitized animals.

Conclusion

The principal contribution of this research is the quantitative demonstration that ixodid tick infestations produce dose-dependent hematological and biochemical alterations in cattle, with heavy infestations inducing clinically significant anemia and inflammatory responses. Supporting evidence includes the strong negative correlation between tick burden and PCV values, alongside significant elevations in inflammatory markers. These findings are significant for the field as they provide measurable biomarkers for assessing tick-induced pathological impacts and defining intervention thresholds. Open questions include the specific contribution of concurrent tick-borne pathogen infections to the observed biochemical alterations and the recovery kinetics of hematological parameters following tick removal.

Acknowledgements

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