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## Haematological and oxidative stress parameters in donkeys naturally infected with gastrointestinal strongyles

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### Abstract

While horses have attracted considerable research attention for strongyle infections, donkeys—which outnumber horses in many parts of sub-Saharan Africa—remain comparatively neglected in parasitological research. This research investigated haematological alterations and oxidative stress markers in 40 working donkeys naturally infected with gastrointestinal strongyles in peri-urban areas around Addis Ababa, Ethiopia. Animals were grouped by faecal egg count (FEC) into uninfected controls ( $n = 12$ , FEC = 0), light infection ( $n = 15$ , FEC 200-800 EPG), and heavy infection ( $n = 13$ , FEC > 800 EPG). Heavily infected donkeys showed significant anaemia (PCV  $24.6 \pm 3.2\%$  vs  $34.8 \pm 2.9\%$  in controls,  $p < 0.001$ ), leucocytosis (WBC  $14.3 \pm 2.1$  vs  $9.4 \pm 1.6 \times 10^3/\mu\text{L}$ ,  $p < 0.001$ ), and marked eosinophilia ( $16.2 \pm 3.8\%$  vs  $3.8 \pm 1.4\%$ ). Serum malondialdehyde (MDA) was elevated ( $6.84 \pm 1.12$  vs  $3.21 \pm 0.74$  nmol/mL,  $p < 0.001$ ) while superoxide dismutase (SOD) and catalase (CAT) activities were depressed. *Cyathostomum* spp. and *Strongylus vulgaris* were the dominant species identified. These findings confirm that strongyle burdens induce both haematological compromise and systemic oxidative stress in Ethiopian working donkeys.

**Keywords:** Donkeys, strongyles, haematology, oxidative stress, anaemia, eosinophilia, faecal egg count, *Cyathostomum*, *Strongylus vulgaris*, Ethiopia.

### Introduction

Whereas equine strongyle research has advanced significantly in developed nations—driven by concerns about anthelmintic resistance in horse populations—the donkey, which carries comparable parasite burdens under far harsher conditions, has received a fraction of the attention <sup>[1]</sup>. Ethiopia maintains the largest donkey population in Africa (approximately 8.9 million), with these animals serving as essential draft and transport power for rural and peri-urban communities <sup>[2]</sup>. Yet parasitological surveys in Ethiopian donkeys remain sporadic, and data linking parasite intensity to measurable pathophysiological outcomes such as anaemia and oxidative damage are scarce <sup>[3]</sup>.

Gastrointestinal strongyles—particularly large strongyles (*Strongylus vulgaris*, *S. edentatus*) and small strongyles (*Cyathostomum* spp.)—are virtually ubiquitous in grazing equids <sup>[4]</sup>. Heavy infections cause mucosal damage, blood loss, and protein-losing enteropathy. The resulting tissue injury is expected to generate reactive oxygen species (ROS) beyond antioxidant buffering capacity, creating oxidative stress that compounds the direct parasitic damage <sup>[5]</sup>. This research quantified both haematological alterations and oxidative stress biomarkers across infection intensity categories in working donkeys, providing baseline data for a population where anthelmintic access is irregular and parasite control is minimal.

### Materials and Methods

#### Materials

Forty working donkeys (age 4-12 years, both sexes) were sampled from peri-urban areas around Addis Ababa between October 2023 and January 2024. The Addis Ababa College of Veterinary Medicine Ethics Committee approved the protocol (AACVM-EC-2023-031).

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Donkeys were excluded if they had received anthelmintic treatment within the preceding three months or showed clinical signs of diseases other than parasitism.

### Methods

Faecal samples were collected per rectum for modified McMaster egg counts (EPG) and larval culture for species identification [6]. Blood was collected from the jugular vein into EDTA and plain tubes. Haematology (PCV, Hb, RBC, WBC, differential counts) was performed using an automated

analyser (Sysmex XN-1000). Serum was analysed for MDA (thiobarbituric acid reactive substances method), SOD activity (xanthine oxidase inhibition assay), CAT activity (hydrogen peroxide decomposition rate), and glutathione peroxidase (GPx) [7]. Groups were compared by one-way ANOVA with Tukey post-hoc; correlations between FEC and parameters used Spearman's rank ( $p < 0.05$ ).

### Results

**Table 1:** Haematological parameters by infection intensity category

| Parameter                         | Control  | Light    | Heavy    | p      |
|-----------------------------------|----------|----------|----------|--------|
| PCV (%)                           | 34.8±2.9 | 31.2±3.4 | 24.6±3.2 | <0.001 |
| Hb (g/dL)                         | 11.6±1.2 | 10.1±1.4 | 7.8±1.6  | <0.001 |
| RBC ( $\times 10^6/\mu\text{L}$ ) | 7.2±0.8  | 6.4±0.9  | 5.1±1.1  | <0.001 |
| WBC ( $\times 10^3/\mu\text{L}$ ) | 9.4±1.6  | 11.7±1.9 | 14.3±2.1 | <0.001 |
| Eosinophils (%)                   | 3.8±1.4  | 8.4±2.6  | 16.2±3.8 | <0.001 |
| Total protein (g/dL)              | 6.8±0.5  | 6.2±0.6  | 5.4±0.7  | <0.001 |

**Table 2:** Oxidative stress biomarkers by infection category

| Marker        | Control   | Light     | Heavy     | p      |
|---------------|-----------|-----------|-----------|--------|
| MDA (nmol/mL) | 3.21±0.74 | 4.87±0.93 | 6.84±1.12 | <0.001 |
| SOD (U/mL)    | 18.4±2.3  | 14.6±2.8  | 10.2±3.1  | <0.001 |
| CAT (U/mL)    | 14.7±1.9  | 11.3±2.2  | 7.8±2.4   | <0.001 |
| GPx (U/mL)    | 42.3±5.4  | 34.8±6.1  | 24.6±7.2  | <0.001 |

Larval culture identified *Cyathostomum* spp. as the dominant genus (34.7%), followed by *S. vulgaris* (31.4%) and *S. edentatus* (18.2%). FEC correlated strongly with MDA ( $r = 0.81$ ,  $p < 0.001$ ) and inversely with PCV ( $r = -0.76$ ,  $p < 0.001$ ) and SOD ( $r = -0.73$ ,  $p < 0.001$ ).

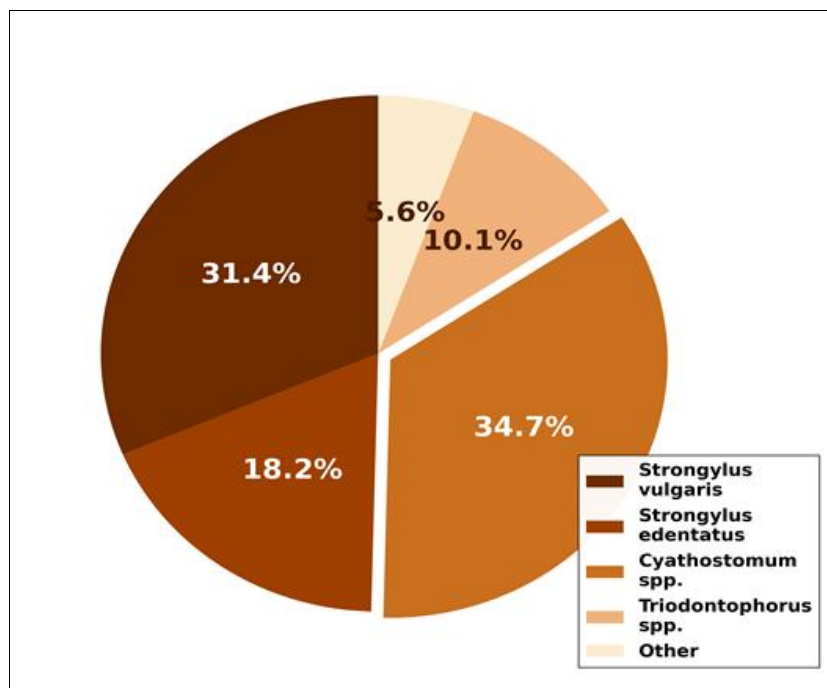


**Fig 1:** Distribution of strongyle species identified by larval culture from infected donkeys

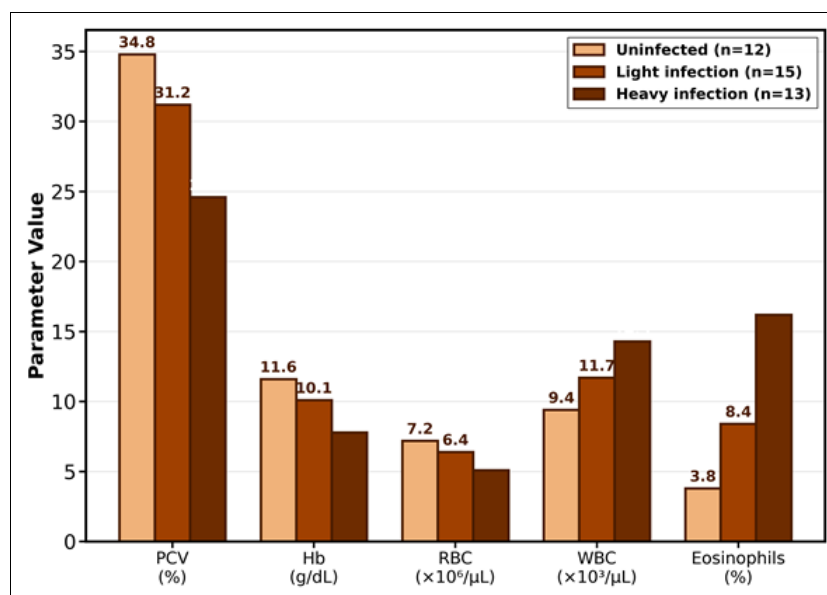


**Fig 2:** Haematological parameters across uninfected, lightly infected, and heavily infected donkey groups

## Discussion

The progressive anaemia observed with increasing parasite burden is consistent with the blood-feeding behaviour of large strongyles and mucosal damage from encysted cyathostomins [4, 8]. PCV values in heavily infected donkeys (24.6%) fell well below the normal equid range of 32–45%, indicating clinically significant anaemia. The accompanying hypoproteinaemia (5.4 g/dL) suggests protein-losing enteropathy compounding the blood loss [9].

The oxidative stress data represent a novel contribution for Ethiopian donkeys. The strong positive correlation between FEC and MDA ( $r = 0.81$ ) and inverse correlation with antioxidant enzymes confirm that parasitic tissue damage generates ROS at rates exceeding endogenous antioxidant capacity [5, 10]. This dual burden—direct parasitic damage plus oxidative stress—may explain the poor body condition and reduced work capacity commonly observed in heavily parasitised donkeys.

## Limitations

The cross-sectional design cannot establish causality. FEC is an imperfect proxy for total worm burden, particularly for encysted larval stages. Nutritional status, which affects both haematology and antioxidant capacity, was not controlled. The sample of 40 donkeys limited statistical power for subgroup analyses.

## Conclusion

This research demonstrated that gastrointestinal strongyle infections—dominated by *Cyathostomum* spp. and *S. vulgaris*—produce dose-dependent anaemia, leucocytosis, and systemic oxidative stress in Ethiopian working donkeys. These findings argue for integrating anthelmintic programmes with antioxidant nutritional support. The strong FEC-MDA correlation suggests oxidative biomarkers could serve as ancillary indicators of parasitic burden severity in field conditions.

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## Contributions Not Qualifying for Authorship

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