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Prevalence and risk factors of gastrointestinal parasitic infections in goats in low-input low-output farming systems in Zimbabwe

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ABSTRACT

A longitudinal study was conducted in low-input low-output farming systems to determine the prevalence of gastrointestinal parasitic infections in different age groups, sex and associated risk factors in goats. A total of 580 indigenous goats were randomly selected in areas representing the five agro-ecological regions of Zimbabwe in the dry and wet seasons. Blood and faecal samples were collected from each animal and egg/oocyst per gram of faeces (epg/opg), larval culture, and packed cell volumes (PCV) were determined. Factors affecting parasitic infections were evaluated. Highest prevalence was determined for *Eimeria* oocysts (43%), strongyles (31%) and lower levels in trematodes and cestodes. Parasites identified were *Haemonchus*, *Strongyloides* and *Oesophagostomum.* Area, season, sex and age significantly influenced patterns of gastrointestinal infections ($P < 0.05$). Cannonical correlations indicated that parasite species composition varied by area and impacts of risk factors also differed. Risk of infection was very high for goats sampled in Natural regions (NR) I, II, III (OR = 6.6–8.2; $P < 0.05$) as compared to those in NR IV and V. Highest helminths and *Eimeria* infections were observed in the wet vs. dry season ($P < 0.05$). Young animals were more susceptible to parasitic infections ($P < 0.05$). Prevalence was higher in males than females, with odds of infection for males being almost three times to that for females ($P < 0.0001$). Knowledge concerning gastrointestinal helminth biology and epidemiological infection patterns caused by these parasites is essential in the development of appropriate control strategies and this has a potential to reduce production losses.

1. Introduction

Goats make important contributions to human livelihoods in developing economies, since they are extremely hardy animals that can survive and reproduce under extremely high temperatures and low humidity with minimum available feed. Of the approximately 1 billion world goat population, 56 and 30% are located in Asia and Africa respectively (FAO, 2015). The majority of the goats in Zimbabwe are owned by smallholder farmers in mixed crop-livestock systems (Rooyen and Tui, 2009). In this farming system, goats are increasingly used to augment cash income and enhance food security, thus serve as an important component in the household's livelihood strategies. Socio-economic importance is attached to goat ownership such that, in some instances they may be the only realisable wealth of a rural household (Nwosu et al., 2007). In addition to that, goats have other functions such as provision of manure, cultural roles, thus playing a significant role in livelihoods.

Gastrointestinal nematode infections (GIN) are the main prevalent parasitic diseases affecting small ruminant productivity worldwide, especially in tropics and sub-tropics (Torres-Acosta and Hoste, 2008; Calvete et al., 2014). Globally the most common nematode species known to affect small ruminants are *Haemonchus contortus*, *Trichostrongylus colubriformis*, *Teladorsagia circumcincta* and some species such as *Nematodirus* spp, which are not found in sub-Saharan Africa (Bishop and Morris, 2007).

Large numbers of internal parasites and their prevalence have been documented in different studies of goats including Zimbabwe (Pandey et al., 1994), Namibia (Kumba et al., 2003), Nigeria (Nwosu et al., 2007), Kenya (Odoi et al., 2007), Ethiopia (Sissay et al., 2007), South Africa (Gwaze et al., 2009), Cameroon (Ntonifor et al., 2013);

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Tanzania (Sharma and Mandal, 2013) and others. The most common nematode genera detected in mixed infections in these studies were *Haemonchus, Trichostrongyles, Strongyloides, Trichuris, Bunostomum, Oesophagostomum, Cooperia, Nematodirus* spp (Badaso and Addis, 2015). Trichostrongyle nematodes are considered among the most pathogenic and economically important parasites of small ruminants (Jurasek et al., 2010) and knowledge of these species is important for preventing and managing parasitic diseases.

Gastrointestinal parasitism is associated with economic losses, lowered productivity, reduced animal performance (Badran et al., 2012), mortality and morbidity (Negasi et al., 2012). In general, severe GIN pathogenesis has been attributed to the migration of the infective larvae after ingestion rather than the adult worms in the gut (Dube et al., 2002). According to Risso et al. (2015), goats infected with internal parasites show a rough dull-coat, weakness, diarrhea, apathy, tail rubbing, signs of hypo-proteinaemia, submandibular oedema (bottle jaw), loss of appetite and weight loss. In addition, some trichostrongyle nematodes cause anaemia due to their ability to remove red blood cells as well as proteins, which can lead to ill-thrift in animals.

In addition to gastrointestinal nematodes, coccidiosis (especially *Eimeria* species) has also been known to infect livestock in Zimbabwe, having moderate to high pathogenic effects (Radfar et al., 2011). However, co-infection with other trichostrongyle nematodes is making diagnosis of clinical coccidiosis difficult (Chhabra and Pandey, 1991; Zainalabidin et al., 2015).

Various risk factors play an important role in the onset of GIN infections, due to host and environment. Environmental factors include agro-ecological conditions, animal husbandry practices such as housing system, deworming intervals and pasture management (Ratanapob et al., 2012); these largely determine the type, incidence and severity of various parasitic diseases (Badran et al., 2012). Other risk factors such as the host species, sex of the animal, age, body condition and breed/genotype (Badaso and Addis, 2015), parasite species and intensity of the worm population, have an effect on the development of gastrointestinal parasitic infections (Tariq et al., 2010).

Limited area-specific studies conducted in Zimbabwe (Pandey et al., 1994; Matika et al., 2003) have generated limited information on gastrointestinal parasite prevalence in the different agro-ecological regions and associated risk factors to parasite infection. Knowledge on the prevalence, specific composition of the gastrointestinal fauna can provide baseline information which can be used to control parasite infections. The specific objectives of the study were to: i) characterise GINs present in diverse farming systems,; ii) determine level of prevalence of the parasites considered; and iii) evaluate risk factors on parasite infections in goats reared in low-input, low-output systems in Zimbabwe.

2. Materials and methods

2.1. Study area and data collection

The study was conducted between November 2014 and June 2015 in low-input low-output farming systems in five districts of Zimbabwe: Chipinge, Shurugwi, Binga, Tsholotsho and Matobo, representing the five agro-ecological regions. Table 1 shows a description of the study districts.

2.2. Animal management

The animals from Chipinge, Shurugwi, Binga, Tsholotsho and Matobo were owned by smallholder farmers who had small flock sizes, ranging from 1 to 10. Animals from these areas were maintained under extensive management systems, where they foraged in farm land or in communal pastures during the day with minimum supplementation and kraaled during the night. In these areas, veterinary care was low to non-existent, with goats not treated/dewormed. Animals mated indiscriminately in communal grazing areas. Goats in these areas had contact with other animal species such as cattle and sheep in the communal grazing areas.

The animals at Matopos Research Station (in the district of Matobo) were managed semi-intensively. The goats foraged on the Research Station open rangeland throughout the year with some rotation in the paddocks during the day, minimum supplementation (1 kg of prepared meal of forage legumes + maize per animal) and penned at night. All animals were treated with an acaricide weekly during the wet season and fortnightly during the dry season

Table 1
Agro-ecological zones/natural regions (NR) of Zimbabwe and vegetation.

NR	District	Rainfall (mm yr^{-1})	Temp (°C)	Altitude (m)	Vegetation
I	Chipinge	>1000	18.2	>1600	**Mountain grassveld:** *Themeda, Loudetia, Andropogon, Monocymbium, Eragrostis* spp. Shrubs*: Senecio* spp.
II	Chipinge	750–1000	18.2	1200–1675	**Hyparrhenia tall grassveld:** *Hyparrhenia, Hyperthelia, Heteropogon, Brachiaria, Digitaria, Eragrostis, Andropogon* spp. Shrubs *Terminalia, Burkea, Combretum, Acacia* spp.
III	Shurugwi	650–800	17.6	>1200	**Hyparrhenia and Eragrostis veld**: *Eragrostis*, *Heteropogon, Themeda, Cymbopogon, Hyparrhenia* spp. Shrubs *Acacia, Brachystegia, Julbernardia* spp.
IV	Binga	450–650	25.3	450–1050	**Eragrostisveld***: Eragrostis Schizachyrium, Heteropogon, Schmidtia, Pogonarthria, Brachiaria, Urochloa, Digitaria, Enneapogon, Aristida* spp. Shrubs: *Terminalia, Combretum*, Acacia, *Commiphora, Colophospermum, Grewia, Brachystegia, Enneapogon* spp.
IV	Tsholotsho	450–650	20.9	450–1050	**Eragrostisveld***: Eragrostis Schizachyrium, Heteropogon, Schmidtia, Pogonarthria, Brachiaria, Urochloa, Digitaria, Enneapogon, Aristida* spp. Shrubs: *Terminalia, Combretum*, Acacia, *Commiphora, Colophospermum, Grewia, Brachystegia, Enneapogon* spp.
V	Matobo	<450	19.9	900–1200	**Aristida and Eragrostis veld:** *Aristida, Digitaria, Triraphis, Heteropogon, Eragrostis, Panicum, Baikiaea* spp. Shrubs: *Colophospermum, Pterocarpus, Julbernardia, Brachystegia, Burkea, Terminalia, Guibourtia, Combretum* spp.

Modified from (Vincent et al., 1960) and (Gambiza and Nyama, 2000).