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Research Article

Prevalence of Gastro-Intestinal Parasites among Goats in Island of Naifaru, Maldives

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ABSTRACT
Gastrointestinal parasitism remains an important constraint to small ruminant productivity; however, data on parasite occurrence in goats in the Maldives are lacking. This study investigated the prevalence of endoparasites in goats reared in Naifaru, Maldives, using standard parasitological techniques. A total of 32 faecal samples were collected from goats across six farms and examined for endoparasites employing direct faecal smear, simple faecal flotation, and sedimentation methods. The use of multiple diagnostic approaches improved detection sensitivity for both protozoan and helminth infections. Data obtained were analyzed descriptively to determine parasite occurrence and overall prevalence. The results indicated the presence of *Eimeria* spp. as the only detected endoparasite, while no helminth eggs or larvae were observed across all samples examined. The overall prevalence of gastrointestinal endoparasites was low, with infections limited to intracellular protozoan parasites. The absence of helminth infections suggests either minimal exposure to infective stages or effective natural or management-related control within the study area. In conclusion, this study provides baseline data on gastrointestinal parasites in goats in Naifaru, Maldives, revealing a low prevalence of endoparasitic infections and no detectable helminthiasis. These findings highlight the need for continued surveillance and the implementation of appropriate management strategies to prevent potential parasite outbreaks and sustain goat productivity in the region.

Keywords: Endoparasites; Goats; Maldives; Prevalence; Public Health

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INTRODUCTION

In Veterinary Medicine, parasites are generally described as single-celled or eukaryotic organisms that reside inside or on the host. Important parasites include helminths, protozoa, and arthropods, typically insects or arachnids (Moorhead, 2014). The host might get harmed as a result of this host-parasite relationship. Although parasites do not usually severely affect the host or always result in their death since parasites rely on the host's body and body functions for nutrition and reproduction, parasites are classified as pathogens. Due to the accompanying morbidity, mortality, the expense of treatment, and control measures, parasitic infections, particularly those caused by gastrointestinal nematodes and trematodes, pose a severe health risk and reduce livestock production (Craig, 2009).

The ability of domestic ruminants to adapt to harsh environments reaches a peak in the case of goats living in such environments. This skill has several contributing factors. Goats' low body mass and low metabolic needs might be a valuable advantage since it reduces their maintenance and water requirements in locations where scarce food and water sources are geographically scattered. Goats can slow down their metabolism, which helps them thrive even when there is little food available for extended periods. Goats have sophisticated grazing behaviour and an effective digestive system, allowing them to achieve maximum food intake and consumption. (Silanikove, 2000).

Endoparasite infestations in small ruminants may cause significant economic losses and threaten animal well-being. Endoparasites have a negative impact on animal health, resulting in clinical and subclinical disorders, which can lead to financial loss and lower production overall (Asif *et al.*, 2008). Protozoan (e.g., coccidia, piroplasms) and metazoan parasites may cause internal diseases (e.g., gastrointestinal nematodes, cestodes, liver trematodes, lungworms, hydatid cysts) and external infestations in goats (e.g., mange mites, lice, fleas). In certain situations, parasites are restricted to a specific organ of predilection (e.g., liver trematodes, lungworms, helminths), whilst in others, they may be found in several locations (e.g., hydatid cysts, cysticerci, *Toxoplasma* cysts) (Bowman, 2021).

Goats are excellent meat suppliers for human consumption in consideration of their short reproductive cycles and the lack of religious taboos linked with their meat since it is a rich source of protein and may effectively bridge the gap of protein deficiency among consumers. Gastrointestinal parasite infestations are widespread in goats inflicting significant economic losses due to death in afflicted animals and impaired weight growth. Helminths and coccidia are the most prevalent GI parasites in goats (Das *et al.*, 2017).

There is an extreme lack of arable pasture lands in the Maldives, owing to the alkaline and saline content in the soil (Shareef & McAleer, 2008). However, goats have been native to the Maldives due to their exceptional climate variability and change tolerance. Goats can live and thrive in the world's most inhospitable places. Well-managed goats can contribute to the preservation of ecosystems and may be utilised as an ecological tool for managing invasive weeds, reducing the risk of wildfire, and optimising land resources and wildlife habitat. (Aich & Waterhouse, 1999) In locations where crop productivity is unpredictable and large ruminants are challenging to rear due to a severe lack of feed and fodder, the goat is a suitable animal species for farming.

Goat husbandry also offers significant economic and management benefits over other livestock species because of its lower initial investment requirement, low input demand, greater prolificacy, early sexual maturity, and direct selling. In challenging environments, goats may effectively subsist on the shrubs and trees that are readily accessible. (Silanikove, 2000). While this seems ideal for the situation in the Maldives, goat husbandry has not been a major agricultural industry in the Maldives owing to difficulties in management which mainly arise from a severe lack of knowledge regarding animal husbandry among the farmers. With proper livestock policies and good management practices, goat husbandry has a lot of potential to improve the agricultural status in the Maldives. Therefore, this study is aim to determine the prevalence of gastro-intestinal parasites in goat populations in the Maldives.

MATERIALS AND METHODS

Study Area

This study was conducted in the Maldives. This study was conducted on the island of Naifaru in Lhaviyani atoll, as over 60% of the goat population in the Maldives is present on that island. The Republic of Maldives is an archipelagic nation located in the Indian Ocean in Southern Asia. The Maldives is one of the world's most geographically dispersed sovereign states, comprising a chain of 26 atolls and occupying a territory of approximately 90,000 square kilometres, including the sea. The land area of all the islands is 298 square kilometres (115 square miles). The Maldives is also the smallest Asian country, one of the smallest Muslim-majority countries by land area, and the second least populous country in Asia, with approximately 557,751 citizens and is the country with the lowest elevation of any nation in the world(Amores *et al.*, 2021; Munawwar, 1995).

The Maldives has a tropical monsoon climate that is perpetually hot and often humid. These causes triggered the southwest monsoon by bringing moist air from the Indian Ocean across South Asia. The climate of the Maldives is dominated by two distinct seasons: the dry season linked to the north-eastern winter monsoon and the wet season related to the southwest monsoon, which is accompanied by high winds and storms. The average annual precipitation in the north is 254 centimetres, while 381 centimetres

in the south. The average high is 31.5 degrees Celsius, and the average low is 26.4 degrees Celsius.

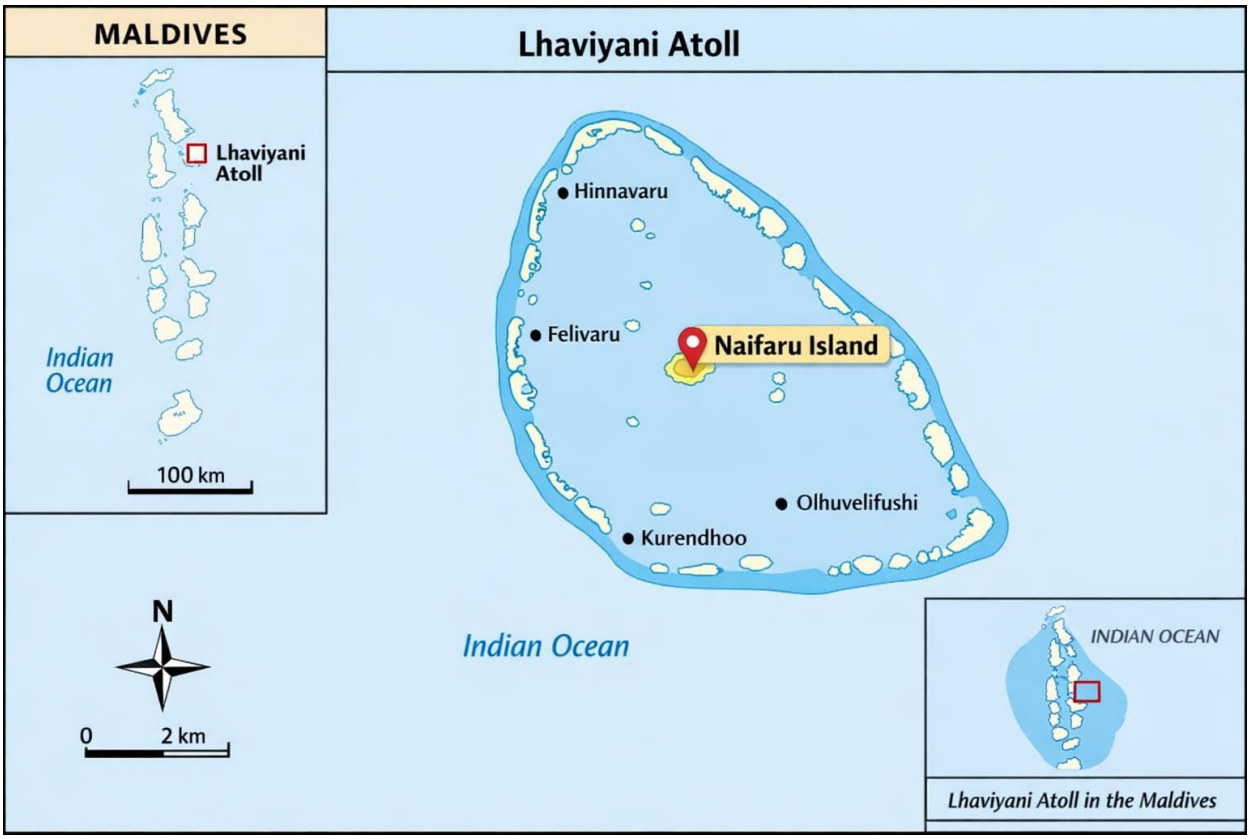

Figure 1. Map of the study area showing Naifaru Island in Lhaviyani Atoll, Maldives

Note. Adapted from *Map of Lhaviyani Atoll, Maldives*, by WorldMaps.info (n.d.), https://www.worldmaps.info/Maldives/lhaviyani/

Study Population

The source population in this study consisted of six goat farms on the island of Naifaru in the Lhaviyani Atoll of the Maldives. At least five goats from each farm were included in this study. At the end of this study, a total of thirty-two goats were sampled.

Study Design

The study design used in this research is a cross-sectional study as this study aims to determine the prevalence, and the study's objective is qualitative. It is conducted without prior knowledge of exposure or disease in the study population and the study lasted for four (4) months.

Selection Criteria

Inclusion Criteria

The age of the goats sampled for this study ranged from six months of age to five years of age. To be included in this study, the goats should also not have undergone anthelmintic treatment within six months before the sampling date.

Exclusion Criteria

Goats less than six months of age were excluded from this study because they were not included in grazing. Goats that have undergone anthelminthic treatment within six months before the sampling will also be excluded from this study.

Sampling Method

Random sampling method was conducted on each of the selected goat farms on the island of Naifaru in the Lhaviyani Atoll of the Maldives. The sampled goats were marked to ensure that double sampling did not occur. Each farm selected for sampling was visited, and the caretaker or farmer was given a questionnaire to ascertain when anthelmintic treatment was conducted most recently, as well as to find information regarding the farm and animals.

Parasite identification

Each sample was examined under a light microscope at magnifications of 40x,100x, 400x, and 1000x. An analysis and identification of any parasites present in the samples and parasitic stages, such as cysts, oocysts, trophozoites, eggs, and larvae, was

conducted by consulting literature; Coccidiosis in Livestock, Poultry, Companion Animals, and Humans (Dubey, 2020), Gastrointestinal Protozoal Infections in Ruminants (Craig, 2009) and Georgis' Parasitology for Veterinarians (Bowman, 2021).

Data Analysis

The data collected were inserted into Microsoft Excel Spreadsheet and presented in tables. The prevalence of the endoparasites in each goat farm was calculated using the formula:

Prevalence (%) = (Number of infected goats with specific endoparasite/Total number of samples) X 100%.

RESULTS

Table 1 shows the number of samples collected from each selected farm in Naifaru, Maldives, as well as the results of the observations conducted on direct faecal smear, simple floatation and sedimentation of the faecal samples taken from the animals in each farm.

Table 2 shows the results of the observation of the faecal samples obtained from each farm based on individual goat faecal samples.

The prevalence of endoparasite infection in the sampled goats of the selected farms of Naifaru, Maldives, is shown in **Table 3**. As seen from the table, no helminths (nematode, cestode and trematode) eggs or worms could be seen in any of the faecal samples obtained from any of the sampled goats of the selected farms in Naifaru, Maldives. However, protozoa were observed in faecal samples obtained from farms B and F. Thus, the prevalence of endoparasites was 16.667 in farm B (n=6) and 40 (n=5) in farm F. The overall prevalence of endoparasites in all the farms from the collected faecal samples was 9.375 (n=32).

Figure 2 shows the images of the unsporulated oocysts of Eimeria spp, which were observed in the faecal samples from goats identified as U4-6, Ef7-2 and EF7-3. The protozoa were identified based on the morphological guidelines provided in Coccidiosis in Livestock, Poultry, Companion Animals, and Humans (Dubey, 2020) and Gastrointestinal Protozoal Infections in Ruminants (Craig, 2009).

DISCUSSION

The results of this study show that the overall endoparasitism prevalence in the goat population present in Naifaru, Maldives was 9.375, which was relatively low. It can also be further seen that helminthiasis was not prevalent among the goat population, while coccidiosis was present with low prevalence. The absence of helminths in the faecal samples could be due to the parameters of soil in the Maldives. The soils of the Maldives are composed primarily of unweathered coral parent material, coral rock, and sand. Due to the soil's high porosity and infiltration rates, the water-holding capacity is very low. The soils of the Maldives are predominantly alkaline, with pH values ranging from 8.0 to 8.8, due primarily to the presence of excess calcium (Selvam *et al.*, 2007).

It has been shown that the survival of soil-transmitted helminths was facilitated by ecological parameters such as adequate rainfall, ambient soil temperature, and a pH range closer to neutral. (Emmanuel Oyewole & Adepeju Simon-Oke, 2022). It was also demonstrated by (Pierangeli *et al.*, 2003) that sandy, well-drained soils with little organic matter content, which encourages surface water runoff and limits water retention between its particles, do not allow for the detection of helminth eggs or larvae. Furthermore, greater soil alkalinity and salinity also reduce parasite contamination (Guerrero de Abreu *et al.*, 2017). This may cause helminth eggs to become inactivated in the soil and cause the death of larvae of helminths in the Maldives, as the soil has a high pH and is typically dry. The absence of helminths in the faecal samples taken from the goats in Naifaru, Maldives, can also be explained by a disruption of the life cycle of helminths. The goats reared in farms in Naifaru, Maldives, are usually fed rice, kitchen waste, shrubs, and agricultural waste such as banana tree stem and fruits and vegetables, which have been damaged and have been rejected from the market. This makes it so that grazing is not a common practice among goat farmers due to a lack of pastures. This would prevent the goats from getting infected by the larval stage of helminths which may present in the soil as the cut-and-carry system, and the zero-grazing system is a viable method for preventing infection since animals are always confined and fed on cut grass with minimal exposure to pastures (Chandrawathani, 2012; Saad *et al.*, 2014) This practice inadvertently, along with the fact that intermediate hosts such as snails are also not common in inhabited Maldivian islands, means that the life cycle of most helminths is disrupted, and there is no opportunity for the helminths to propagate as well as a reduced risk of goats being infected by helminths as well.

Table 1: Number of collected samples and detection of endoparasites in selected goat farms in Naifaru, Maldives

Farm ID	Samples taken	Endoparasites detected
A	5	No
B	6	No
C	6	Yes
D	5	No
E	5	No
F	5	Yes

Table 2: Presence of endoparasites in individual faecal samples collected in each farm

Farm	ID	Nematode	Cestode	Trematode	Protozoa
A	M5-1	NO	NO	NO	NO
	M5-2	NO	NO	NO	NO
	M5-3	NO	NO	NO	NO
	M5-4	NO	NO	NO	NO
	M5-5	NO	NO	NO	NO
B	U4-1	NO	NO	NO	NO
	U4-2	NO	NO	NO	NO
	U4-3	NO	NO	NO	NO
	U4-4	NO	NO	NO	NO
	U4-5	NO	NO	NO	NO
	U4-6	NO	NO	NO	YES
C	W4-1	NO	NO	NO	NO
	W4-2	NO	NO	NO	NO
	W4-3	NO	NO	NO	NO
	W4-4	NO	NO	NO	NO
	W4-5	NO	NO	NO	NO
	W4-6	NO	NO	NO	NO
D	L5-1	NO	NO	NO	NO
	L5-2	NO	NO	NO	NO
	L5-3	NO	NO	NO	NO
	L5-4	NO	NO	NO	NO
	L5-5	NO	NO	NO	NO
E	EF6-1	NO	NO	NO	NO
	EF6-2	NO	NO	NO	NO
	EF6-3	NO	NO	NO	NO
	EF6-4	NO	NO	NO	NO
	EF6-5	NO	NO	NO	NO
F	EF7-1	NO	NO	NO	NO
	EF7-2	NO	NO	NO	YES
	EF7-3	NO	NO	NO	YES
	EF7-4	NO	NO	NO	NO
	EF7-5	NO	NO	NO	NO

Table 3: Prevalence of intercellular endoparasites collectively and based on the type of endoparasite

Farm	n	Nematode	Cestode	Trematode	Protozoa
A	*5*	0	0	0	0
B	*6*	0	0	0	16.667
C	*6*	0	0	0	0
D	*5*	0	0	0	0
E	*5*	0	0	0	0
F	*5*	0	0	0	40
Total prevalence		0	0	0	9.375

Figure 2: Unsporulated oocysts of Eimeria spp was observed in the faecal samples from U4-6, Ef7-2, and EF7-3

CONCLUSION

In conclusion, this study has shown that the overall prevalence of intercellular endoparasites in goats in Naifaru, Maldives was relatively low and that the prevalence of helminthiasis is non-existent. However, further studies can be done whereby faecal culture, which was not conducted in this study, can be performed in the future to verify this study's findings further. The study population can also be augmented to include the goat populations in other goat-rearing islands of the Maldives, thereby increasing the sample size for increased accuracy.

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APPENDIX- A

Appendix A-1: Feed given to goats reared in Naifaru, Maldives

Appendix A-2: Feed given to goats reared in Naifaru, Maldives

Appendix A-3: Farmer preparing feed

Appendix A-4: Typical goat pen in Naifaru, Maldives