PREVALENCE OF ENDOPARASITES AMONG GOATS IN MALDIVES

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CERTIFICATION

This is to certify that we have read this research paper entitled '**Prevalence Of Endoparasites Among Goats In Maldives ' by Hussain Misfah Saamee**, and in our opinion it is satisfactory in terms of scope, quality and presentation as partial fulfillment of the requirement for the course DVT 44603– Research Project.

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ABSTRACT

An abstract of the research paper presented to the Faculty of Veterinary Medicine, Universiti Malaysia Kelantan, in partial requirement on the course DVT 44603 – Research Project.

Endoparasite infections in goats have a deleterious effect on animal health, causing clinical and subclinical illnesses that can result in monetary loss and a decline in overall production. Goat husbandry has not been a big agricultural enterprise in the Maldives due to difficulties in management, which stem primarily from a severe lack of animal husbandry skills and knowledge among the farmers. Additionally, no scientific surveys or studies on goats in the Maldives have been done, and there are no data regarding the presence or absence of parasites and pathogens in the goat population of the Maldives. Thirty two faecal samples were taken from six goat farms in Naifaru, Maldives and tested for the presence of endoparasites by direct faecal smear, simple faecal flotation and faecal sedimentation. The result of this study shows while *Eimeria* spp was present, no helminth parasites were detected in the goat population of Maldives. This may be due to a few factors and needs further examination in future studies.

Keywords: Goats, Endoparasites, Prevalence, Maldives

ABSTRAK

Abstrak daripada kertas penyelidikan dikemukakan kepada Fakulti Perubatan Veterinar, Universiti Malaysia Kelantan untuk memenuhi sebahagian daripada keperluan kursus DVT 44603 – Projek Penyelidikan.

Jangkitan endoparasit dalam kambing mempunyai kesan buruk terhadap kesihatan haiwan, menyebabkan penyakit klinikal dan subklinikal yang boleh mengakibatkan kerugian kewangan dan penurunan dalam pengeluaran keseluruhan. Penternakan kambing bukanlah perusahaan pertanian yang besar di Maldives kerana kesukaran dalam pengurusan, yang berpunca terutamanya daripada kekurangan kemahiran dan pengetahuan penternakan yang teruk di kalangan petani. Selain itu, tiada tinjauan saintifik atau kajian tentang kambing di Maldives telah dilakukan, dan tiada data mengenai kehadiran atau ketiadaan parasit dan patogen dalam populasi kambing di Maldives. Tiga puluh dua sampel najis telah diambil dari enam ladang kambing di Naifaru, Maldives dan diuji untuk kehadiran endoparasit melalui sapuan najis terus, pengapungan najis ringkas dan pemendapan najis. Hasil kajian ini menunjukkan semasa Eimeria spp hadir, tiada parasit helminths dikesan dalam populasi kambing Maldives. Ini mungkin disebabkan oleh beberapa faktor dan memerlukan pemeriksaan lanjut dalam kajian akan datang.

Kata kunci: Goats, Endoparasites, Prevalence, Maldives

1. 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. Ectoparasites and endoparasites are two categories of parasites. Ectoparasites are parasites that live outside the host, whereas endoparasites live inside the host. 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).

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.

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. Therefore, with proper training and

guidance, goat husbandry has a lot of potential to improve the agricultural status in the Maldives

1.1. Research Problem

One of the major limiting factors of ruminant production is parasitic diseases caused by endoparasites. However, no surveys or studies of a scientific nature have been conducted on goats in the Maldives, and there is no data regarding the presence or absence of endoparasites present in the goat population in the Maldives.

1.2. Research Questions

- Are endoparasites prevalent among goat populations in the Maldives?
- What is the genus or species of endoparasites which are prevalent in the goat populations in the Maldives?

1.3. Research Hypothesis

H_0: Endoparasites are not prevalent among goat populations in the Maldives.

HA: Endoparasites are prevalent among goat populations in the Maldives.

1.4. Objectives

- To identify the endoparasites present among goat populations in the Maldives up to the genus or species level.
- To investigate the prevalence of endoparasites among goat populations in the Maldives using goat faecal samples.

2. LITERATURE REVIEW

2.1. Goat Farming

Small ruminants are more feasible than cattle and other monogastric species owing to their cheap cost of production, low reproductive interval, suitability to small holdings, multifunctional usage, capacity to use agricultural wastes efficiently, and, most crucially, resistance to unfavourable climatic factors such as low rainfall and heat stress(Marino et al., 2016)

For generations, people have utilised goats for various reasons (milk, meat, fibre, skin, and even labour). Although goats are found on all continents, the goat industry has received far less public and academic backing than other animal-producing industries such as cow milk, beef meat, poultry, pigs, and horses. (Nure & Siddiky, 2017) It should also be noted that goat farming provides a reliable source of supplementary income for landless, impoverished, or marginal farmers. Goats have been referred to as the poor man's cow. Due to their small size, goats are easily cared for by women and children. Feeding, milking, and caring for goats require minimal equipment and work. In addition, construction expenditures and feeding costs are low (Dubeuf et al., 2004). Goat husbandry can provide additional prospects for organisations to intervene in microcredit, extension, and marketing support, particularly for rural women, landless farmers, and small farmers. It should also be noted that in the past 15 years, the global population of goats has expanded by about 50 per cent, whereas cattle and sheep populations have only increased by 9 and 4 per cent, respectively. (Nure & Siddiky, 2017)

2.2. Parasites

Parasites such as protozoa, helminths, and arthropods are living organisms that receive their sustenance from other species (hosts), causing damage to the host while benefiting the parasite. Parasites can cause mortality or severe illness in single or several species and animal output losses. Depending on the parasite species/burden and the host's immunity, the clinical manifestations of parasitism may differ in their severity. Often, they are non-specific, inconclusive, and only suggestive of parasite infection/infestation upon clinical examination. The most common symptoms are weight loss, diarrhoea, a rough hair coat, lethargy, anaemia, and coughing. Depending on the affected organ, other symptoms may also be present. In many circumstances, parasite infections/infestations predispose to other illnesses, particularly subclinical or chronic (Bowman, 2020).

Parasites can be differentiated into two categories based on where they are found in the host animal's body. Ectoparasites live on the external surface of animals that are mostly skin, such as ticks, fleas, leeches, lice, mites, flies, and maggots. Endoparasites are parasites found in organ systems, digestive tracts, and blood. According to their size, endoparasites are intercellular or extracellular (living in the body's spaces or fluids), while others are intracellular (inhabiting host cells). As with all host-parasite relationships, the pathogenic effects of parasite burdens depend on the species of parasites and stage of life cycle present, the number of parasites present, the predilection site, as well as the age and host immunity which directly affect the endoparasite populations and pathogenicity(Rohde, 2013).

2.3. Endoparasitism in Goats

Goats can be infected by various endoparasites, which can be protozoan or metazoan, in specific predilection organs and found at multiple sites. Endoparasitism causes the loss of afflicted animals' resources and, in many situations, a reduction in feed intake, resulting in lower productivity. Endoparasitism frequently causes anaemia, anorexia, impaired immunity, decreased reproductive performance, potentially causing abortions or stillbirths and a long-term decrease of fertility in affected does, impaired meat, fibre, or milk output due to decreased feed-conversion ratio, and even death, all of which may be costly for a farmer. These productivity limitations are especially significant in many tropical and subtropical regions, where goats play a vital role in the agricultural system. (Fthenakis & Papadopoulos, 2018)

The most common endoparasitic diseases in goats are parasitic gastroenteritis caused by gastrointestinal nematodes and coccidiosis caused by protozoan parasites of the genus Eimeria. Other internal parasitic diseases in goats include cryptosporidiosis, a rapidly expanding zoonotic infection of domestic animals (and humans), cestode, metacestode and trematode infestation, and Oestridae insect larvae infestation (bots and warbles) (Matthews, 2016)

2.4. Clinical Signs Associated with Endoparasite Infestation

The clinical signs of endoparasitism are similar to those of many other diseases and disorders, but an initial diagnosis based on symptoms, history, and the season is generally justifiable. Some common clinical signs associated with endoparasites infestation in goats are weight loss, diarrhoea, rough hair coat, depression, weakness, anaemia, and fever as well; as in the late stages of the disease, the cold extremities, particularly at the ears and legs(Rohde, 2013).

3. MATERIALS AND METHODS

3.1. 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.

3.2. Source Population

The source population in this study consisted of six goat farms on the island of Naifaru in the Lhaviyani Atoll of the Maldives.

3.3. Study Population

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.

3.4. 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

3.5. Selection Criteria

3.5.1. 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.

3.5.2. Exclusion Criteria

Goats less than six months of age were excluded from this study. Goats that have undergone anthelminthic treatment within six months before the sampling will also be excluded from this study.

3.6. Sampling Method

Random sampling 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.

3.7. Sampling Procedure

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.

3.7.1. Faecal sample collection:

Gentle pressure is applied to the anal sphincter until penetration into the rectum is obtained. The index and middle fingers will be inserted into the rectum of the animal, one finger at a time. The fingers will be spread to allow air into the rectum and massage the rectal wall to stimulate rectal evacuation. Around 10 grams of faecal matter will then be removed using a gloved hand. The glove will then be peeled off the hand, keeping the faecal sample encased within it. As much air as possible will be squeezed out of the glove, and the wrist portion of the glove will be twisted and labelled. The samples will be placed in a cooler with ice to keep the samples cool until they can be stored in a refrigerator, taking care not to put samples in direct contact with ice/ice packs to prevent freezing. The samples will then be stored at 4 °C until processing.

3.8. Sample processing and observation

The samples were processed by simple faecal flotation, faecal sedimentation, and faecal smear techniques.

3.8.1. Direct faecal smear technique

This method is mainly used to identify stages of protozoa in faeces. Motile stages, such as trophozoites, can be detected in diarrhoeic faeces, but cysts, oocysts or sporocysts are more commonly found, even in formed faeces. To identify motile stages, it is desirable to examine a sample as rapidly as possible and use a warm stage on the microscope. The sample was processed using the following protocol.

A drop of saline solution was placed on a clean glass slide. A toothpick was used to collect fresh faecal samples. The faecal sample was spread very thinly on a clean microscope slide and covered with a coverslip. Due to the transparent hue of most unstained parasites, less illumination was used while the examination was conducted under a microscope(Abdisa, 2018).

3.8.2. Simple flotation technique

The simple faecal floatation procedure is suitable for isolating and identifying a majority of nematode eggs and protozoan oocysts in faeces. The method is quick, inexpensive and does not require a centrifuge. The solution used for this method is Sheather's solution. To make Sheather's solution, the solution was prepared by using 454 g granulated sugar, 355 ml water, and 6 ml formalin (40% formaldehyde) which was dissolved over heat to get a sugar solution of specific gravity 1.27(Dryden et al., 2015). The sample was then processed using the following protocol.

One gram of faecal sample was taken, ground, and mixed with forty-two ml of saline water. The solution was filtered through a fine sieve into a test tube until it formed a

positive meniscus. A clean cover slip was placed on the mouth of a test tube and then left for fifteen minutes at room temperature without disturbance. The cover slip was then removed and placed on a glass slide and examined under a microscope. The unfiltered material remaining on the sieve was inspected for segments of cestodes as well(Abdisa, 2018).

3.8.3. Faecal sedimentation

This technique is used to recover eggs of trematodes and some cestodes, which do not float in standard flotation techniques. Clean trematode eggs can be found in a small amount of faecal waste after repeated "washing" with water. The "washing" is commonly done by combining a large volume of water with a small amount of faeces, allowing the suspension to sit for at least ten minutes, decanting the supernatant, mixing additional water with the sediment, and repeating the procedure three to five times. The eggs are visible in the final sediment. The faecal sedimentation was conducted using the following protocol.

Three grams of faeces that had been ground and weighed were transferred into a cylinder. Forty-fifty ml of tap water was added to the cylinder, and the faeces and water were mixed. The suspension was strained into another cylinder using a sieve. The filtered mixture was placed in a test tube and allowed five minutes for sedimentation. The supernatant was carefully removed using a pipette. The sediment was then resuspended in five ml of water and kept for five minutes for sedimentation. The supernatant was then discarded, and a drop of methylene blue was added to the sediment. The dyes stain the faeces a dark blue or green while keeping the trematode eggs unstained. A pipette was used to transfer a drop of the stained sediment to a microscope slide. The droplet was covered with a coverslip and then observed under a microscope(Abdisa, 2018).

3.9. 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).

3.10. Data Analysis

The data collected were tabulated in Microsoft Excel Spreadsheet. 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%

4. RESULTS

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

Farm	ID	Nematode detected	Cestode detected	Trematode detected	Protozoa detected
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 2 shows the results of the observation of the faecal samples obtained from each farm based on individual goat faecal samples.

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

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

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).

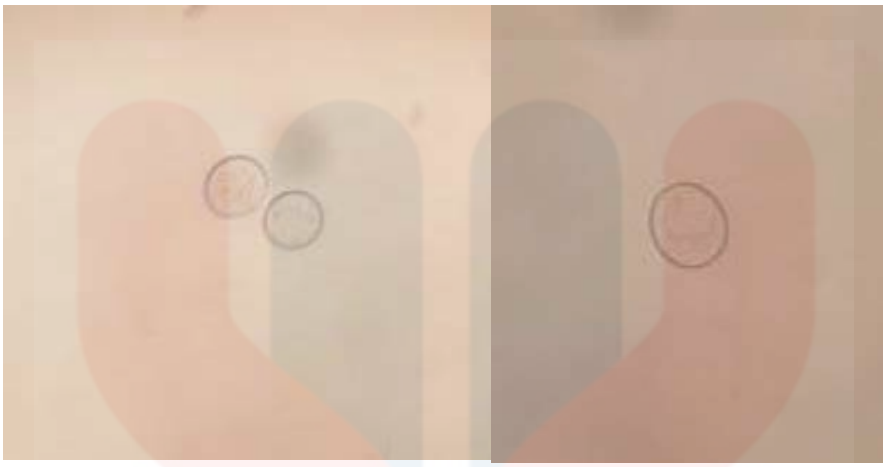

Figure 1: Unsporulated oocysts of Eimeria spp was observed in the faecal samples from U4-6, Ef7-2, and EF7-3.

Figure 1 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).

5. 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 present in the faecal samples which were tested 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.

6.0 CONCLUSION AND RECOMMENDATION

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 A4: Typical goat pen in Naifaru, Maldives