PREVALENCE OF GASTROINTESTINAL PARASITES IN GOATS AT SELECTED ABATTOIRS IN BENIN CITY, EDO STATE.

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A PROJECT WORK SUBMITTED TO THE

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CERTIFICATION

This is to certify that this project work was carried out by IYOHA VERA OSAHENRUMWEN with matriculation number BMS2001172 in partial fulfilment of the requirements for the award of Bachelor of Medical Laboratory Science (BMLS) from the University of Benin, Benin City, Edo State, Nigeria.

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This project is dedicated to Almighty God who is the source of all knowledge and wisdom and to my lovely parents and siblings for their unwavering love and support.

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ABSTRACT

Gastrointestinal parasites pose significant threats to the health and productivity of goat populations, particularly in rural settings. This study aimed to assess the prevalence and impact of gastrointestinal parasites in goats at selected abattoirs in Benin City, Edo State, Nigeria. A total of 200 goat fecal samples were obtained from goats across two selected abattoirs located in New Benin and Aduwawa markets within Benin City. These comprised 100 samples each from New Benin and Aduwawa abattoirs, with 20 fecal samples obtained from Red Sokoto goats and 80 fecal samples from West African Long-legged goats in each abattoir. Ethical approval was obtained, and informed consent was secured from all involved parties before the commencement of sample collection. The samples were examined microscopically using direct wet mount and formalin-ethyl acetate concentration techniques to detect gastrointestinal parasite. Key findings revealed a high overall prevalence of 82.5%, with *Eimeria* spp. (49.5%), *Haemonchus* spp. (48.5%), and *Strongyloides papillosus* (48.0%) being the most frequently identified parasites. Significant breed-related differences were observed, with Red Sokoto goats exhibiting a higher prevalence of *Strongyloides papillosus* at 85.0% compared to 38.8% in West African Long-Legged goats. Statistical analyses highlighted significant associations between market environment and the prevalence of *Haemonchus* spp, as well as breed differences in susceptibility to various parasites. The prevalence rates identified in this study emphasize the urgent need for effective management and control strategies to combat gastrointestinal parasitism in goat populations within the region. The findings emphasize the necessity for integrated animal health initiatives aimed at improving livestock management practices and enhancing overall animal productivity, consequently improving the livelihoods of local farmers in Benin City.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of Study

Gastrointestinal parasites are a serious concern for livestock health, affecting both productivity and the economic viability of farms, especially in places like Benin City, Edo State, Nigeria. In goats, some of the most common culprits are nematodes such as *Haemonchus contortus* and *Trichostrongylus* spp., along with protozoa like *Eimeria spp*. These parasites can cause major health problems, leading to malnutrition, stunted growth, and in severe cases, even death. This situation can have a devastating impact on farmers who depend on these animals for their livelihood (Bhowmik *et al*., 2020). Research has shown that the prevalence of gastrointestinal parasites in goats can range from 60% to over 90%, influenced by geographical and environmental factors (Challaton *et al*., 2022; Ramakant *et al*., 2024).

In Benin City, where goat farming is common for both personal and commercial use, it's crucial to understand the extent of these parasitic infections. To effectively manage and treat these issues, we need solid data on the types and prevalence of infections affecting local goat populations (Singh *et al*., 2022; Patel *et al*., 2023). Recent studies have highlighted a worrying trend in the prevalence of gastrointestinal parasites among livestock worldwide, emphasizing the need for localized research to better understand the specific conditions impacting areas like Benin City (Challaton *et al*., 2022; Mohamed *et al*., 2023).

Furthermore, any successful control measures to tackle these infections must be based on local epidemiological data. Without detailed studies tailored to specific regions, interventions may not effectively address the unique challenges posed by gastrointestinal parasites (Hurisa *et al*., 2021). According to previous findings, livestock health can be adversely affected by environmental factors, husbandry practices, and seasonal changes that influence parasitic load (Thompson *et al*., 2022; Okafor *et al*., 2023). This study aims to assess the prevalence and impact of gastrointestinal parasites in goat populations at selected abattoirs in Benin City, Edo State, Nigeria.

1.2 Statement of Problem

Understanding the role of gastrointestinal parasites is crucial, especially in areas where goats play a key role in agricultural livelihoods. In Benin City, the absence of data on the prevalence of these parasites in local goat populations makes it tough to create effective strategies to tackle their impact on health and productivity. While previous studies have shed light on the prevalence of gastrointestinal parasites in goats across various regions, there's a significant lack of research specifically focused on Benin City. This gap underscores the urgent need for solid evidence to grasp the local epidemiological situation (Challaton *et al*., 2022; Ramakant *et al*., 2024).

Research from different areas shows high prevalence rates in various regions, but we still lack data to predict similar trends in Benin City (Williams *et al*., 2021; Challaton *et al*., 2022). Ignoring this gap could lead to ongoing economic losses for farmers and negative health effects for livestock, creating a cycle of underperformance in goat production and related industries (Johnson *et al*., 2022). Since goats are a vital source of food and income for many households, it's essential to understand the prevalence of parasites and the risk factors involved in Benin City. Recent findings indicate that poor husbandry practices, environmental stresses, and a lack of awareness about managing parasites are making the situation worse (Kalwaghe *et al*., 2022). Therefore, this study aims to clarify the details surrounding gastrointestinal parasitic infections in goats at local abattoirs, ultimately focusing on enhancing food security and public health.

1.3 Significance of Study

This study carries important implications for veterinary practices and public health policies in Benin City. By carefully documenting the prevalence and types of gastrointestinal parasites found in goat populations, we can provide valuable insights for farmers and local authorities. This information can help improve animal health management and control strategies (Ramakant *et al*., 2024; Davis *et al*., 2023). With up-to-date data, policies can be tailored to enhance outcomes, benefiting not just the health of livestock but also the sustainability of local agriculture. Since goats are a vital source of nutrition and income, tackling these parasitic issues can lead to broader economic advantages (Hassan *et al*., 2022; Thompson *et al*., 2022).

Moreover, this research could support educational initiatives aimed at raising awareness among goat farmers about best practices for livestock management and parasite control. By equipping farmers with knowledge about the risks and effects of various parasites, we can potentially reduce infection rates and boost the productivity of local livestock (Challaton *et al*., 2022; Patel *et al*., 2023). The public health implications are significant, as the health of livestock directly influences food safety and the risk of zoonotic infections being transmitted to humans.

Additionally, by bridging the gap between academic research and practical field application, this study could pave the way for future longitudinal studies that deepen our understanding of gastrointestinal parasites in goat populations. Such foundational research is essential for establishing best practices and enhancing the resilience of agricultural sectors that rely heavily on livestock (Challaton *et al*., 2022; Mohamed *et al*., 2023; Johnson *et al*., 2022). Ultimately, this study aims not only to address existing knowledge gaps but also to improve the welfare of livestock and contribute to the economic stability of rural communities in Benin City.

1.4 Aim and Objectives

Aim:

The aim of this study is to assess the prevalence of gastrointestinal parasites in goat populations at selected abattoirs in Benin City, Edo State, Nigeria.

1.4.1 Specific Objectives

The Specific Objectives of this study are;

1. to evaluate the presence and types of gastrointestinal parasites in goats at selected abattoirs in Benin City.
2. to determine the prevalence and distribution of these parasites across different goat breeds within the study area.
3. to identify potential risk factors associated with higher rates of parasitic infections in goat populations.

1.5 Research Questions

1. What is the prevalence of gastrointestinal parasites in goats at selected abattoirs in Benin City?
2. Are there significant differences in the prevalence of these parasites across various goat breeds?
3. What specific environmental and management practices correlate with higher levels of parasitic infections in goat populations?

1.6 Research Hypotheses

1.6.1 Null Hypotheses (H_0):

There is no significant difference in the prevalence of gastrointestinal parasites in goats at selected abbatoirs in Benin City,Edo State.

1.6.2 Alternative Hypotheses (H_1):

There is a significant difference in the prevalence of gastrointestinal parasites in goats at selected abbatoirs in Benin City,Edo State.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Goat Overview

The goat (*Capra hircus*) is a key player in the world of livestock diversity and has a versatile role in agricultural systems. It's believed that goat domestication dates back to the Neolithic era, when these animals were first cared for not just for their meat, milk, and hides, but also for their usefulness as pack animals. Archaeological findings indicate that goats were among the earliest livestock to be domesticated, around 10,000 years ago in the Fertile Crescent, making them crucial to the rise of early agricultural societies. Nowadays, goats are found all over the globe and are a vital part of various farming systems, thanks to their ability to adapt to different environmental conditions and management styles. Their knack for thriving in tough climates where other livestock might struggle highlights their importance in supporting the livelihoods of pastoral communities (Williams *et al*., 2021; Anderson *et al*., 2023).

In Nigeria and West Africa, goats are essential for food security and economic stability. They offer a range of resources, including meat, milk, and hides, which significantly contribute to the diets and economies of farming households. Nigeria boasts an estimated goat population of over 3.9 million, underscoring their importance in rural economies (Obinna and Onu, 2021). Additionally, goats provide a source of income for smallholder farmers, who often rely on them as a safety net against economic challenges, given their relatively low maintenance costs compared to larger livestock like cattle (Nwachukwu and Berekwu, 2020).

Some common indigenous goat breeds in Nigeria include the West African Dwarf (WAD), Sahel, and Red Sokoto. The WAD goats are particularly remarkable for their resilience and adaptability to the humid conditions of southern Nigeria. In contrast, Sahel goats thrive in arid and semi-arid areas and are known for their larger size and impressive milk production capabilities. Understanding the characteristics of these breeds is crucial, as breed differences can influence susceptibility to diseases, including gastrointestinal parasites, which are a significant concern in goat production systems (Okafor *et al.*, 2023; Rahman *et al.*, 2024; Singh *et al.*, 2022).

Goats play a vital role in agriculture around the globe, especially in developing nations. They're found in large numbers across Africa, Asia, Europe, and the Americas, showcasing their remarkable adaptability to various farming systems (Anderson *et al.*, 2023; FAO, 2021). In many regions, goats are favored over other livestock because they can thrive on limited food sources, require less space, and reproduce quickly. This makes them not just livestock but also a dependable source of income for many families, particularly in areas with fewer resources.

For communities engaged in subsistence farming, goats are essential to rural life. Their resilience allows them to flourish in tough conditions where other animals might struggle, thus ensuring food security. As natural browsers, they help control vegetation by eating shrubs and weeds, which can lower fire risks and enhance land management (Kumar *et al.*, 2021; Obinna and Onu, 2021). This ecological function highlights the many advantages goats offer, extending well beyond just their economic value.

2.1.1 Origin, Domestication, and Global Distribution of Goats

The journey of goat domestication is a fascinating chapter in our history, showcasing the profound shifts in human society. Archaeological evidence shows that this process began as people moved from a nomadic lifestyle of hunting and gathering to more settled agricultural ways of living. Goats were among the first animals to be domesticated, thanks to their manageable size and flexible diet, making them perfect for early farming practices (Miller *et al.*, 2022; Adebayo *et al.*, 2022). Fossil remains and ancient writings shed light on the different phases of goat domestication, revealing the long-standing bond between these animals and humans over thousands of years. In many developing countries, goats hold significant value as a source of protein, income, and even social standing (Obinna and Onu, 2021;

Okpara *et al*., 2021). Their widespread presence reflects a range of agricultural methods, from intensive farming in wealthier nations to extensive subsistence farming in less developed areas. Recent research emphasizes how well goats adapt to various environments, making them vital to smallholder farming, particularly in Africa (Anderson *et al*., 2023; Adebayo *et al*., 2022). Their adaptability allows them to take on multiple roles, such as controlling pests and managing weeds in pastures. These benefits significantly boost their worth in agricultural systems, especially when resources are scarce (Williams *et al*., 2021; Okafor *et al*., 2023).

Interestingly, the global spread of goats is shaped by their ability to thrive in different climates. They are particularly well-suited for arid, semi-arid, and tropical regions, which is why they are favored in both developed and developing countries. According to the Food and Agriculture Organization (FAO, 2021), there are over a billion goats worldwide, with Asia having the largest population, followed by Africa and Europe (FAO, 2021; Okpara *et al*., 2021). This distribution underscores their importance not only as a source of meat and milk but also as cultural symbols and elements of social status in various communities.

In Nigeria, goats play a vital role, with various breeds offering unique benefits tailored to different ecological zones. The rich variety of goat breeds found in Nigeria mirrors the country's diverse agro-ecological conditions and traditional farming methods. Indigenous breeds like the West African Dwarf and the Sahel breed are essential for the livelihoods of rural communities, while some exotic breeds are occasionally brought in to enhance productivity through breeding initiatives (Thompson *et al*., 2023; Okafor *et al*., 2023). Grasping the significance of breed diversity is crucial for developing effective management strategies that address livestock challenges, such as disease vulnerability and the impacts of climate change.

2.1.2 Economic Importance of Goats in Nigeria

In Nigeria, the importance of goats in the economy is truly remarkable. They provide essential sources of protein through their meat and milk, which are crucial for the nutritional well-being of local communities. Goat farming not only offers a reliable income for low-income families but also acts as a safety net during tough times (Ahmed *et al*., 2023; Singh *et al*., 2022). In many rural areas, goats are frequently sold for cash, traded, or used to cover basic household expenses like education and healthcare, making them a vital part of efforts to reduce poverty.

Moreover, goats hold significant cultural value in Nigerian society. They're often abundant during celebrations, rites of passage, and religious festivals, highlighting their worth beyond just economic factors. As pointed out by Brown *et al*. (2023), goats are seen as symbols of status within families, which adds to the reasons for keeping and caring for them properly.

Research shows that goat production is a key element of Nigeria's agricultural economy, with over 95% of rural households involved in some form of goat farming. This makes goats an integral part of local diets and economic stability (Davis *et al*., 2022). In areas where growing crops is tough due to unpredictable weather, goats offer an alternative way to earn a living that satisfies both personal and market needs.

Additionally, goats contribute significantly to improving soil health and promoting sustainable agriculture. Their grazing habits can enhance biodiversity in pastures and lessen the need for chemical herbicides, which benefits the ecological health of farming landscapes (Kumar *et al*., 2021; Obinna and Onu, 2021). These practices not only add value to goat farming but also bolster resilience against environmental changes and encourage sustainable management practices that are vital for ensuring food security in the future.

2.1.3 Major Goat Breeds

Understanding the different characteristics of goat breeds is crucial for boosting productivity while also ensuring sustainable farming practices. In Nigeria, indigenous breeds like the West African Dwarf (WAD), Sahel, and Red Sokoto stand out because of their unique traits that fit well with local conditions. The WAD breed, for instance, is small and tough, perfectly suited for humid areas with limited feed options, making them a great choice for backyard and small-scale goat farming. These goats are known for their resistance to certain diseases, which is a big plus for farmers who may not have the means for extensive veterinary care.

On the other hand, the Sahel breed flourishes in arid and semi-arid regions. This breed is larger and boasts impressive milk production capabilities, making it a vital resource for pastoralist communities where milk is a key part of the diet. Sahel goats play a significant role in nutritional security by providing both milk and meat, which are essential protein sources in local diets. Recently, traditional farming practices have started to blend these breeds into mixed farming systems, boosting both productivity and livelihoods.

The Red Sokoto breed, easily recognized by its striking reddish coat, is highly prized for its meat quality, presenting a valuable commercial opportunity for farmers. This breed is naturally adapted to its environment and shows resilience to diseases, making it an excellent option for those focused on meat production. The success of these indigenous breeds highlights the need for breed conservation efforts aimed at preserving genetic diversity and resilience against emerging climate and disease challenges.

Across Nigeria's goat farming landscape, crossbreeding initiatives are becoming more common to enhance desirable traits like growth rates, disease resistance, and reproductive performance. While exotic breeds can boost productivity, it's important to approach their integration with care. We need to make sure we preserve the indigenous genetic traits that give local goats their hardiness and adaptability (Thompson *et al*., 2023; Okafor *et al*., 2023).

Additionally, gastrointestinal parasites are a major hurdle for all goat breeds, particularly in traditional farming setups. Research shows that while indigenous breeds are resilient, they still face significant threats from common helminth infections, especially those caused by *Haemonchus contortus*, which can impact their health and productivity (Williams *et al*.,2021). Protecting goats from these parasites is crucial, and understanding the specific vulnerabilities of different breeds can help us develop targeted control strategies.

Implementing effective management strategies in goat farming, such as breeding for traits that enhance disease resistance, can lead to notable improvements in both economic returns and productivity. Recognizing the diverse characteristics of goat breeds allows farmers to customize their management practices, ultimately promoting better goat health and minimizing losses due to parasitic infections, which is essential for sustainable meat and milk production.

Crossbreeding programs have been introduced to further boost the resilience and productivity of local breeds. Occasionally, exotic goat breeds are brought in to enhance genetic diversity and productivity, particularly in dairy farming (Obinna and Onu, 2021; Okpara *et al*., 2021). These initiatives are crucial, as gastrointestinal parasites pose serious threats to goat mortality rates and overall productivity, with studies indicating high prevalence rates among local breeds (Williams *et al*., 2021; Okafor *et al*., 2023).

2.1.4 Anatomy and Physiology of the Goat Gastrointestinal Tract

Understanding the anatomy and physiology of a goat's gastrointestinal (GI) tract is crucial for grasping how these animals digest their food and their vulnerability to gastrointestinal parasites. Unlike animals with a single-chambered stomach, goats are ruminants, which means they have a unique stomach structure made up of four compartments: the rumen, reticulum, omasum, and abomasum. Each of these sections plays a vital role in breaking down fibrous plant materials, enabling goats to efficiently extract nutrients from their mainly herbivorous diet.

1. **Rumen:** The rumen is the largest compartment and serves as a fermentation chamber where a variety of microbes work to break down tough plant fibers. This fermentation is key to transforming cellulose found in plant cell walls into volatile fatty acids, which are essential energy sources for ruminants. The rumen can hold a significant amount of feed and has muscular walls that constantly mix its contents, promoting microbial activity and effective breakdown of what the goat eats. Additionally, the rumen absorbs some nutrients directly into the bloodstream, boosting nutrient efficiency (Garcia *et al*., 2022; Okafor *et al*., 2023).
2. **Reticulum:** Located next to the rumen, the reticulum plays a supportive role in fermentation and is often called the "honeycomb" due to its unique internal structure. Its main job is to catch and recycle any coarse feed particles that need more digestion, allowing them to be chewed again in a process known as "rumination." This ensures that the feed is thoroughly processed before moving on in the digestive system. The reticulum also helps separate heavier particles from lighter, more fully digested feed (Peterson *et al*., 2023).
3. **Omasum:** After the reticulum, the omasum takes on the important job of absorbing water and continuing the digestive process. Its inner surface is lined with numerous folds or leaves, which help maximize the area available for absorption and nutrient extraction. Additionally, the omasum helps break down the size of the digesta before it moves on to the abomasum, the last part of the stomach (Johnson *et al*., 2022; White *et al*., 2023). This section plays a vital role in enhancing digestive efficiency, especially as the process shifts from fermentation to enzymatic digestion.
4. **Abomasum:** Commonly known as the "true stomach," the abomasum functions similarly to a monogastric stomach. This is where enzymatic digestion really kicks in, thanks to gastric juices that include hydrochloric acid and digestive enzymes like pepsin, which work to break down proteins into smaller peptides (Lopez *et al*., 2023; Johnson *et al*., 2022). Once the contents are

processed here, they move into the small intestine, where further digestion and nutrient absorption occur, supported by secretions from the pancreas and bile from the liver.

5. **Intestines:** The small intestine is the main hub for nutrient absorption, aided by tiny finger-like projections called villi that increase the surface area. Enzymes from the pancreas and bile from the liver help break down fats, carbohydrates, and proteins. The next section, the large intestine, plays a key role in absorbing water and fermenting any remaining fibrous materials, which is essential for maintaining gastrointestinal health by supporting beneficial microbial populations.

The distinctive structure of ruminant digestive anatomy highlights the ecological role that goats play as herbivores. Their gastrointestinal tracts are specially designed to efficiently process high-fiber diets, which is especially important in regions where high-quality forage might be scarce. However, this unique anatomy can also create a favorable environment for gastrointestinal parasites. The warm, moist conditions within the rumen and intestines are ideal for the survival and proliferation of parasites such as *Haemonchus contortus*, which thrive in these regions, contributing to disease outbreaks and productivity losses (Rahman *et al*., 2024; Martin *et al*., 2023).

2.1.5 Husbandry and Management Systems

Goat husbandry practices in Nigeria can be grouped into three main systems: extensive, semi-intensive, and intensive. Each of these practices reflects the socio-economic conditions, available resources, and cultural preferences of local farmers.

In extensive systems, goats roam freely, grazing on natural pastures with little to no supplementary feeding. This approach is common among smallholder farmers who may not have the resources for more intensive management. Goats are often herded daily to find food and water, allowing them to take advantage of a variety of forage options, which encourages their natural foraging instincts (Yakubu and Achapu, 2021). While this system is cost-effective and requires minimal infrastructure investment, it does expose goats to various health risks, including parasites, predation, and diseases, which can significantly affect herd productivity.

The semi-intensive method strikes a balance, where goats enjoy a combination of grazing and supplementary feed. Farmers often keep goats in enclosed housing at night to shield them from predators and harsh weather, which helps improve health management and lowers mortality rates. This system allows for more controlled breeding and feeding practices, enabling farmers to keep an eye on weight gain and overall health (Clark *et al.*, 2022). Additionally, some farmers adopt better feeding practices that incorporate crop residues and forage supplements to boost growth rates and productivity.

Intensive goat farming is marked by a higher level of management, housing, and feeding, with diets that include concentrated and fortified commercial feeds. Farmers who use this method often compete in markets where meat prices are influenced by quality and productivity. Intensive systems demand more technical knowledge, capital investment, and veterinary care to maintain optimal health, especially in terms of disease management and parasite control (Harrison *et al*., 2023; Turner *et al*., 2022). While this system promises higher yields, it also poses challenges regarding waste management and environmental impacts, requiring effective planning and practices to mitigate negative effects.

Feeding Practices, Housing, and General Care

Feeding practices in Nigerian goat husbandry can differ quite a bit depending on the system in place. In extensive systems, goats mainly graze on natural pastures, which sometimes don't provide all the nutrients they need, especially during the dry season. Unfortunately, supplementary feeds like agricultural by-products are seldom used, which can lead to undernutrition (Baker *et al*., 2023). On the flip side, in intensive and semi-intensive systems, farmers tend to mix a variety of feed ingredients into their goats' diets, including legumes, grains, and commercial concentrates, which helps boost their nutritional intake and overall health.

Housing is another key factor, as it provides shelter, safety, and helps reduce disease risk. Most extensive systems feature simple enclosures that allow goats to roam freely and access pastures during the day. In more intensive setups, specially designed pens with good ventilation, drainage, and bedding materials are used to enhance goat health and comfort. It's important for these facilities to adapt to seasonal changes to minimize stress; for example, during the rainy season, having shelter from excess moisture is crucial (Foster *et al*., 2022; Rahman *et al*., 2024).

General care practices include regular health check-ups, vaccinations, and deworming programs. These steps are vital for managing parasites and preventing outbreaks of common diseases like peste des petits ruminants (PPR) and brucellosis, which can have serious economic consequences for goat farming (Mitchell *et al*., 2023; Wilson *et al*., 2022). Access to regular veterinary services, along with farmer education, is essential for improving knowledge about best management practices, including hygiene, feeding, and biosecurity measures.

Common Challenges in Goat Production in Nigeria

Despite the many advantages and potential that goat farming offers, Nigerian goat farmers are grappling with a host of challenges that hinder their productivity. One major concern is the widespread issue of gastrointestinal parasites, which can lead to serious health problems and financial losses. Research indicates that these parasitic infections can result in slower weight gain, decreased milk production, and higher rates of illness and death among goats (Clark *et al*., 2022). These parasites thrive in the warm, humid conditions typical of goat-rearing areas, making effective veterinary care and sound management practices essential for control.

Additionally, environmental factors like seasonal grazing patterns and climate changes add another layer of complexity to feeding practices. During the dry season, the availability of forage drops, which can lead to nutritional shortfalls. Unpredictable weather can also affect pasture quality, forcing smallholder farmers to seek alternative feeding methods that might be too expensive for them (Green *et al*., 2023).

Infrastructural challenges are another significant barrier, as many farmers lack proper animal housing and access to veterinary services. A lack of technical knowledge about effective animal husbandry can worsen issues like disease management and overall animal welfare (Green *et al*., 2023). The socio-economic landscape further complicates matters, with many farmers focusing on short-term income rather than investing in the long-term health and sustainability of their herds, which keeps them trapped in a cycle of low productivity.

The intricacies of goat anatomy and care underscore the need for customized management strategies to tackle the diverse challenges faced by goat farmers in Nigeria. Developing integrated systems that emphasize health management, proper nutrition, and suitable housing will be vital for boosting goat production and supporting the sustainable livelihoods of farming communities.

2.2 Gastrointestinal Parasites in Goats Overview

Gastrointestinal (GI) parasites pose a major challenge for goat farming around the globe, including in Nigeria. Their presence can lead to lower productivity, higher rates of illness and death, and financial setbacks for farmers. To tackle this issue effectively, it's crucial to understand these parasites and how they affect goats, which will help in crafting suitable management strategies (Gofwan *et al*., 2024).

Gastrointestinal parasites in goats include a range of organisms such as helminths (which consist of nematodes, trematodes, and cestodes), protozoa, and arthropods. Each of these groups has distinct traits and infection methods that impact the health of their hosts (Gofwan *et al.,*2024).

Nematodes are among the most common gastrointestinal parasites in goats are nematodes, or roundworms. Notable species include *Haemonchus contortus*, *Ostertagia circumcincta*, *Trichostrongylus colubriformis*, and *Strongyloides papillosus* (Roberts *et al*., 2023; Chen *et al*., 2024).

These parasites attach to the intestinal wall or live in the rumen, where they absorb nutrients and inflict damage on the mucosa. Their life cycle typically involves direct transmission through contaminated pastures, and they are particularly tough due to their ability to enter a dormant state, allowing them to survive harsh conditions (Challaton *et al*., 2022; Hussein *et al*., 2023).

Trematodes, commonly known as flukes, include species like *Fasciola hepatica*, which can infect goats when they consume contaminated aquatic plants (Clark *et al*., 2022). These parasites inhabit the liver and biliary duct, causing significant liver damage and leading to conditions such as fasciolosis, which can severely hinder goat productivity due to inflammation and fibrosis.(Clark *et al*., 2022).

Cestodes, commonly known as tapeworms, like *Moniezia expansa*, may not be as prevalent as nematodes, but they still play a significant role in certain regions. These parasites make their home in the intestines, soaking up nutrients directly through their skin. While many tapeworm infections don't show any symptoms, they can lead to digestive issues and nutrient deficiencies in animals that are heavily infected (Sharma *et al*., 2023).

On the other hand, protozoan parasites such as *Eimeria spp*. and *Giardia spp*. can cause diseases like coccidiosis, which tends to be especially troublesome for younger animals. These parasites wreak havoc on the intestinal lining and are often linked to poor sanitation and stress (Rahman *et al*., 2024; Clark *et al*., 2022). When infected with protozoa, animals may experience diarrhea, dehydration, and in severe cases, even death.

Goats, in particular, have gastrointestinal mucosa that is quite vulnerable to these parasites, leading to some serious negative effects. Infections can hinder nutrient absorption, resulting in weight loss, anemia, and overall poor health. Additionally, the immune response triggered by these parasites can further impact performance during crucial growth and reproductive stages (Chovanová *et al*., 2021).

2.2.2 Economic Importance of Gastrointestinal Parasites in Goats

The economic effects of gastrointestinal parasites in goats are significant and complex. These pesky parasites can really take a toll on productivity in several ways, such as slowing down growth, reducing milk output, and affecting reproductive success.

1. **Impact on Productivity:** Gastrointestinal parasites can seriously stunt growth, especially in young goats. When these animals get infected, they might lose weight or not grow as they should because the parasites interfere with nutrient absorption. For example, research has indicated that goats infected with *Haemonchus contortus* can lose anywhere from 6 to 12 kg each year due to these infections, which translates to major financial losses in meat production (Hassan *et al*., 2022). In lactating goats, these infections can lead to lower milk production by impacting their overall health and nutrient availability, which in turn affects both the mother and her kids (Lee *et al*., 2024).
2. **Mortality and Morbidity Rates:** The high rates of illness and death linked to gastrointestinal parasites create even more economic hurdles. In severe cases, goat herds can see mortality rates soar to 40% due to serious parasitic infections, especially when combined with other stressors like poor nutrition and management practices (Hassan *et al*., 2022). This alarming mortality rate not only cuts into profits but can also disrupt the social structure of farming communities that depend on goat farming for their income.
3. **Treatment Costs and Management Implications:** Dealing with gastrointestinal parasites requires a hefty financial commitment for veterinary care, anthelmintic treatments, and preventive strategies like pasture management and rotation. The expenses for treating infected goats can pile up quickly, particularly if anthelmintic resistance becomes an issue (Smith *et al*., 2023). Regular deworming protocols are certainly effective, but they can also add extra costs to production systems. Many farmers, especially those in low-resource settings, might struggle to stick to these best practices consistently because of financial limitations (Taylor *et al*., 2022).

The ongoing issue of gastrointestinal infestation hampers the overall efficiency of goat production systems. This situation highlights the need for farmers to embrace better management strategies and invest in continuous education about good animal husbandry practices (Alaku *et al*., 2021). Gastrointestinal parasites pose a significant threat to goat production, impacting both animal health and economic viability. It's essential to have a solid understanding of the different types of parasites, their life cycles, and the consequences of infections to create effective management strategies that can lessen their harmful effects. Tackling these challenges calls for a united effort to boost knowledge, enhance practices, and ensure sustainable grazing and animal management systems for goat farmers.

2.2.3 Life Cycles and Transmission Routes of Parasites

Grasping the life cycles of gastrointestinal parasites is essential for effective management and control. Most of the parasites that impact goats can be divided into two primary categories based on how they develop: direct and indirect.

Parasites with direct life cycles only need one host to mature and reproduce. A prime example is the gastrointestinal nematode *Haemonchus contortus*. In this scenario, adult worms live in the host's intestine, where they lay eggs that are then excreted in feces. Given the right environmental conditions like warmth and moisture these eggs hatch into larvae that evolve into infective forms. Goats pick up these larvae while grazing, and the cycle starts all over again (Martinez-Gonzalez *et al*., 2022). Direct life cycles can lead to rapid population growth, especially in environments that support survival and transmission.

On the other hand, parasites with indirect life cycles need one or more intermediate hosts to complete their development. For instance, trematodes such as *Fasciola hepatica* rely on snails as intermediate hosts before they can infect goats (Rodriguez-Vivas *et al*., 2023). Goats become infected by consuming the encysted larvae found in aquatic plants. Indirect life cycles can make control efforts more challenging, as managing the intermediate hosts is crucial to breaking the transmission chain.

Various environmental factors play a role in the transmission and prevalence of these parasites. Pasture contamination is a significant issue, as fecal matter containing eggs or larvae can linger in the environment for weeks, particularly in warm, moist conditions that are ideal for larval development. Research has indicated that seasonal changes can affect the survival rates of larvae and boost parasite transmission (Thompson *et al*., 2024). During the rainy season, for example, the increased moisture can lead to more contamination in pastures, making it easier for parasites to spread. Climate also plays a big part in shaping where infections occur. Areas with warm temperatures and high humidity are perfect for helminth larvae to thrive, which can lead to large populations of parasites. Research in tropical regions has shown that weather conditions often align with spikes in gastrointestinal parasite transmission (Ruhoollah *et al*., 2023; Anderson *et al*., 2024). This highlights the importance for farmers to keep an eye on both the weather and how they manage their pastures to reduce the risk of parasitic infections.

2.2.4 Factors Influencing Susceptibility to Parasitic Infestation in Goats

There are several factors related to both the goats themselves and their management that affect how susceptible they are to gastrointestinal parasities.

1. **Age:** Young goats tend to be more vulnerable to parasitic infections compared to adults. This increased risk is partly due to their still-developing immune systems, which aren't strong enough yet to fight off infections (Hassan and Jibrin, 2022). Research shows that younger goats often have higher fecal egg counts and display more severe symptoms than their older counterparts (Ortega *et al*., 2022). Therefore, it's crucial to implement management strategies that focus on the health of young kids to help control parasitic infections.
2. **Breed:** The genetic differences among goat breeds significantly influence their susceptibility to parasites. Some breeds have a natural resistance thanks to their immune responses. For example, indigenous breeds like the West African Dwarf have demonstrated a better ability to handle

nematode infections compared to exotic breeds (Yirsa *et al*., 2024). Recognizing the resistance traits specific to each breed is essential for creating breeding programs that aim to boost resistance in more vulnerable populations.

3. **Nutritional Status:** The link between nutritional deficiency and the immune response in goats is pretty clear. When goats are malnourished, their immune systems take a hit, making them more vulnerable to infections, especially those pesky gastrointestinal parasites (Davis *et al*., 2023). A balanced diet is crucial for a strong immune system, helping goats fend off these infections more effectively. So, making sure they get enough nutrition—especially during key growth and reproductive stages—can really help lower their risk of getting sick.
4. **Immune Status:** Goats with weakened immune systems, whether from poor nutrition or other health issues, are at a higher risk for infections. The relationship between stress, immune function, and parasite load highlights how important it is to manage stressors like overcrowding, unsanitary conditions, and lack of veterinary care. Taking care of these factors can boost their immune health and cut down on the risk of parasitism.
5. **Management Practices:** The way goats are managed, including stocking density and grazing systems, plays a big role in how often they get parasitic infections. When there are too many goats in one area, they compete for food, which can lead to stress and increase the chances of parasite transmission due to their close quarters (Chen *et al*., 2024). On the flip side, using rotational grazing allows pastures to recover and helps reduce the buildup of infective larvae, showing just how vital good grazing management is for keeping parasite infections at bay (Thompson *et al*., 2024; Anderson *et al*., 2024).

The susceptibility of goats to gastrointestinal parasites is a complex issue shaped by factors like age, breed, nutritional status, immune health, and management practices. By understanding these elements, farmers can create effective strategies to lessen the impact of parasitic infections in their herds.

2.3 Major Gastrointestinal Parasite Genera Affecting Goats

2.3.1 Nematodes (Roundworms)

Gastrointestinal nematodes pose a significant challenge for goat farmers, primarily due to their widespread presence and the economic repercussions. Among these troublesome parasites are several genera, such as *Haemonchus, Trichostrongylus, Ostertagia, Bunostomum, Oesophagostomum,* and *Strongyloides*, all of which can severely impact the health and productivity of goats.

***Haemonchus contortus* (Barber Pole Worm)**: *Haemonchus contortus*, often called the Barber Pole Worm, stands out as one of the most critical gastrointestinal parasites affecting goats globally. It's particularly infamous for causing haemonchosis, a condition that can lead to serious anemia and weight loss due to its blood-feeding habits. This parasite resides in the abomasum, where adult female *H. contortus* can consume a significant amount of blood each day, resulting in the weakness and lethargy commonly observed in infected goats (Matsepe *et al*., 2021; Okpara *et al*., 2021). The life cycle of this parasite is straightforward, with eggs being excreted in the feces of infected animals, and larvae developing in suitable environmental conditions. This ability to rapidly multiply in warm, moist environments makes controlling *H. contortus* particularly tough for goat farmers.

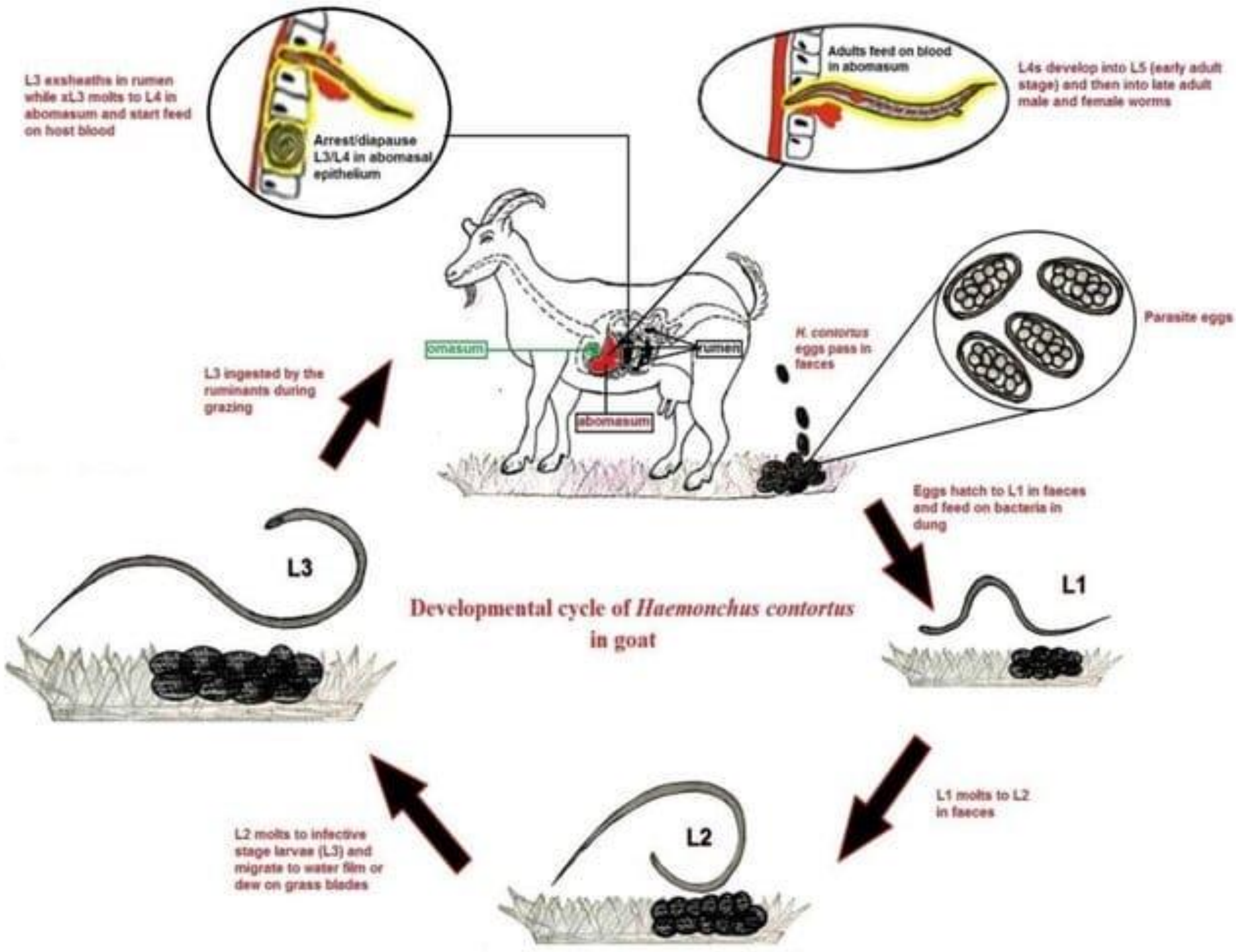

Figure 2.2: Life Cycle of *Haemonchus contortus* (Ensan et al., 2024).

The health issues linked to *H. contortus* infections go beyond just blood loss; they also increase the risk of secondary infections due to the weakened state of the infected goats (Ndlela *et al*., 2022). Additionally, many goat populations have developed resistance to commonly used dewormers like ivermectin and benzimidazoles, which complicates management strategies (Mickiewicz *et al*., 2020). While studies have shown significant drops in fecal egg counts following treatment, the persistent emergence of resistant strains highlights the urgent need for integrated parasite management practices that incorporate a variety of approaches beyond just anthelmintics (Negash *et al*., 2023).

The economic impact of *H. contortus* is huge and shouldn't be overlooked. Goats that are infected can experience slower growth, lower milk production, and in the worst cases, even death. Studies indicate that these infections can lead to goats losing between 6 to 12 kg of body weight each year, which translates to significant financial losses in meat production (Okpara *et al*., 2021). To combat this issue, effective strategies like rotational grazing and targeted deworming are vital for reducing the effects of this parasite on goat farming.

***Trichostrongylus* Spp:** When it comes to *Trichostrongylus* species, this genus includes several types, with *Trichostrongylus colubriformis* and *Trichostrongylus* axei being the most notable culprits behind gastrointestinal infections in goats. These nematodes take up residence in the stomach and intestines, competing for nutrients and causing malabsorption and weight loss in affected goats (Ndlela *et al*., 2022).

The harm caused by *Trichostrongylus* species mainly arises from their ability to damage the intestinal lining, leading to enteritis and symptoms like diarrhea, lethargy, and poor feed efficiency (Matsepe *et al*., 2021). Their lifecycle is quite similar to that of other gastrointestinal nematodes, with eggs being excreted in feces and hatching into larvae that grazing goats then ingest. These larvae are tough and can survive in the environment for long periods, which raises the chances of infection (Sharma *et al*., 2023).

To effectively manage *Trichostrongylus* infections in goats, farmers need to adopt good pasture management practices and use rotational grazing to limit parasite populations. Regular deworming is also key to significantly lowering the occurrence of these parasites, which helps keep livestock healthier and boosts overall herd productivity (Miller *et al*., 2022). It's important to keep an eye on resistance patterns, as monitoring treatment effectiveness is crucial for successful management (Mickiewicz *et al*., 2020).

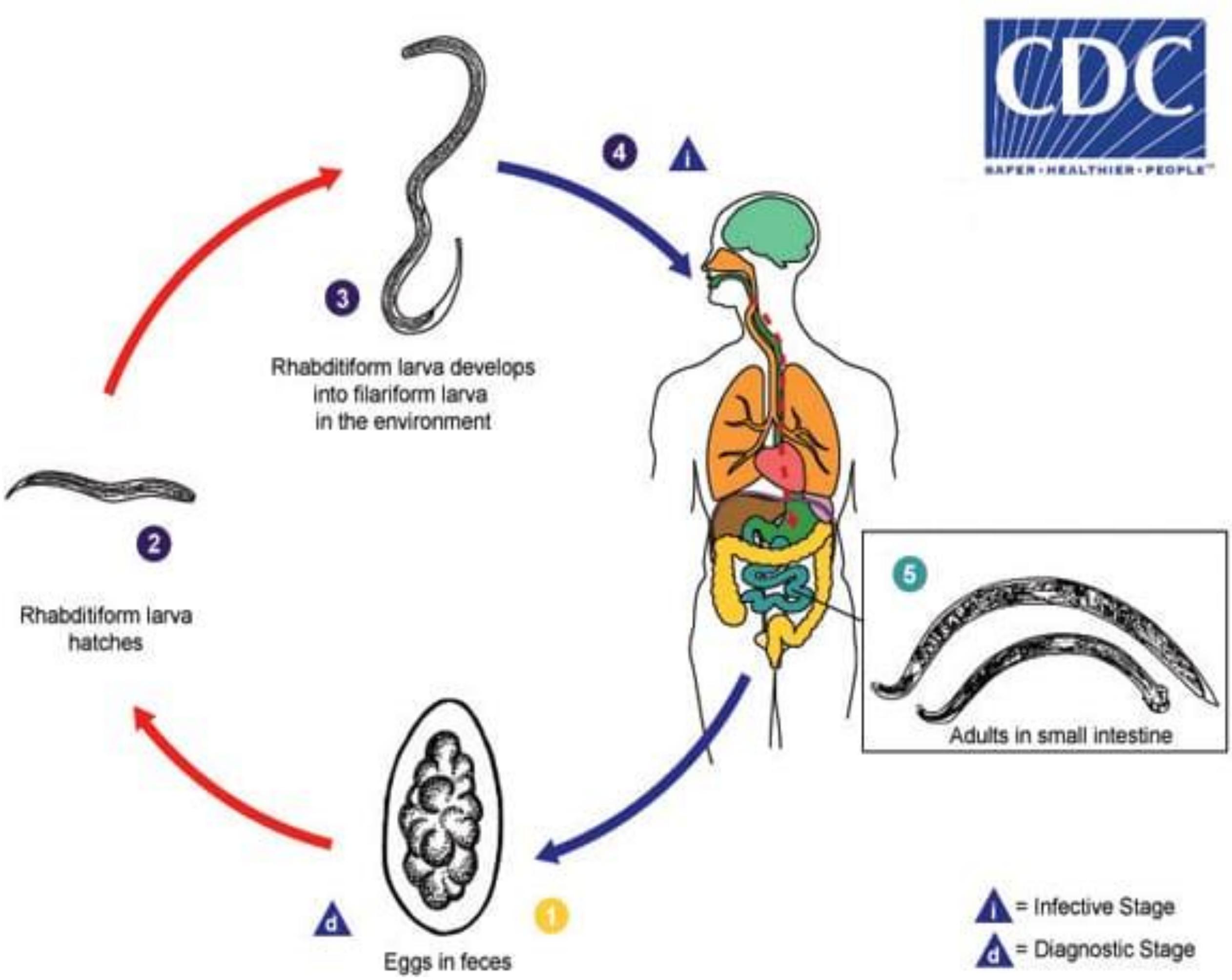

Figure 2.3: Life Cycle of *Trichostrongylus* spp. (Centers for Disease Control and Prevention, 2025).

***Ostertagia/Teladorsagia* Spp:** *Ostertagia* species, especially *Teladorsagia circumcincta*, are a serious concern for goat farming. These pesky parasites make their home in the abomasum and can lead to a condition known as *Ostertagia*sis. One of the biggest worries with an *Ostertagia* infection is its ability to cause severe symptoms like diarrhea, weight loss, and hypoproteinemia, which happens when nutrients aren't absorbed properly, ultimately affecting the goat's overall health (Matsepe *et al*., 2021; Ndlela *et al*., 2022).

The life cycle of *Ostertagia* is pretty straightforward. Adult worms lay their eggs in the intestines of infected goats, and those eggs hatch into larvae that can survive in pastures. When goats graze, they can ingest these larvae. The time it takes from eating the larvae to shedding eggs can change depending on the environment, but *Ostertagia* has a clever trick: it can go into a dormant state during tough conditions, known as hypobiosis (Fauziah *et al*., 2021). This makes controlling them tricky, as the larvae can bounce back when the weather warms up and conditions become just right for them to thrive.

The economic toll of *Ostertagia* infections on goat herds is significant. Infected goats often suffer from noticeable weight loss, become more vulnerable to other infections, and show a drop in overall productivity (Negash *et al*., 2023). To effectively manage this issue, a comprehensive strategy is essential, this means combining smart deworming practices with better herd management and nutrition to help the goats recover from the infection's effects (Tumusiime *et al*., 2022; Okpara *et al*., 2021).

***Bunostomum* Spp (Hookworms):** *Bunostomum* species, or hookworms, are another major threat to goat health, especially in warm, humid climates that are perfect for their lifecycle. When goats get infected, they often suffer from blood loss because these worms attach to the intestinal walls and feed on the host's blood, leading to anemia and nutritional deficiencies. As a result, goats may show signs of lethargy, weight loss, and even protein-losing enteropathy if the infestation is severe (Fauziah *et al*., 2021).

The way *Bunostomum* spreads is quite unique; its larvae actually penetrate the skin, which sets them apart from many gastrointestinal nematodes that depend on being ingested. When goats graze on contaminated pastures, these larvae can infect them through their skin, potentially leading to systemic infections (Elkhatam *et al*., 2020). This method of transmission highlights just how crucial hygiene and pasture management are in keeping hookworm infections at bay.

The economic fallout from *Bunostomum* infections goes beyond just the health of individual animals; it can significantly impact the overall productivity of the herd. Infected goats often struggle with weight gain and milk production due to the anemia caused by blood loss (Negash *et al*., 2023). To effectively manage this issue, strategies like proper deworming, rotational grazing, and diligent health monitoring are essential to minimize the prevalence of hookworms (Miller *et al*., 2022).

Oesophagostomum species: Now, let's talk about *Oesophagostomum species*, commonly known as nodular worms. This genus is notorious for its considerable economic impact on goat farming. These nematodes create nodular lesions in the intestinal wall, which disrupts nutrient absorption and can lead to symptoms like diarrhea, weight loss, and a decreased appetite (Fauziah *et al*., 2021). What's particularly challenging is that *Oesophagostomum species* can lie dormant in the intestinal mucosa, making control efforts tricky and resulting in repeated cycles of infection.

The life cycle of *Oesophagostomum* is straightforward. The eggs produced in the intestines are expelled into the environment through feces, where they develop into infective larvae. These larvae are remarkably adaptable and can survive in less-than-ideal conditions, which increases the chances of them infecting grazing goats (Torres *et al*., 2023). The ability of this parasite to cause intestinal lesions can lead to chronic problems that negatively impact weight gain and the overall productivity of the herd.

Managing *Oesophagostomum* in goats calls for a well-rounded approach that includes strategic deworming, rotating pastures to reduce contamination, and enhancing herd nutrition to boost their immune systems against infections. The presence of these worms underscores the importance of monitoring in goat farming to help reduce the economic impact of gastrointestinal nematodiasis (Elkhatam *et al*., 2020; Shah *et al*., 2022).

Strongyloides papillosus: Now, let's talk about *Strongyloides papillosus*, or the threadworm, which is another nematode that poses a threat to goat health. This parasite is particularly worrisome because it can reproduce inside the host, leading to a swift rise in the number of infective larvae. Infections from *S. papillosus* can cause serious digestive issues, resulting in symptoms like diarrhea, stunted growth, and overall weakness (Matsepe *et al*., 2021; Ndlela *et al*., 2022).

The life cycle of *S. papillosus* can occur directly or through free-living stages in the environment, which allows for various ways it can be transmitted. The larvae can either enter through the skin or be ingested while the goats graze on contaminated pastures (Li *et al*., 2021). This dual method of transmission makes controlling infestations quite challenging, highlighting the need for thorough management strategies that consider both internal and external factors.

From an economic standpoint, the impact of *S. papillosus* infections can be significant, leading to higher veterinary bills, reduced weight gains, and even increased mortality rates in affected herds. To effectively manage these infections, it's crucial to conduct regular fecal monitoring to catch and treat any issues early, while also ensuring the goats receive optimal nutrition to maintain their overall health (Li *et al*., 2021; Hassan and Jibrin, 2022).

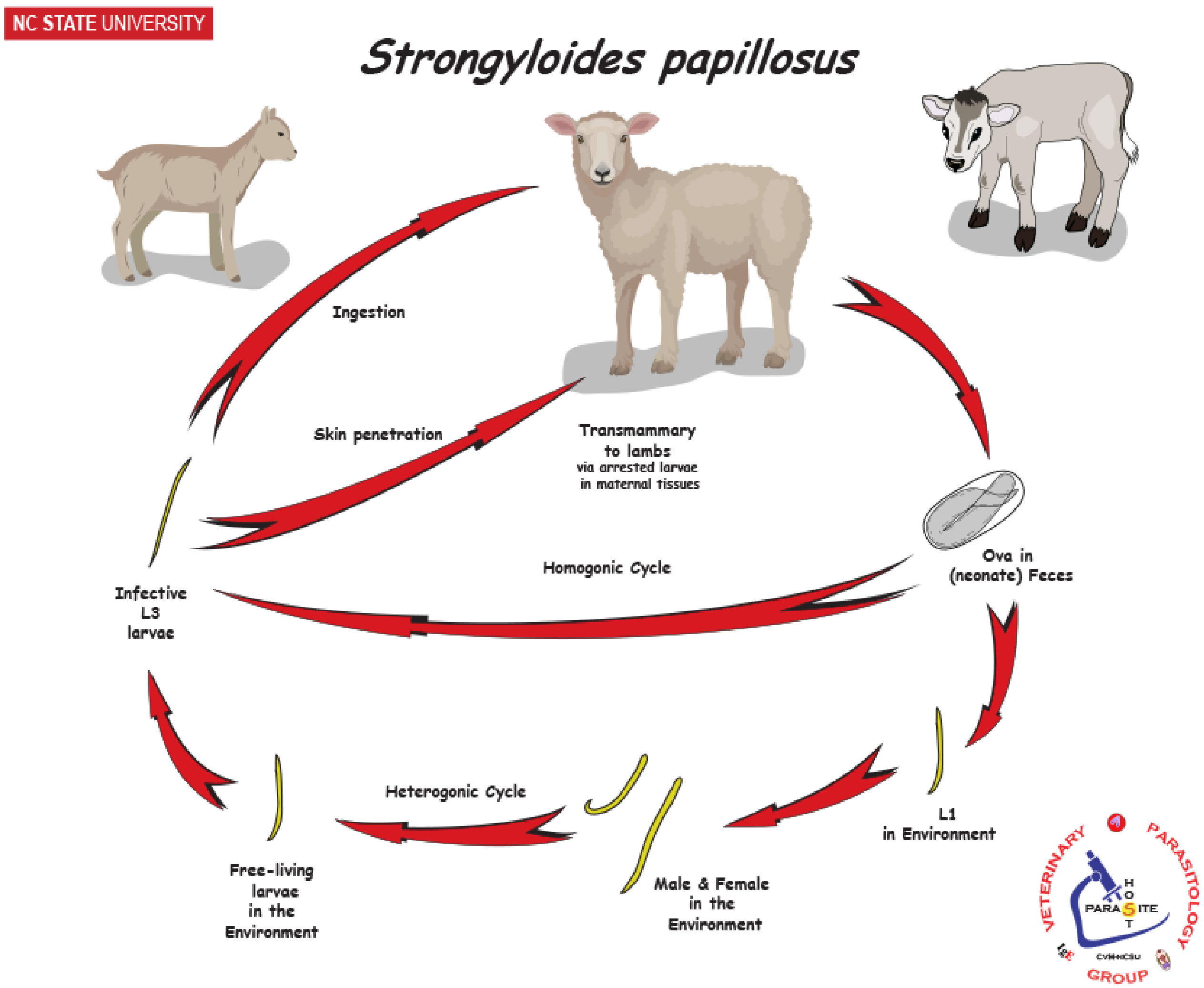

Figure 2.4: Life Cycle of *Strongyloides papillosus*

Source: NC State University, Veterinary Parasitology Group (n.d).

2.3.2 Cestodes (Tapeworms)

Cestodes, or tapeworms as they're commonly called, are a significant group of gastrointestinal parasites that can impact goats. Among the different types, *Moniezia* and *Avitellina* stand out as particularly important.

Moniezia expansa**:** its life cycle and the issues it can cause. *Moniezia expansa* is one of the most common tapeworms found in ruminants, especially in sheep and goats. Its life cycle is pretty straightforward, with ruminants serving as the main hosts. Adult tapeworms live in the small intestine of their host, where they can grow impressively long sometimes even several meters! These tapeworms release eggs that are then passed out in the host's feces (Jyothimol and Dehuri, 2024). When an intermediate host, usually a pasture mite, ingests these eggs, they develop into cysticercoid larvae inside the mite. If a goat or sheep eats contaminated forage that contains these infected mites, the larvae are released and grow into adult tapeworms in the host's intestine (Ahmed *et al*., 2023).

Generally, the health issues linked to *Moniezia expansa* infections are mild, especially in healthy goats. However, if the infection is severe, it can lead to gastrointestinal blockages, particularly in younger animals. Signs of infection may include weight loss, diarrhea, and a decreased appetite. While *Moniezia* spp typically doesn’t cause serious systemic diseases, it can affect the nutritional status of the host, especially when combined with other infections or poor diet, which can hinder growth and productivity (Sharbatkhori *et al*., 2023).

To manage *Moniezia expansa*, control measures focus on practices that reduce the spread of eggs in the environment. Effective strategies include regular deworming to keep adult tapeworms at bay, proper pasture management to avoid contamination, and educating livestock owners about the tapeworm's life cycle and how it spreads (Ayan *et al*., 2021).

Avitellina centripunctata**:** *Avitellina centripunctata* is a type of tapeworm that can infect goats, but it’s not as common as *Moniezia expansa*. The life cycle of A. *centripunctata* is quite similar to that of

Moniezia, with ruminants acting as the main hosts. These adult tapeworms usually live in the small intestine and can grow several centimeters long, showcasing unique features like segmented proglottids that house eggs (Foster *et al*., 2023).

The eggs are expelled through feces and then consumed by intermediate hosts, such as oribatid mites. Inside the mite, the larvae develop until they're ready to infect. When goats munch on these infected mites while grazing, the larvae grow into adult tapeworms in the goat's intestine (Mitiku and Alehegn, 2022).

Although *Avitellina centripunctata* is often linked to infections that don't show symptoms, heavy infestations can lead to gastrointestinal issues. Signs to watch for include weight loss, reduced appetite, and in more serious cases, intestinal blockage or enteritis. Infected goats face a significant risk of declining health and productivity due to nutrient deficiencies and the subclinical illness caused by the tapeworm burden (Roberts *et al*., 2023).

Managing *Avitellina centripunctata* infections is similar to handling other tapeworms, highlighting the need for good pasture management and regular veterinary check-ups to catch any signs of infection. Educating goat owners about avoiding grazing in contaminated areas and using rotation systems can help minimize the chances of exposure to intermediate hosts and, ultimately, tapeworm infections in goats (Hansh, 2023).

2.3.3 Trematodes (Flukes)

Trematodes, or flukes as they're often called, represent a significant group of parasitic organisms that can impact goats quite seriously. Among the most notable genera are *Fasciola* and *Dicrocoelium*, both of which have crucial implications for animal health and economic productivity.

***Fasciola* Spp:** *Fasciola hepatica* and *Fasciola gigantica*, commonly known as liver flukes, are notorious for causing fasciolosis in goats and other ruminants. Their life cycle is quite intricate, relying on intermediate hosts, mainly specific freshwater snails from the Lymnaea genus. Once inside an infected host, the adult fluke makes its home in the liver and bile ducts. The adult flukes lay eggs that are then excreted in the host's feces, eventually hatching in water and releasing miracidia that can invade suitable snail hosts (Jyothimol and Dehuri, 2024).

Inside the snail, the trematode transforms into cercariae, which are then released back into the water. These cercariae can encyst on vegetation or in the surrounding environment. When goats munch on contaminated plants, the encysted larvae are freed in the intestine, migrate to the liver, and mature into adult flukes (Sharbatkhori *et al*., 2023). This complex life cycle makes the parasite incredibly resilient and adaptable, posing significant challenges for control efforts.

The effects of fasciolosis can be quite severe, especially in younger or immunocompromised animals. Infections can lead to considerable liver damage, resulting in symptoms like jaundice, anemia, and digestive issues. The harm inflicted on the liver and bile ducts can lead to a decline in nutritional status and overall performance in infected goats (Thompson *et al*., 2022). Additionally, the compromised health of the host can pave the way for secondary infections. To manage fasciolosis effectively, it's essential to control the intermediate snail hosts, enhance sanitation practices, and reduce exposure to contaminated grazing areas, particularly those near water bodies where snails thrive. Moreover, strategic deworming protocols, including the use of effective anthelmintics such as albendazole or nitroxynil, can significantly alleviate the impacts of liver flukes in goat populations (Rodriguez *et al*., 2023).

Dicrocoelium dendriticum: *Dicrocoelium dendriticum*, or the lanceolate fluke, is a type of trematode that primarily affects ruminants. Its life cycle is quite fascinating, involving two intermediate hosts: land snails and ants. Adult flukes make their home in the bile ducts of their definitive hosts, which are usually sheep or goats. They release eggs that end up in the feces (Galavani *et al*., 2024). Once in the environment, these eggs are gobbled up by snails, where they hatch into miracidia and then transform into cercariae inside the snail's body. These cercariae eventually form cysts that the snail excretes in a slimy mucus (Cwiklinski and Dalton, 2022).

The next stop in this life cycle is the ants. While foraging, ants unknowingly consume the cysts of *D. dendriticum* as they lick the mucus off plants. This leads to the development of a metacercaria that alters the ant's behavior, making it more likely to be eaten by grazing livestock (Shahnazi *et al*., 2020). Once the fluke is ingested, it matures into an adult in the bile ducts of its definitive host.

The impact of *Dicrocoelium dendriticum* on health can be quite serious, causing damage to the bile ducts, inflammation, and even liver dysfunction. While infections can often go unnoticed when the burden is low, heavy infestations can result in significant issues, such as abdominal pain, stunted weight gain, and decreased productivity (Galavani *et al*., 2024).

To control *D. dendriticum*, efforts focus on minimizing the presence of its intermediate hosts and adjusting grazing practices to keep goats from eating contaminated ants and plants. Regular veterinary check-ups and vigilance for signs of infection are key to managing infection rates effectively, ensuring the health of livestock and maintaining overall herd productivity (Jones *et al*., 2023; Lall *et al*., 2022).

2.3.4 Protozoa

Protozoa, those tiny unicellular eukaryotic organisms, can be quite the troublemakers for various hosts, including our friendly goats. Some of the most notable protozoan parasites that can affect goat health are *Eimeria*, Cryptosporidium, and *Giardia spp*. To effectively manage goat farming, it's essential to understand their life cycles, how they cause disease, and their potential to affect humans.

***Eimeria* spp:** *Eimeria* species, commonly known as coccidia. These gastrointestinal parasites are everywhere and have a direct life cycle that involves just one definitive host. Goats get infected when they munch on feed or drink water contaminated with sporulated oocysts. Once these oocysts are in the goat's system, they release sporozoites in the intestine, which then invade the intestinal lining. From there, they go through several stages of asexual and sexual reproduction, eventually producing new oocysts that are expelled in the feces (Chen *et al*., 2022).

The severity of *Eimeria* infections can vary based on the specific species and the immune status of the host. Heavy infestations can lead to coccidiosis, a nasty condition marked by severe enteritis, which can cause diarrhea, dehydration, and in extreme cases, death due to electrolyte imbalances or secondary infections (Clark *et al*., 2023). Young goats, especially kids, are particularly vulnerable to the harsh effects of coccidia infections since their immune systems are still maturing. There can also be subclinical infections, where the parasites thrive in the intestinal lining without showing obvious signs of illness, yet they still hinder growth and productivity (Davis *et al*., 2024).

One interesting aspect of *Eimeria* species is their host specificity. Different species tend to infect specific hosts, such as goats, sheep, cattle, and poultry. This specificity helps to limit cross-infection among various livestock species (Miller *et al*., 2023). Recent studies have identified various *Eimeria* species specific to goats, including *Eimeria ninakohlyakimovae* and *Eimeria necatrix*, which further emphasizes the importance of species identification in managing outbreaks and understanding epidemiological patterns in goat populations (Kumar *et al*., 2024).

Cryptosporidium parvum: *Cryptosporidium parvum* is a protozoan parasite that poses a significant risk to both animals and humans. Its life cycle includes both sexual and asexual reproduction, primarily taking place in the intestines of mammals. Infected animals release oocysts through their feces, which can easily contaminate water sources and feed. These oocysts are incredibly tough and can stay infectious even in harsh environmental conditions (Roberts *et al*., 2023). Goats typically get infected by ingesting these oocysts from contaminated sources. Once they reach the gastrointestinal tract, the oocysts undergo excystation, releasing sporozoites that then invade the cells lining the intestines.

The health issues linked to *C. parvum* infections can vary widely, from having no symptoms at all to experiencing severe diarrhea, especially in young or immunocompromised goats. For young kids, this diarrhea can lead to dehydration, weight loss, and, in some unfortunate cases, even death (Thompson *et al*., 2023). The duration and severity of the illness can differ, often worsened by other infections or environmental stressors. On the zoonotic front, *C. parvum* is a leading cause of gastrointestinal illness in humans, with transmission usually happening through the fecal-oral route. This highlights the critical need to limit contact between livestock and water supplies meant for human use (Garcia *et al*., 2022).

The zoonotic potential of *C. parvum* emphasizes the importance of strict biosecurity measures in farming. Ensuring proper sanitation, effectively managing animal waste, and preventing cross-contamination are vital steps to reduce the risk of this pathogen spreading between goats and humans (Roberts *et al*., 2023). Raising awareness about *C. parvum* in agricultural environments is crucial to prevent outbreaks of cryptosporidiosis in both livestock and the communities around them.

Giardia duodenalis: It is often referred to as *Giardia lamblia*, is a flagellated protozoan parasite that makes its home in the small intestines of various mammals, including goats. The life cycle of Giardia features both cyst and trophozoite stages. When animals ingest water or food contaminated with feces that contain cysts, the infection kicks off with excystation in the duodenum, followed by colonization in the small intestine (Kim *et al*., 2023). The trophozoites then cling to the intestinal lining, which can lead to various health issues.

The problems linked to Giardia infections often manifest as gastrointestinal disturbances, resulting in diarrhea, weight loss, and difficulties in nutrient absorption. While many goats can carry the parasite without showing any symptoms, those with more severe infections might display noticeable gastrointestinal signs, making it tricky to diagnose without specific tests (Park *et al*., 2022). Chronic infections can lead to malnutrition and hinder growth in younger goats. Additionally, similar to *Cryptosporidium*, *Giardia duodenalis* poses a risk to humans, especially in settings where people might come into contact with fecally contaminated areas, like farms or petting zoos (Foster *et al.*, 2024).

To tackle Giardia infections in goats, it's crucial to implement effective management strategies. This includes keeping an eye on water quality and enhancing sanitation practices to avoid fecal contamination (Williams *et al.*, 2023). Regular health checks and fecal tests are vital for managing potential outbreaks and ensuring the overall health of the herd. By understanding the life cycle and pathology of Giardia, we can develop better treatment strategies, ultimately reducing the incidence of giardiasis in goat farming operations (Foster *et al.*, 2024).

2.4 Diagnostic Methods for Gastrointestinal Parasites in Goats

Getting an accurate diagnosis of gastrointestinal (GI) parasites in goats is essential for effective management and control strategies. The main diagnostic methods revolve around various fecal examination techniques, which can be divided into qualitative and quantitative approaches. These techniques help identify and measure parasite infections, guiding treatment decisions.

2.4.1 Faecal Examination Techniques

Qualitative Methods

Qualitative methods for fecal examination mainly aim to detect the presence of gastrointestinal parasites without measuring the number of their eggs or larvae. Common techniques include direct fecal smear, flotation methods (like the McMaster technique), and simple flotation.

In a direct fecal smear, a small sample of feces is mixed with a saline solution on a microscope slide and then examined under a microscope. This method is quick and budget-friendly, but it might overlook low-intensity infections because it's not as sensitive as some other techniques (Johnson *et al.*, 2024). On the other hand, flotation techniques take advantage of the fact that eggs and other stages of parasites are less dense than the flotation solution. In these methods, feces are combined with a flotation solution (usually saturated salt or sugar solutions) and then spun in a centrifuge. This process causes the eggs to float to the top, creating a distinct layer that can be easily collected and analyzed (Chen *et al*., 2023).

The McMaster technique is a specialized flotation method aimed at counting eggs, which is particularly helpful for assessing the level of parasitic infections. This method allows for the determination of the number of eggs per gram (EPG) of feces, offering valuable insights into the infection levels within a herd and assisting in management decisions (Torres *et al*., 2024).

Quantitative Methods

Quantitative methods for analyzing fecal samples focus on accurately counting the number of eggs or cysts present, which helps gauge the severity of parasitic infections. One of the most popular techniques used is the McMaster egg counting method. This method uses a specialized counting chamber that makes it easy to see the samples under a microscope (Martinez *et al*., 2023).

By applying the McMaster technique, veterinarians can estimate the eggs per gram (EPG) of various intestinal parasites, which leads to better-informed treatment plans. For example, a rise in EPG might signal the need for deworming, while consistently low EPG levels could indicate effective management of the parasite load (Johnson *et al*., 2024). These quantitative methods play a vital role in herd health management, allowing both veterinarians and farmers to keep a close eye on parasite levels and adjust treatment schedules as needed.

Moreover, there are other quantitative techniques, such as larval culture and identification that focus on analyzing fecal samples for specific nematode larvae rather than just eggs. This method involves growing larvae from the eggs found in feces on a controlled medium, which helps identify specific nematode species. Larval culture is essential for assessing the potential pathogenicity of the nematodes present and helps tailor deworming strategies to target specific threats within a population (Davis *et al*., 2022)(Lopez *et al*., 2024).

Larval Culture and Identification

When it comes to larval culture and identification, this technique is key for gathering quantitative data on gastrointestinal nematodes in goats. By optimizing the incubation conditions, larvae can hatch from the eggs in the fecal sample, allowing for identification at the larval stage (Davis *et al*., 2022). This method improves the ability to target specific parasites like *Haemonchus contortus* and *Trichostrongylus* spp., which are particularly concerning in goat farming (Lopez *et al*., 2024).

The variety of fecal examination techniques plays a crucial role in diagnosing gastrointestinal parasites in goats. Qualitative methods offer a first glimpse into the issue, while quantitative techniques provide a deeper understanding of the infection load, which helps improve management strategies that protect animal health and productivity. By using these diagnostic tools, goat producers can keep a close eye on and tackle the effects of gastrointestinal parasites, resulting in healthier animals and better economic outcomes.

Collection and Identification of Adult Parasites

During post-mortem examinations, gathering adult parasites is key for accurate diagnosis and effective management strategies. You can find adult parasites in the gastrointestinal tract, typically extracted from specific areas like the abomasum, small intestine, and large intestine. This process requires careful dissection to avoid damaging the parasites. The severity of *Eimeria* infections can vary based on the specific species and the immune status of the host. Heavy infestations can lead to coccidiosis, a nasty condition marked by severe enteritis, which can cause diarrhea, dehydration, and in extreme cases, death due to electrolyte imbalances or secondary infections (Tang *et al*., 2018). Young goats, especially kids, are particularly vulnerable to the harsh effects of coccidia infections since their immune systems are still maturing. There can also be subclinical infections, where the parasites thrive in the intestinal lining without showing obvious signs of illness, yet they still hinder growth and productivity (Jarquín-Díaz *et al*., 2020).

One interesting aspect of *Eimeria* species is their host specificity. Different species tend to infect specific hosts, such as goats, sheep, cattle, and poultry. This specificity helps to limit cross-infection among various livestock species (Lovy and Friend, 2015). Recent studies have identified various *Eimeria* species specific to goats, including *Eimeria* ninakohlyakimovae and *Eimeria* necatrix, which further emphasizes the importance of species identification in managing outbreaks and understanding epidemiological patterns in goat population

2.5 Epidemiology of Gastrointestinal Parasites in Goats

Epidemiological research on gastrointestinal (GI) parasites in goats offers vital insights into how common these pathogens are, where they're found, and how they affect livestock health and productivity. Grasping the factors that influence infection rates across various regions and farming practices is key to crafting effective control strategies and improving goat management.

2.5.1 Global and Regional Prevalence Studies

Studies from different regions and countries show a high prevalence of gastrointestinal parasites in goat populations, highlighting the challenges faced in goat husbandry. For example, research in Terengganu, Malaysia, found an astonishing infection rate of 97.6% among 287 goats examined, with Eimeria species being the most common culprits (Peterson *et al*., 2023). This underscores how widespread coccidial infections are in goats, especially in areas where management practices might fall short.

In a similar vein, a study from Lesotho revealed a significant infection level caused by *Haemonchus contortus*, a major gastrointestinal nematode, which was notably more prevalent in highland regions compared to lowland areas (Matsepe *et al*., 2021). The researchers pointed out that climatic conditions and management practices likely played a role in these differences, emphasizing the need for localized data to guide effective control strategies. Furthermore, the prevalence rate for gastrointestinal parasites in goats has been recorded at 37.5% in Abuja, Nigeria, which emphasizes the need for targeted health interventions in vulnerable populations (Roberts *et al*., 2024).

When we look at global comparisons, it's clear that the rates of prevalence differ quite a bit depending on the region and the management system in place. For instance, a comprehensive study conducted in Jabalpur, India, found a striking prevalence rate of 73.07%, with nematodes like Strongyles and Coccidia being among the most commonly found (Kumar *et al*., 2023). These results resonate with findings from other areas, such as Somalia, where research pointed out how farming systems can influence the burden of parasites (Garcia *et al*., 2024). Together, these studies highlight the intricate relationship between environmental factors, farming methods, and animal health that shapes the epidemiology of gastrointestinal parasites in goats.

When we compare prevalence across different farming systems, we see notable differences: intensive, extensive, and semi-intensive. A study in Terengganu revealed that goats raised in intensive systems had the highest prevalence at 99%, closely followed by those in extensive systems at 98.3%. On the other hand, goats in semi-intensive systems showed a lower prevalence rate of 96% (Peterson *et al*., 2023). This pattern indicates that the management practices unique to each system play a crucial role in determining parasite burdens.

Goats in intensive systems often face higher stocking densities and environmental conditions that promote the spread of parasites. In contrast, while extensive systems offer more natural foraging opportunities, they can still face significant parasite challenges based on grazing patterns and management strategies. For example, research in Benin reported a general prevalence of 96.82%, with *Haemonchus spp.* and *Trichostrongylus spp*. being prevalent in both extensive and semi-intensive systems (Brown *et al*., 2024).

The relationship between intensive and extensive systems is further clarified by findings from Southern Spain, where mixed farming of sheep and goats was found to increase the risk of parasitic infections due to shared pastures and fecal contamination (Thompson *et al*., 2022).

Such interactions between farming systems not only affect infection rates but also highlight the necessity for integrated parasite management strategies that consider all species within an ecosystem.

Recognizing how widespread and distributed gastrointestinal parasites are in goats across different farming systems is crucial for veterinarians and farmers alike. It allows them to create targeted strategies for intervention. By customizing management practices to fit specific environmental and contextual factors, the risk of parasitic infections can be reduced, ultimately enhancing the health and productivity of goat herds.

The epidemiology of these gastrointestinal parasites in goats is shaped by various factors, such as geographical location, farming systems, and management practices. Research from different regions shows that the high prevalence of these parasites presents significant challenges for goat producers. Grasping the dynamics of infection across various systems is vital for putting effective control measures in place, underscoring the ongoing need for tailored strategies that tackle the unique challenges faced by goat farmers around the world.

2.5.2 Factors Influencing Prevalence of Infection

To effectively control gastrointestinal (GI) parasite infections in goats and improve overall herd health, it's essential to understand the factors that influence their prevalence and intensity. These factors can be grouped into climatic conditions, seasonal changes, management practices, and traits specific to the host.

1. Climatic Factors

Climatic conditions significantly impact the epidemiology of gastrointestinal parasites in goats. Elements like temperature, rainfall, and humidity directly influence the survival and development of free-living parasite stages in the environment (Chen *et al*., 2024). For instance, warm and humid weather is ideal for the survival of parasitic larvae, especially in tropical and subtropical areas. Sufficient moisture promotes the rapid development of nematode larvae in pastures, increasing the chances of infection as goats graze and consume these infectious stages. Higher temperatures can also speed up the life cycles of various helminths, boosting their reproduction rates (Torres *et al*., 2023; Roberts *et al*., 2024).

Research has shown a clear link between climate conditions and the occurrence of certain parasites. For example, one study indicated that heavy rainfall can lead to a rise in the numbers of *Haemonchus* and *Trichostrongylus* species in small ruminants during the monsoon season (Martinez *et al*., 2022). This highlights the importance of understanding local climate patterns to create effective seasonal management strategies aimed at reducing parasitic infections in goat populations.

2. Season Variations

The prevalence of gastrointestinal parasites in goats is greatly influenced by seasonal changes. Numerous studies have found that infection rates often peak during certain times of the year, especially after heavy rains, which provide perfect conditions for larvae to thrive in pastures (Ruhoollah *et al*., 2023). In tropical regions, infections from gastrointestinal nematodes, particularly *Haemonchus contortus*, frequently surge during the rainy season when pastures are lush and offer plenty of forage (Kumar *et al*., 2023). On the flip side, drier seasons tend to see lower infection rates as the environment becomes less hospitable for larvae.

In areas with distinct seasonal changes, researchers have noted significant variations in parasite loads that correspond with these transitions (Lopez *et al*., 2024). The ongoing cycle of pasture contamination and larval survival underscores the necessity of rotating grazing areas and implementing deworming strategies that align with climatic and seasonal shifts to better manage and control parasitic infections.

3. Management Practices

Different management practices can have a major impact on the prevalence and severity of gastrointestinal parasites in goats. Grazing systems are particularly crucial; extensive grazing may expose goats to higher parasite loads, while intensive systems can help minimize contact with infective stages through controlled feeding and housing (Davis *et al*., 2024).

Inadequate management practices, like not deworming enough or failing to rotate pastures, can really worsen parasite issues and lead to resistance against anthelmintics, as shown in several studies (Johnson *et al*., 2023). The size of the herd also plays a big role in how infections spread. Larger flocks can create more competition for resources, which can increase stress and weaken immune responses, making goats more prone to infections (Kim *et al*., 2022). On the flip side, smaller herds might allow for better management, like more focused deworming schedules and closer monitoring of health indicators. So, having a strategic management plan that considers herd size, composition, and grazing systems can really make a difference in how prevalent and intense parasite infections are (Thompson *et al*., 2022; Williams *et al*., 2023).

4. Host Factors

When it comes to host factors, several elements also affect how often and how severely goats suffer from gastrointestinal infections. Age is a key factor; younger goats are usually more vulnerable to parasites because their immune systems are still developing (Hassan and Jibrin, 2022). In contrast, older goats might show more resistance thanks to previous exposures, which help them fight off infections better. Additionally, sex and breed can influence susceptibility; some breeds have genetic traits that give them an edge against certain parasites (Anderson *et al*., 2024).

5. Nutrition

Nutritional status is another crucial factor. Goats that are poorly nourished often have weakened immune systems, making them more susceptible to infections. In contrast, well-fed goats generally enjoy better health, allowing them to handle parasitic challenges more effectively (Baker *et al*., 2024). Physiological conditions, such as being pregnant or lactating, can also affect how susceptible goats are to parasites, as their immune responses may change during these times (Kim *et al*., 2022).

The interplay of climatic conditions, seasonal variations, management practices, and host-specific factors significantly influences the prevalence and intensity of gastrointestinal parasites in goats. Understanding these dynamics enables farmers and veterinarians to develop targeted intervention strategies, ultimately promoting animal health and improving productivity in goat farming.

2.5.3 Anthelmintic Resistance

Anthelmintic resistance is a major global issue when it comes to managing gastrointestinal parasites in livestock, especially goats. This term refers to the reduced effectiveness of anthelmintics against certain parasites due to genetic changes, and it creates real challenges for sustainable animal husbandry. The increasing rates of resistance have raised alarms among veterinarians, researchers, and farmers, as it threatens the reliability of common treatment options.

This resistance often arises from the selective pressure created by the frequent and sometimes careless use of anthelmintic drugs. When parasites are exposed to these medications, those with genetic mutations that allow them to resist the drugs survive and reproduce, resulting in populations that are largely made up of resistant strains. This is a growing concern globally, as veterinarians are noticing that essential drugs like benzimidazoles and macrocyclic lactones commonly used to treat gastrointestinal nematodes are becoming less effective.

The problem is made worse by the heavy reliance on a small number of anthelmintic drugs and the poor implementation of integrated parasite management strategies. Organizations like the World Organisation for Animal Health (OIE) and the Food and Agriculture Organization (FAO) have pointed out that anthelmintic resistance is a critical issue affecting livestock health around the world, calling for urgent attention and action. The rising resistance levels not only pose a threat to goat health but also impact economic productivity, leading to higher costs due to treatment failures and the need for more intensive control measures (Foster *et al*., 2023).

2.6 Prevalence of Gastrointestinal Parasites in Goats in Nigeria

2.6.1 Studies on Gastrointestinal Parasites in Goats in Nigeria

Research into the prevalence of gastrointestinal parasites in goats throughout Nigeria sheds light on the significant challenges that livestock producers face in the area. A variety of studies have been carried out across different geopolitical zones, uncovering common parasite species and general trends related to prevalence rates and contributing factors.

Several studies have looked into the prevalence of gastrointestinal parasites in goats across various states in Nigeria. In the Federal Capital Territory (FCT), a notable study by Roberts *et al*. (2024) found a prevalence rate of 37.5% in goats, with Eimeria and strongyle species being the most frequently encountered parasites. This finding is consistent with similar patterns seen in other regions, where both nematodes and protozoa pose significant threats to goat health and productivity.

In southeastern Nigeria, Chen *et al*. reported a concerning prevalence of 96.2% for gastrointestinal *trichostrongyles*, with *Haemonchus contortus* identified as the most common species (Chen *et al*., 2022). This high prevalence was linked to various factors, including environmental conditions that favor parasite survival, such as humidity and rainfall. These results highlight the difficulties in managing gastrointestinal parasites in this region, especially within the traditional farming practices that dominate Nigerian goat production.

On the other hand, studies from northern Nigeria have shown varying prevalence rates influenced by geographical and climatic conditions. For instance, in Maiduguri, Garcia *et al*. (2023) reported a prevalence of 81.2% for gastrointestinal parasites in goats, illustrating the severe impact these infections can have on livestock populations in arid areas. The differences in findings underscore how geographical location and local management practices can greatly affect the epidemiology of gastrointestinal parasites in goats.

Commonly Reported Parasite Species

In Nigeria, goats are often affected by a variety of parasitic species, including gastrointestinal nematodes, cestodes, and protozoa. Research consistently points to *Haemonchus contortus* as one of the most common nematodes found in different areas, notorious for causing significant production losses due to its blood-feeding habits (Roberts *et al*., 2024; Chen *et al*., 2022). Other nematodes that frequently show up include *Trichostrongylus* spp., *Oesophagostomum* spp., and *Strongyloides papillosus* (Ruhoollah *et al*., 2023).

Protozoan infections, especially those caused by *Eimeria* species, are also quite prevalent. Many studies have linked high prevalence rates to stress factors like poor management, inadequate nutrition, and challenging environmental conditions (Roberts *et al*., 2024). While cestodes like *Moniezia expansa* are less common, they have still been reported in certain areas, adding to the gastrointestinal parasitic load in goats (Ruhoollah *et al*., 2023). The variety of these parasite species underscores the importance of developing integrated control strategies that are tailored to the specific epidemiological situations in different regions of Nigeria.

When it comes to reported prevalence rates and the factors that influence them, the rates of gastrointestinal parasites in Nigerian goats can vary widely based on regional characteristics and farming practices. For instance, the prevalence of these parasites tends to rise with climatic changes, especially during the rainy season when moisture helps the infective stages survive. Seasonal changes are significant, as seen in northern Nigeria, where studies have shown that infection rates are higher during the wet season compared to the dry season. This is largely due to increased pasture contamination and favorable conditions for parasite development (Brown *et al*., 2024).

Management practices play a crucial role in determining how prevalent parasites are among goats. Farming systems that struggle with poor sanitation, overcrowding, and a lack of strategic deworming tend to see higher infection rates. For example, traditional extensive grazing methods often put goats at greater risk of infection because they have uncontrolled access to pastures and don't practice sufficient rotational grazing (Kumar *et al*., 2023). On the flip side, farms that are well-managed and adopt practices like timely deworming, proper sanitation, and effective pasture management usually report lower rates of infection (Lee *et al*., 2023).

Ongoing research into the prevalence of gastrointestinal parasites in Nigerian goats highlights the variety of species involved and the significant influence of environmental, management, and host-specific factors. Grasping these dynamics is essential for crafting and implementing effective strategies to enhance the health and productivity of goat populations across the country.

Out of 56 goats examined, 21 (37.5%) were found to be infected with gastrointestinal (GI) parasites, while 19 (43.1%) of the 44 sheep tested also showed signs of infection. This study identified *strongyle* and *Eimeria* species as the most common parasites affecting small ruminants in the area (Roberts *et al*., 2024). These results align with findings from Chen *et al*. (2022), which reported a staggering 96.2% prevalence of GI *trichostrongyles*, with *H. contortus* being the most frequently identified nematode in goats brought to the Nsukka municipal abattoir. *Haemonchus contortus* is often cited as the leading and most significant parasite in outbreaks of parasitic gastroenteritis in Nigeria.

The current study found an overall prevalence of gastrointestinal parasite infection in goats to be 70.55%, which is consistent with previous research findings.

We've noticed some significant differences in how often *H. contortus* shows up in sheep compared to goats. These variations really highlight the need for specific control strategies tailored to each species. Several risk factors, like grazing habits, geographical locations, and environmental conditions, play a big role in how prevalent gastrointestinal parasites are in goat populations, as seen in various studies from different areas. Infections from gastrointestinal helminths and enteric protozoan parasites can lead to serious economic setbacks, including illness and death, particularly among younger animals.

The wet season tends to see a spike in gastrointestinal parasites, mainly because the increased moisture and warmer temperatures create perfect conditions for these parasites to thrive. While some studies have reported alarmingly high rates of gastrointestinal parasites, claims of 100% infection rates should be approached with caution and verified locally, as they often surpass what reputable studies typically find.

Research underscores the vital role goats play as a source of income for rural communities in Nigeria. The overall prevalence of gastrointestinal parasites found in goats at the abattoir raises significant public health concerns regarding infections linked to livestock. Additionally, there have been reports of high rates of zoonotic parasites in goats, which can particularly impact children who might come into contact with contaminated environments.

The widespread occurrence of gastrointestinal parasites across various regions highlights the pressing need for effective management practices and further research efforts.

2.6.2 Specific Studies on Gastrointestinal Parasites in Goats in Edo State

Looking into gastrointestinal parasites in goats in Edo State and nearby areas reveals serious issues for livestock farmers. A number of studies conducted in this region have found high levels of parasite prevalence, species diversity, and associated risk factors, all of which stress the importance of implementing effective control measures.

There's a noticeable gap in research regarding the prevalence of goats in Edo State, which is a field that hasn't been fully explored yet. However, several studies in neighboring regions can provide valuable insights. For example, research by Adebayo and Okafor (2022) highlighted the high rates of gastrointestinal parasites in goats, particularly in Osun State, where they found that helminth infections were most common during the wet season. This study pointed out that the prevalence was significantly influenced by factors like high moisture levels, cooler temperatures, and ideal habitats for parasites. Given that Edo State shares a tropical climate, it's reasonable to assume similar environmental conditions might exist there (Adebayo and Okafor, 2022).

In a more localized effort, Inegbenosun *et al*. (2023) focused their research specifically on Edo State and found a high prevalence of gastrointestinal parasites, with a notable percentage of the goats they sampled showing signs of infection. This aligns with trends seen in neighboring states and underscores the considerable risks that goats in this area face, making routine monitoring and management essential.

Additionally, Inegbenosun *et al*. (2023) identified several parasite species, including *Haemonchus contortus*, *Oesophagostomum* spp., and *Trichuris* spp., among goats in Edo State. These species are commonly found throughout West Africa, reinforcing the idea that local goat populations are under similar parasitic threats. This highlights the urgent need for targeted veterinary care to tackle these widespread health challenges.

When it comes to goats in Edo State, there are several parasite species that frequently make the rounds. One of the most notorious is *Haemonchus contortus*, a gastrointestinal nematode that really takes a toll on goat health due to its blood-feeding habits. This parasite is a major player in causing weight loss and anemia among goats, as highlighted by Adebayo and Okafor (2022). Other common culprits in the region include *Trichostrongylus* spp., *Oesophagostomum* spp., *Eimeria* spp., and *Strongyloides papillosus*, as noted by Inegbenosun *et al*. (2023). The consistent reports of these parasites underline the pressing need for effective treatment and management strategies that are tailored to the local environment.

Understanding how prevalent these parasites are is key. For instance, if left unchecked, *Haemonchus contortus* infections can lead to significant production losses in goat herds, as pointed out by Inegbenosun *et al*. (2023). Trends show that implementing targeted interventions like better grazing practices and proper anthelmintic treatments can help reduce the negative effects of these infections.

When it comes to reported prevalence rates and the factors at play, studies focusing on gastrointestinal parasites in Edo State reveal alarmingly high infection rates, which pose serious public health concerns. For example, Inegbenosun *et al*. (2023) found that up to 76.3% of goats were infected with gastrointestinal parasites. Similar trends have been observed in other parts of Nigeria, where *Haemonchus contortus* and *Eimeria* spp. are also common.

Several factors contribute to these high prevalence rates. Seasonal changes, particularly during heavy rains and humid conditions, create an ideal environment for parasites to thrive, as noted by Adebayo and Okafor (2022). Additionally, poor grazing management and a lack of regular deworming practices keep infection rates high.

The gaps in our understanding of gastrointestinal parasites in Edo State really highlight the urgent need for more thorough research, especially when it comes to how abattoir practices affect these issues. While some studies have shared prevalence rates, we still lack in-depth investigations into how different farming systems influence the dynamics of these parasites. By focusing on at-risk populations through enhanced abattoir studies, we can gain valuable insights that will help us develop better management strategies for parasites in goat farming.

Research on gastrointestinal parasites in goats in Edo State shows a troubling rate of infections, influenced by various environmental and management factors. Identifying key parasitic species, along with the effects of seasonal climate changes and farming practices, emphasizes the need for targeted intervention strategies. However, there are still significant knowledge gaps, particularly regarding prevalence studies linked to abattoirs. Addressing these gaps is crucial for improving health management practices and ensuring the economic sustainability of goat farming in the area.

In this study, 21 out of 56 goats (37.5%) were found to be infected with gastrointestinal (GI) parasites, while 19 out of 44 sheep (43.1%) examined also showed infections. The findings indicate that strongyle and Eimeria species are the most prevalent parasites among small ruminants in the region, recognized as major gastrointestinal threats to domestic ruminants.

Supporting our findings, Okafor *et al*. (2022) noted a higher prevalence of parasitic diseases in sheep and goats during the wet season compared to the dry season in their research conducted in Edo State. This trend may be linked to the increased moisture and cooler temperatures of the wet season, which create favorable conditions for the growth and spread of parasites and their vectors.

The presence of these parasites confirms their role as significant pathogens impacting cattle and goats in tropical and subtropical climates. Co-infection with *Haemonchus contortus* and *Trichostrongylus* spp. has been reported, indicating their prevalence and high pathogenicity in livestock.

The parasites acquired by these animals can adversely affect their economic value and pose serious public health challenges. The effects of parasitic infections could worsen in areas with limited veterinary care and inadequate disease control policies, which is largely the case in rural Edo.

2.7 Control and Prevention Strategies for Gastrointestinal Parasites

2.7.1 Chemotherapy (Anthelmintics)

Classes of Anthelmintics and Their Modes of Action

1. Anthelmintics play a vital role in managing gastrointestinal parasites in goats, and they're usually grouped into several categories based on how they work: benzimidazoles, macrocyclic lactones, imidazothiazoles, and a few others like pyrantel and closantel.
2. **Benzimidazoles**: This category includes medications like albendazole and fenbendazole, which attach to the β-tubulin of parasites. This action prevents the formation of microtubules, disrupting crucial cellular functions such as glucose absorption and cell division (Martinez *et al*., 2022). Ultimately, this leads to the parasite's demise.

3. **Macrocyclic Lactones**: This group features ivermectin, doramectin, and moxidectin, which target glutamate-gated chloride channels. This results in increased permeability of neuronal and muscle cells to chloride ions, causing paralysis and death in the parasites. Known for their broad-spectrum effectiveness against nematodes and ectoparasites, macrocyclic lactones are often the go-to choice in many goat farming operations (Thompson and Singh, 2023).
4. **Imidazothiazoles**: Medications like levamisole fall into this category, acting as agonists for nicotinic acetylcholine receptors. This leads to paralysis of the parasites, making it easier for the host to expel them. However, their use can be limited in some cases due to potential side effects and toxicity (Williams *et al*., 2024).
5. **Others**: Drugs such as pyrantel induce paralysis by depolarizing neuromuscular junctions, helping to push parasites out through the gastrointestinal tract. Meanwhile, closantel has shown particular effectiveness against flukes (Chen and Rodriguez, 2023).

When it comes to effective drug administration, especially for anthelmintics, having the right strategies in place is crucial. One key tactic is rotational deworming, which involves using different classes of anthelmintics in a planned sequence. This method helps reduce the pressure that comes from repeatedly using the same drug class, ultimately delaying the development of resistance (Kumar *et al*., 2022). Another important strategy is to keep an eye on how well the drugs are working by conducting fecal egg count reduction tests (FECRT). This ensures that the treatments are still effective against the targeted parasites. By selectively treating individual animals based on their fecal egg counts, we can take a more targeted approach that not only cuts down on the overall use of anthelmintics but also helps maintain their effectiveness longer than blanket treatment methods (Patel and Johnson, 2024). It's vital to keep accurate records of treatment protocols and monitor parasite loads so we can adjust our strategies as needed.

Additionally, good sanitation practices and effective grazing management can significantly reduce goats' exposure to infective larvae, boosting the overall success of anthelmintic treatments. Regularly rotating pastures and avoiding overstocking are great ways to lower parasite transmission and enhance the sustainability of livestock management (Mbeki *et al*., 2023).

2.7.2 Non-Chemotherapeutic Control Methods

As the threat of anthelmintic resistance grows, non-chemical control methods are becoming increasingly important for managing gastrointestinal parasites in goats. These strategies include grazing management, nutritional support, genetic selection, biocontrol methods, and vaccination—each playing a crucial role in developing sustainable parasite management systems.

Grazing Management (Rotational Grazing, Mixed Grazing)

Managing how goats graze is key to keeping gastrointestinal parasites in check. One effective strategy is rotational grazing, where livestock are moved from one pasture to another. This not only allows the grass to recover but also disrupts the life cycles of parasites, making it a smart way to reduce their numbers (Anderson and Davis, 2022). By rotating pastures, we can prevent overgrazing and limit goats' exposure to infective larvae that thrive in manure and plant matter. Research shows that giving pastures some downtime helps kill off these larvae, which ultimately lowers the risk for grazing animals (López-Martínez *et al*., 2023). This sustainable approach not only boosts goat health but also improves pasture quality and productivity.

Another effective method is mixed grazing, where goats share pastures with other livestock. Different species have unique grazing habits, which can help reduce the spread of parasites by lowering the overall parasite load in shared areas. For example, sheep and goats carry different types of Eimeria, and by strategically grazing them together, we can lessen the impact of certain parasites on each host (Singh and Patel, 2023). This teamwork not only makes better use of resources but also enhances herd health management.

Research backs up the idea that good grazing management can help prevent the rise of anthelmintic resistance. By adopting practices that lessen the need for chemical treatments and encourage a diverse grazing environment, farmers can positively influence parasite populations and reduce the pressure for resistant strains to develop (Brown *et al*., 2024).

Nutritional Supplementation

Providing proper nutrition is vital for boosting goats' resilience against gastrointestinal parasites. A well-balanced diet is essential for a strong immune response, which is crucial for effectively managing parasitic infections.

Studies have shown that goats fed a balanced diet are better equipped to fend off infections, thanks to an enhanced immune system that allows for quicker responses to parasitic threats (Ahmed and Hassan, 2023). To support this, supplementation strategies can include high-quality forage, protein-rich feeds, and essential minerals that boost immune health. For example, adding certain dietary additives like garlic and plant extracts has been found to have anthelmintic properties (Okonkwo *et al*., 2024). These natural supplements not only offer nutritional perks but also help strengthen the immune system, making it easier for goats to combat infections.

Research indicates that well-nourished goats tend to have fewer gastrointestinal parasites, which translates to better growth rates and production results. By focusing on nutritional strategies, goat producers can enhance the effectiveness of their current parasite management practices, ultimately leading to more sustainable goat farming operations (Brown *et al*., 2024; Ahmed and Hassan, 2023).

Genetic Selection for Resistant Animals

Genetic selection for resistance to gastrointestinal parasites is a promising new strategy for sustainable goat production. Breeding programs that aim to enhance resistance traits in goats can significantly reduce parasitic infections and the economic losses that come with them (García *et al*., 2023). Certain breeds, like the West African Dwarf goat, have been recognized for their natural resistance to infections, providing a genetic advantage that can be utilized in breeding efforts.

Research shows that selective breeding based on phenotypic traits linked to parasite resistance—such as higher antibody levels or improved immune responses—can produce goats that are more resilient to gastrointestinal parasites (Wilson and Taylor, 2022). This genetic approach to managing parasites fits well with integrated management strategies and plays a key role in promoting the sustainability of goat production.

Bringing genetic selection into breeding programs allows farmers to create herds that are better prepared to fight off parasitic infections. This approach highlights the importance of using resistance traits as a sustainable management strategy, which helps lessen the dependence on chemical anthelmintics and addresses the challenges posed by anthelmintic resistance (Nakamura *et al*., 2024).

Biocontrol Methods

Biocontrol methods present exciting alternatives for tackling gastrointestinal parasites in goats. One notable biocontrol agent is nematode-trapping fungi, which have garnered interest for their ability to lower parasitic nematode populations in the environment. These fungi, including species from the Arthrobotrys and Duddingtonia genera, have developed unique ways to trap and eliminate nematodes that come into contact with their hyphae (Mitchell and Clark, 2023).

By incorporating nematode-trapping fungi into pasture management practices, farmers can reduce the number of infective larvae in the environment, creating a healthier grazing area for goats. Studies have shown that using these fungi alongside traditional management techniques can lead to significant decreases in parasite loads, ultimately enhancing goat health (Rodriguez *et al*., 2022). Implementing biocontrol strategies not only provides an eco-friendly approach to managing parasites but also helps alleviate the risks tied to anthelmintic resistance.

Vaccination

The pursuit of vaccination strategies against gastrointestinal parasites is an exciting frontier in research that could revolutionize parasitic control in goats. While there are currently only a few commercial vaccines available for these parasites, ongoing research aims to develop effective vaccine candidates targeting various parasitic species, including *Haemonchus contortus* (Thompson *et al*., 2024).

Progress is looking quite promising! Studies indicate that immunizing goats against specific parasite antigens can trigger protective immune responses. For instance, recent research has been honing in on developing vaccines that target the major surface protein of *Haemonchus*, and the results so far suggest it could help reduce parasite loads and the damage they cause (Kim and Lee, 2023).

The future of vaccination as a strategy to combat gastrointestinal parasites is bright. To make this a reality, we need to keep pushing forward in molecular biology and immunology to pinpoint the right antigens that can spark those protective immune responses. This will pave the way for more effective vaccines that can be used commercially. By weaving vaccination strategies into a broader integrated parasite management plan, we can tackle gastrointestinal parasites from multiple angles, ultimately boosting goat health and productivity in sustainable farming systems (Johnson and Park, 2024).

To effectively control and prevent gastrointestinal parasites in goats, a well-rounded approach is essential—one that combines both chemotherapeutic and non-chemotherapeutic methods. Key strategies include grazing management, nutritional support, genetic selection, biocontrol methods, and vaccination. By embracing a holistic strategy that incorporates these various methods, goat farmers can enhance herd health, lower parasite burdens, and strengthen the resilience of their farming practices.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

This study was conducted in the Department of Medical Laboratory Science, School of Basic Medical Sciences, University of Benin, Edo State, Nigeria. Goat fecal samples were obtained from selected abattoirs located in New Benin and Aduwawa markets within Benin City.

3.2 Study Population

The study focused on goats, The West African long-legged or Sahelian goat and the Red Sokoto breed, which are commonly found in Benin City and are crucial for the local economy and cultural practices. The sample included goats of various ages, health statuses, and sex that were used.

3.3 Sample Size Calculation

The sample size for this study involved calculations based on previous research findings related to the prevalence of gastrointestinal parasites found in goats at various abattoirs in Nigeria. An estimated prevalence rate of 89% as documented in existing literature (Idika *et al*., 2021; Alaku *et al*., 2021), the sample size (n) was calculated using the formula:

$$n = \frac{Z2.\ P.(1-P)}{E2}$$

Where:

(Z) = Z-value (1.96 for a 95% confidence level)

(p) = estimated prevalence (84.5% =0.845)

(E) = margin of error (0.05)

Substituting in the values:

$$n = \frac{(1.96)2\ .\ 0.845\ .\ (1-0.845)}{(0.05^2)}$$

n =201.437 ≅ 200

A total of 200 goat fecal samples were obtained for the study. These comprised 100 samples each from Aduwawa and New Benin abattoirs with 20 fecal samples from obtained from Red Sokoto goats and 80 fecal samples from West African Long-legged goats in each abattoir.

3.4 Ethical Approval

Ethical approval for this research for sought from the Ethics and research committee Ministry of Health, Edo State, Nigeria with Ref No: HA/737/25/D/09180811. Informed consent was also sought and obtained from abattoir workers.

3.5 Stool Sample Collection

The sampling involved the collection of goat feces. Goat traders were approached in the selected abattoirs for samples. The fecal matter was collected from the rectum of the goats utilizing sterile gloves to maintain hygiene. Each sample was collected into sterile containers and preserved using 10% formol saline to prevent decomposition and allow for the evaluation of the gastrointestinal parasites. The collection process took place in the early morning hours between 06:00 and 11:00, and all samples were labeled appropriately for identification and traceability.

3.6 Materials

3.6.1 Equipment

Light microscope, centrifuge, test tubes, rack, glass slides, cover slips, pipettes, gauze.

3.6.2 Reagents and Solutions

10% formalin solution, normal saline (0.85%), Lugol's iodine, distilled water, 10% formol saline, Ethyl acetate.

3.6.3 Collection Materials

Sterile universal bottles, disposable gloves, masking tape, permanent marker.

3.7 Stool Sample Examination

3.7.1 Macroscopic Examination – Fecal samples were examined macroscopically for the presence of adult worms, mucus, blood and to assess their color and consistency *(Poonia et al.,2022).*

3.7.2 Microscopic Examination – The fecal samples were processed using the formalin-ethyl acetate sedimentation method and wet mount method (Taylor *et al*., 2020).

3.7.3 Formalin-Ethyl Acetate Sedimentation Method

Procedure:

For each sample, 1g of feces was thoroughly mixed with 10 ml of 10% formalin solution. The suspension was strained through wetted gauze to remove large debris and collected in a centrifuge tube. The mixture was then centrifuged at 500 × g for 10 minutes, and the supernatant was decanted. The sediment was then re-suspended with 10% formalin before adding 4 ml of ethyl acetate. The tube was stoppered and shaken vigorously to mix the layers, then centrifuged again at 500 × g for 10 minutes. The mixture separated into four layers. The top three layers were carefully decanted, leaving only the concentrated sediment at the bottom of the tube. A drop of this sediment was transferred onto a microscope slide, covered with a coverslip, and examined under the microscope using X10 and X40 objectives. Eggs were identified on the basis of their morphological features (Saif, 2020).

3.7.4 Wet Mount Method

For each sample, 1g of faeces was put on a slide with a wooden applicator stick, the stool was emulsified with a drop of iodine. Each preparation was covered with a cover slide and examined under a microscope using first 10× objectives and then 40× objectives, and the results were recorded (Poonia *et al*., 2022).

3.8 Statistical Analysis

The data collected on the prevalence of gastrointestinal parasites from each sample were analyzed statistically. Data were analyzed using Statistical Package for Social Sciences (SPSS) software version 27. Descriptive statistics summarized the information, categorical variables were presented as frequency and percentage. Continuous variables were presented as mean and standard deviation (SD).Chi-sqaure and independent t-test were used to compare variables. A significance level of $p < 0.05$ was considered statistically significant.

CHAPTER FOUR

4.0 RESULTS

4.1 Prevalence of Gastrointestinal Parasites in Goats at Selected Abattoirs in Benin City

Across both abattoirs, the most frequently encountered parasites were *Eimeria* spp. (49.5%), *Haemonchus* spp. (48.5%), *Strongyloides papillosus* (48.0%), and *Trichostrongylus* spp. (45.0%). In Aduwawa Abattoir, the highest prevalence was recorded for *Haemonchus* spp. (62.0%), followed by *Trichostrongylus* spp. (47.0%) and *Eimeria* spp. (46.0%). In New Benin Abattoir, *Strongyloides papillosus* (56.0%) and *Eimeria* spp. (53.0%) were the most frequently identified parasites. The prevalence of *Haemonchus* spp. (35.0%) was comparatively lower than that observed in Aduwawa.

4.2 Prevalence and Distribution of Gastrointestinal Parasites Across Goat Breeds

In Red Sokoto goats, *Strongyloides papillosus* was the most prevalent parasite (85.0%), followed by *Eimeria* spp. (65.0%) and *Trichostrongylus* spp. (47.5%). Among West African Long-Legged goats, the parasites with the highest prevalence were *Haemonchus* spp. (49.4%), *Eimeria* spp. (45.6%), and *Trichostrongylus* spp. (44.4%).

4.3 Association Between Market Environment and Prevalence of Parasitic Infections

There was a significant association between market environment and the prevalence of *Strongyloides papillosus* ($X^2 = 5.128$, $p = 0.024$) and *Haemonchus* spp. ($X^2 = 14.593$, $p < 0.001$).

Table 4.1: Prevalence of Gastrointestinal Parasites in Goats at Selected Abattoirs

Parasite n (%)	Aduwawa Abattoir (N = 100)	New Benin Abattoir (N = 100)	X^2	p-value
Strongyloides papillosus#	40 (40.0)	56 (56.0)	5.128	0.024
Trichostrongylus spp.	47 (47.0)	43 (43.0)	0.328	0.570
Moniezia spp.	8 (8.0)	17 (17.0)	3.703	0.054
Eimeria spp.	46 (46.0)	53 (53.0)	0.980	0.322
Haemonchus spp.#	62 (62.0)	35 (35.0)	14.593	<0.001
Paramphistomum spp.	9 (9.0)	6 (6.0)	0.649	0.421
Taenia spp.	12 (12.0)	9 (9.0)	0.479	0.489
Trichuris spp.	12 (12.0)	8 (8.0)	0.889	0.348

X^2 = Chi-square test statistic. # - significantly different, $p < 0.05$.

Table 4.2: Prevalence of Gastrointestinal Parasites Across Goat Breeds

Parasite n (%)	RSG (N = 40)	WALL (N = 160)	X^2	p-value
Strongyloides papillosus #	34 (85)	62 (38.8)	27.424	<0.001
Trichostrongylus spp.	19 (47.5)	71 (44.4)	0.126	0.722
Moniezia spp.#	11 (27.5)	14 (8.8)	10.286	0.001
Eimeria spp.#	26 (65.0)	73 (45.6)	4.805	0.028
Haemonchus spp.	18 (45.0)	79 (49.4)	0.245	0.620
Paramphistomum spp.	5 (12.5)	10 (6.3)	1.802	0.179
Taenia spp.	3 (7.5)	18 (11.3)	0.479	0.489
Trichuris spp.#	0 (0)	20 (12.5)	5.556	0.018

RSG = Red Sokoto Goat, WALL = West African Long-Legged Goat

X^2 = Chi-square test statistic. # - significantly different, $p < 0.05$.

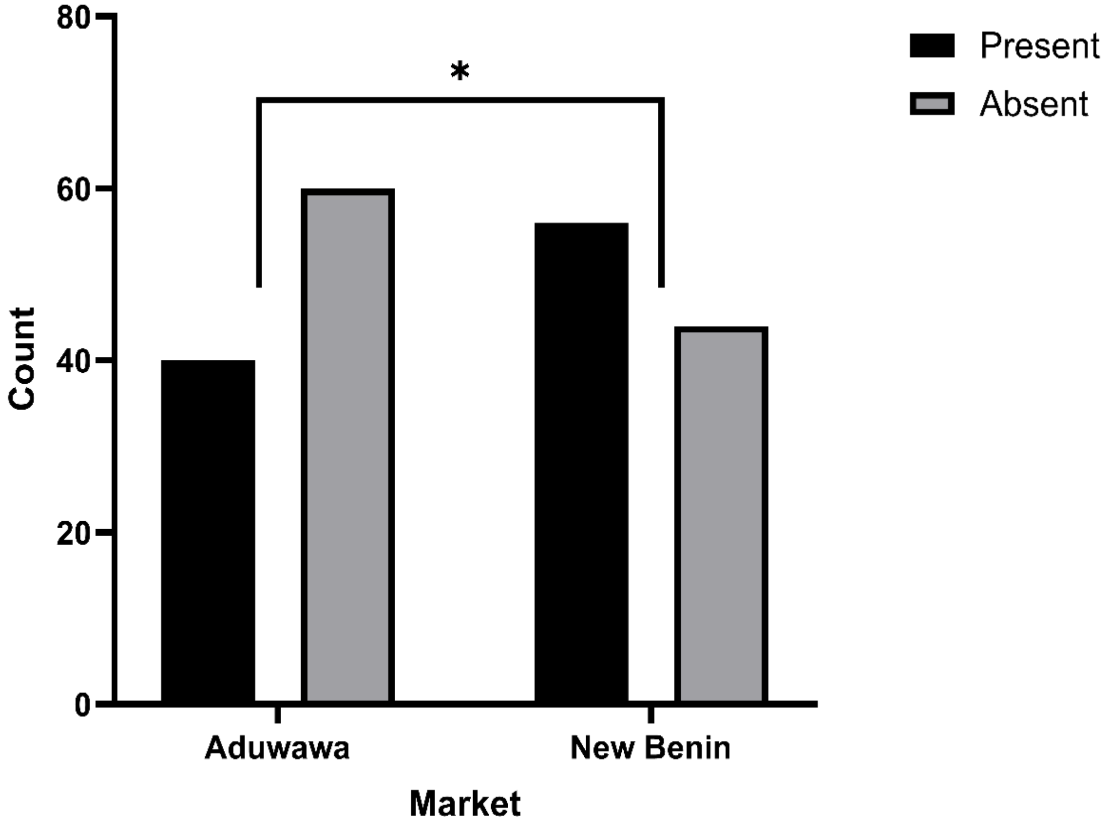

Figure 4.1: Cross-Tabulation for the Prevalence of *Strongyloides papillosus* Across Markets

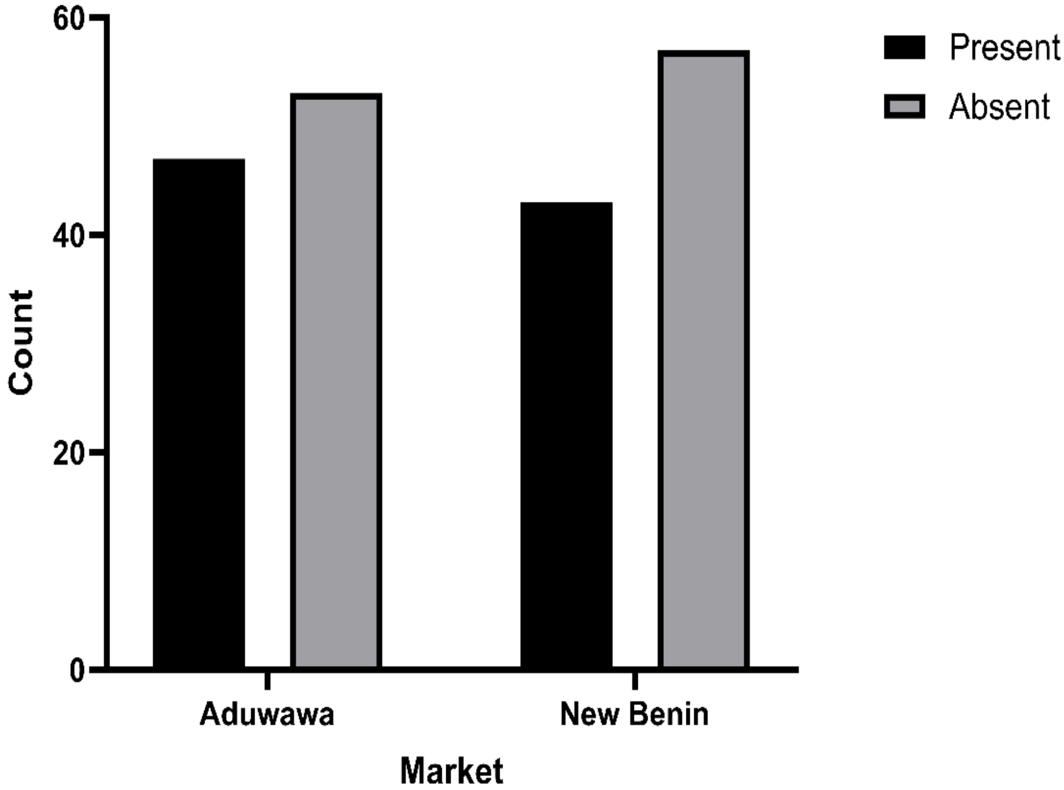

Figure 4.2: Cross-Tabulation for the Prevalence of *Trichostrongylus* spp. Across Markets

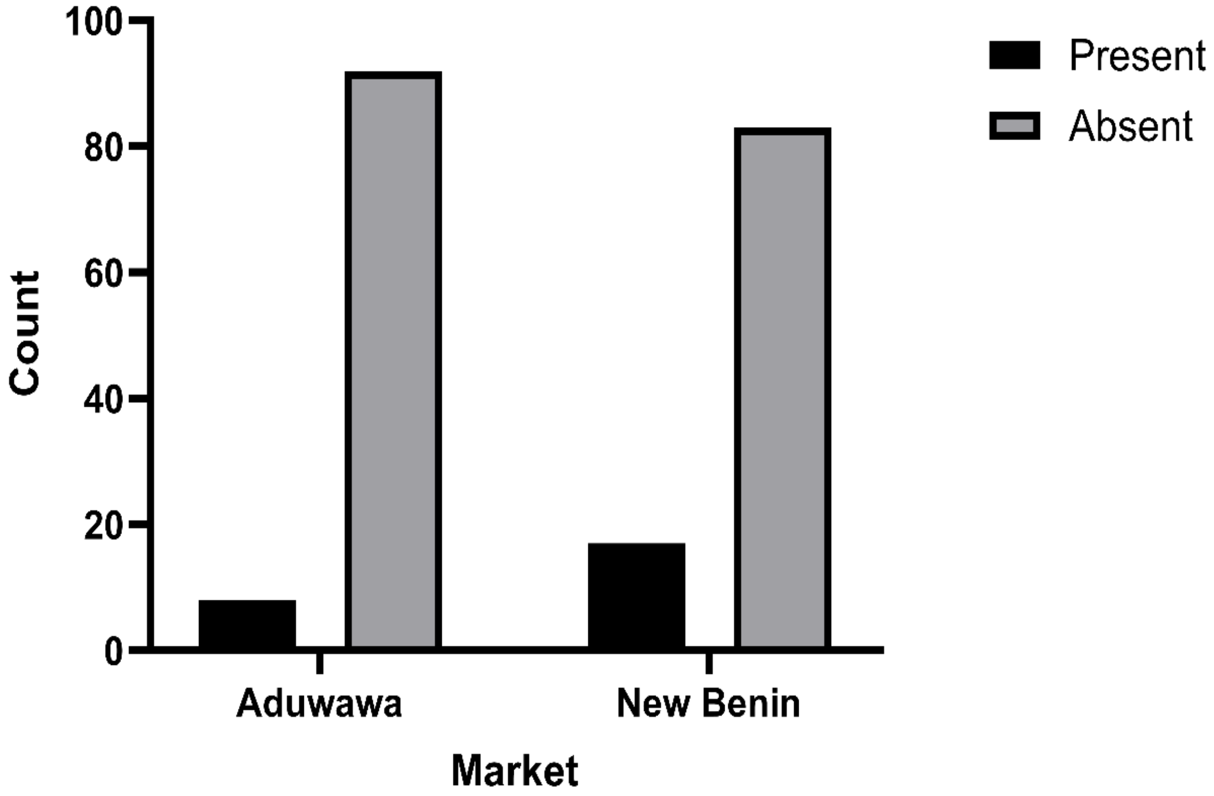

Figure 4.3: Cross-Tabulation for the Prevalence of *Moniezia* spp. Across Markets

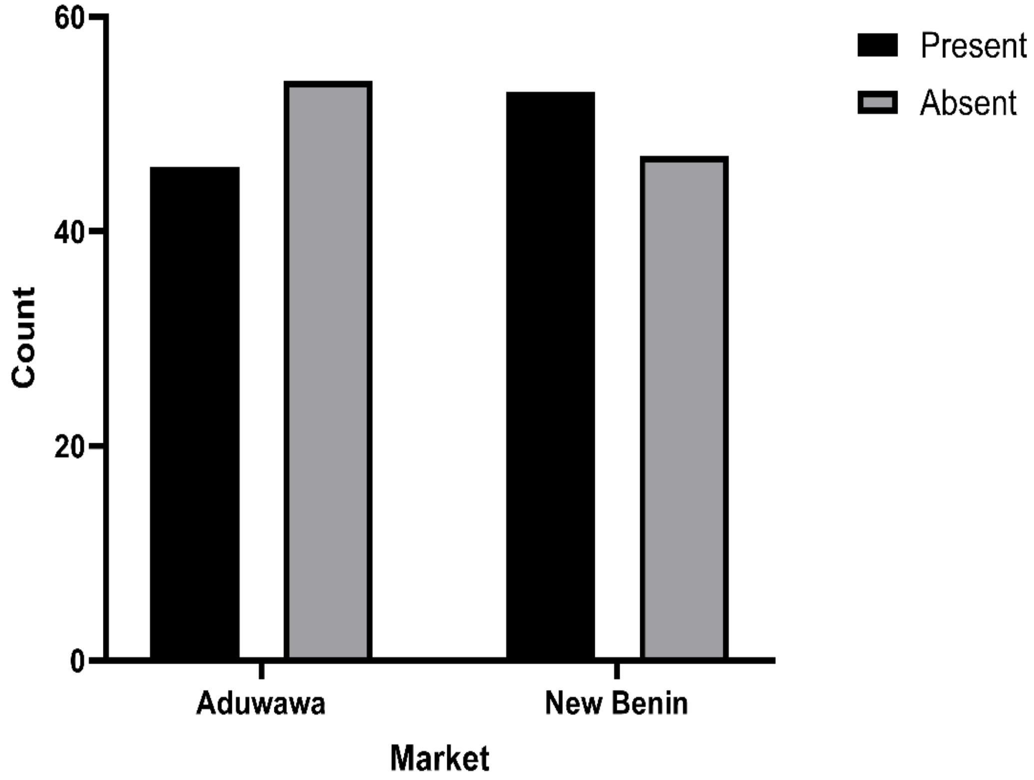

Figure 4.4: Cross-Tabulation for the Prevalence of *Eimeria* spp. Across Markets

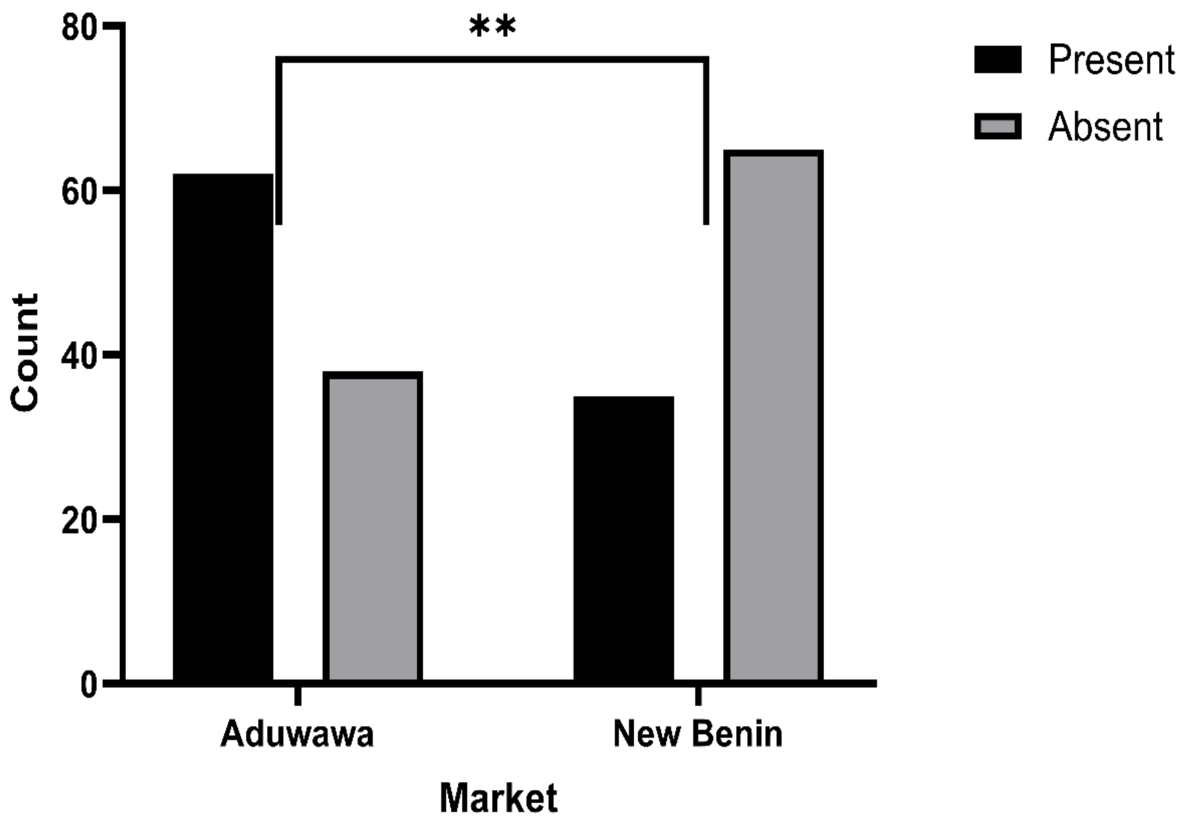

Figure 4.5: Cross-Tabulation for the Prevalence of *Haemonchus* spp. Across Markets

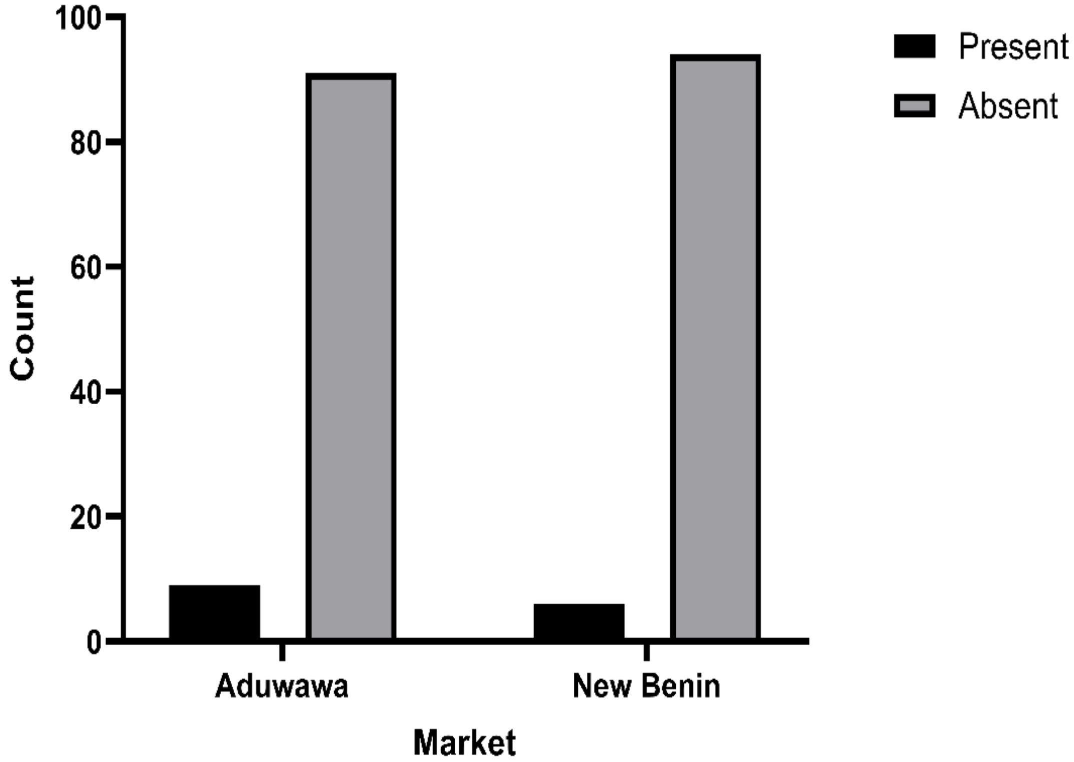

Figure 4.6: Cross-Tabulation for the Prevalence of *Paramphistomum* spp. Across Markets

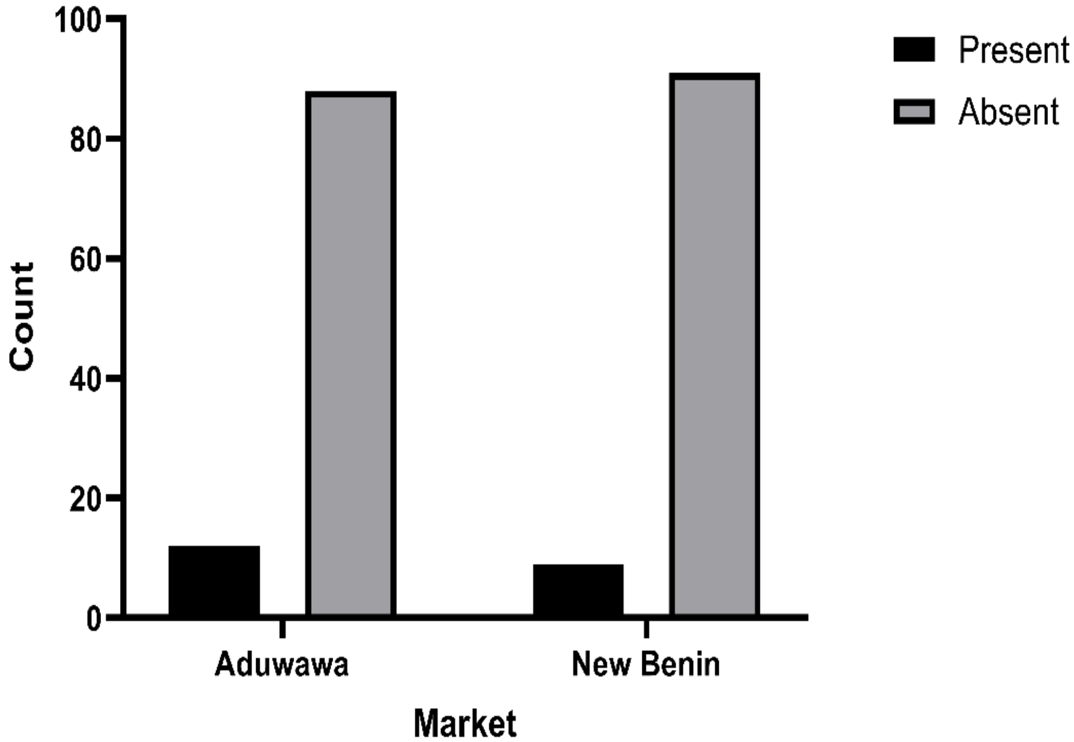

Figure 4.7: Cross-Tabulation for the Prevalence of *Taenia* spp. Across Markets

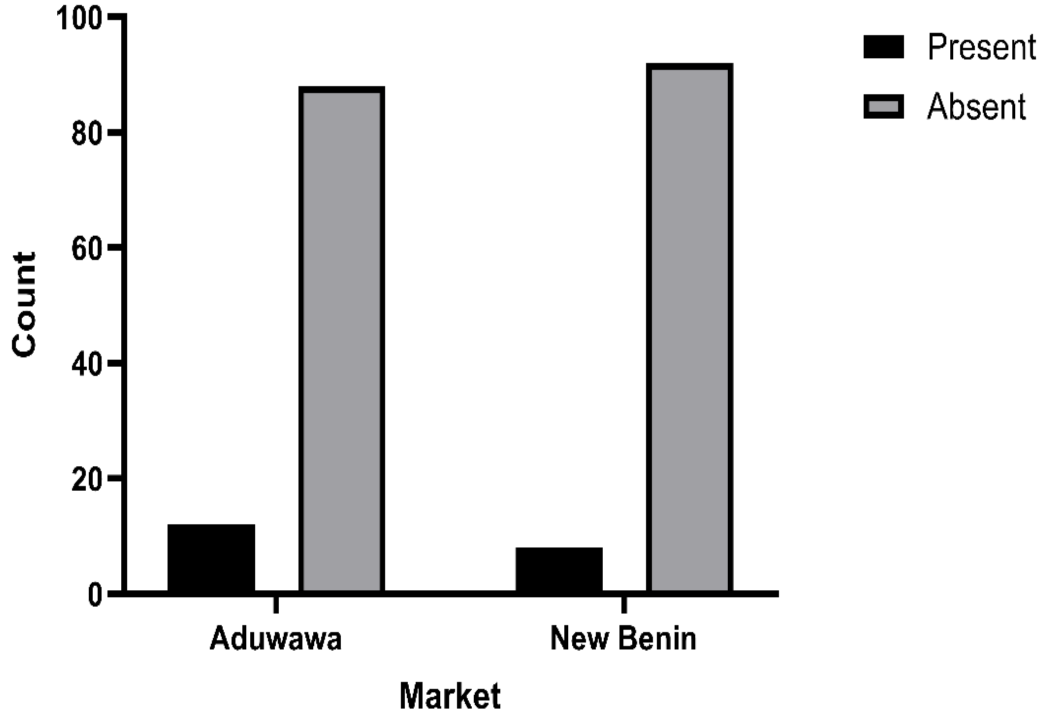

Figure 4.8: Cross-Tabulation for the Prevalence of *Trichuris* spp. Across Markets

4.4 Association between Breed and Prevalence of Parasitic Infections

There was a significant association between breed and the prevalence of *Strongyloides papillosus* (X^2 = 27.424, $p < 0.001$), *Moniezia* spp. (X^2 = 10.286, $p < 0.001$), *Eimeria* spp. (X^2 = 4.805, p = 0.028) and *Trichuris* spp. (X^2 = 5.556, p = 0.018).

4.5 Influence of Market Environment on Numbers of Parasitic Infections

There was no statistically significant difference ($p > 0.05$) in the number of parasitic infections among goats at Aduwawa and New Benin market.

4.6 Influence of Goat Breed on Number of Parasitic Infections

There was a statistically significant difference ($p < 0.05$) in the number of parasitic infections among both Red Sokoto and West African Long-Legged breed of goats.

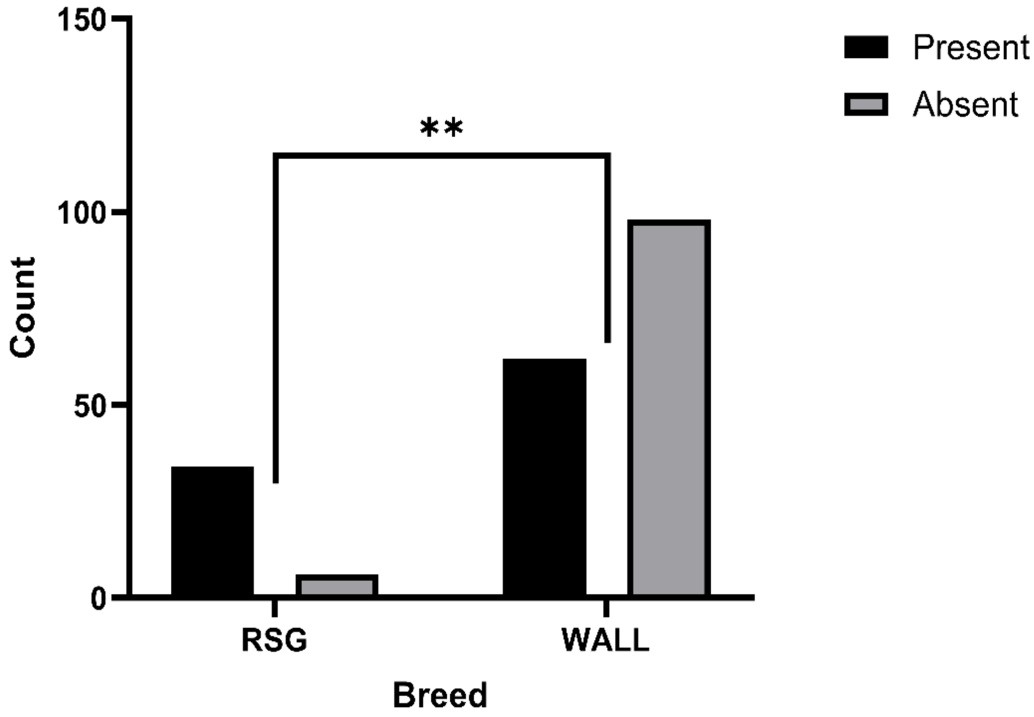

Figure 4.9: Cross-Tabulation for the Prevalence of *Strongyloides papillosus* Across Goat Breeds

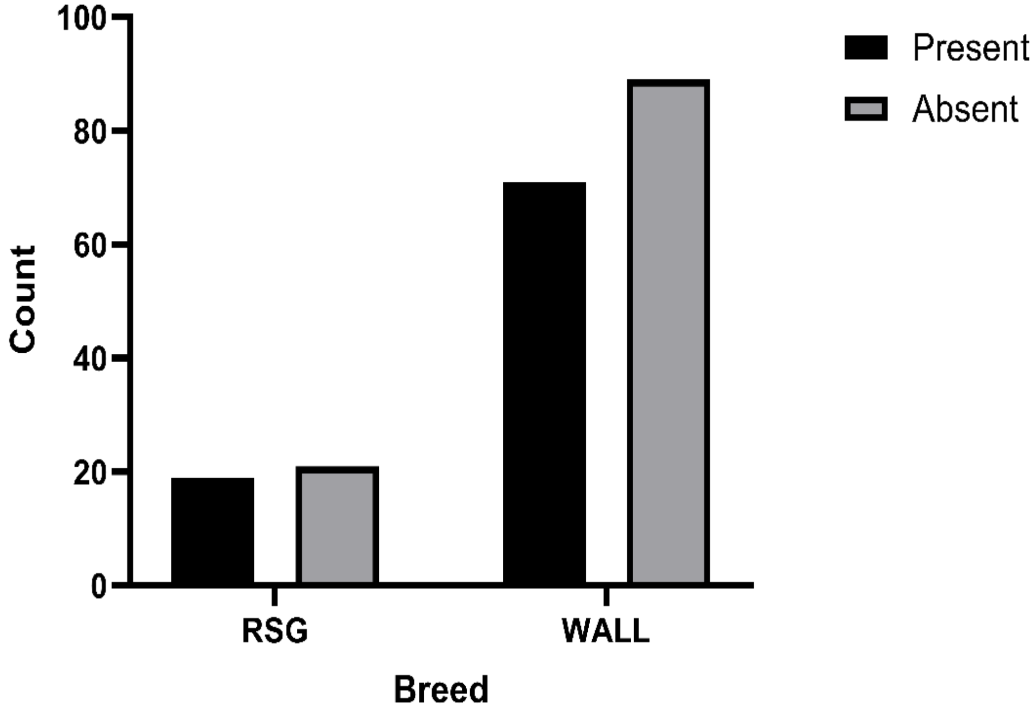

Figure 4.10: Cross-Tabulation for the Prevalence of *Trichostrongylus* spp. Across Goat Breeds

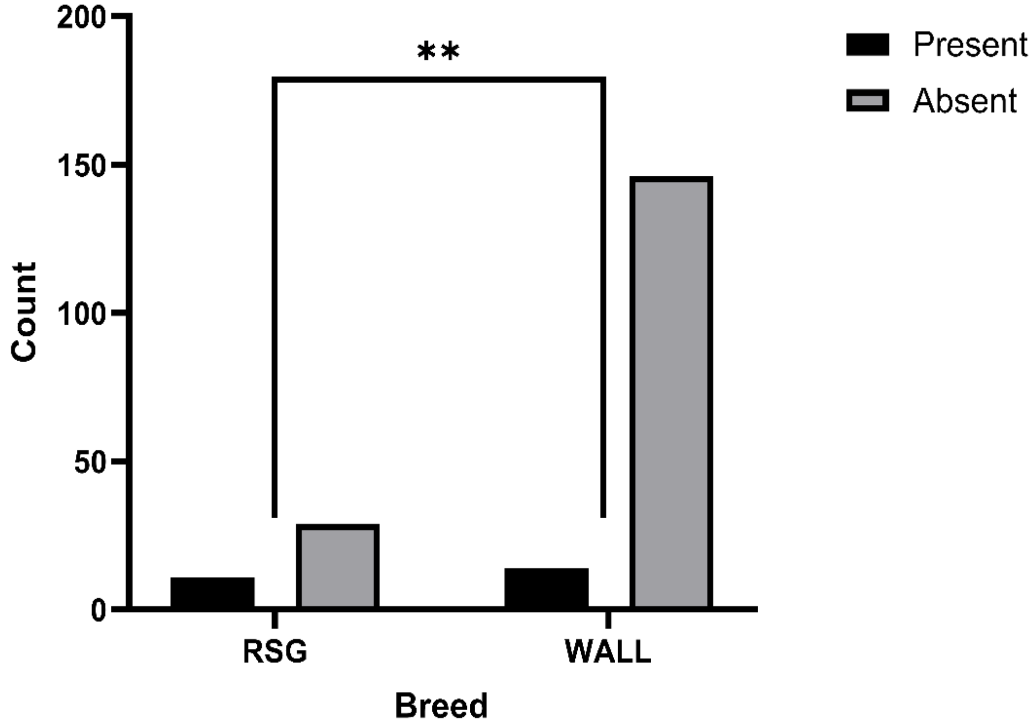

Figure 4.11: Cross-Tabulation for the Prevalence of *Moniezia* spp. Across Goat Breeds

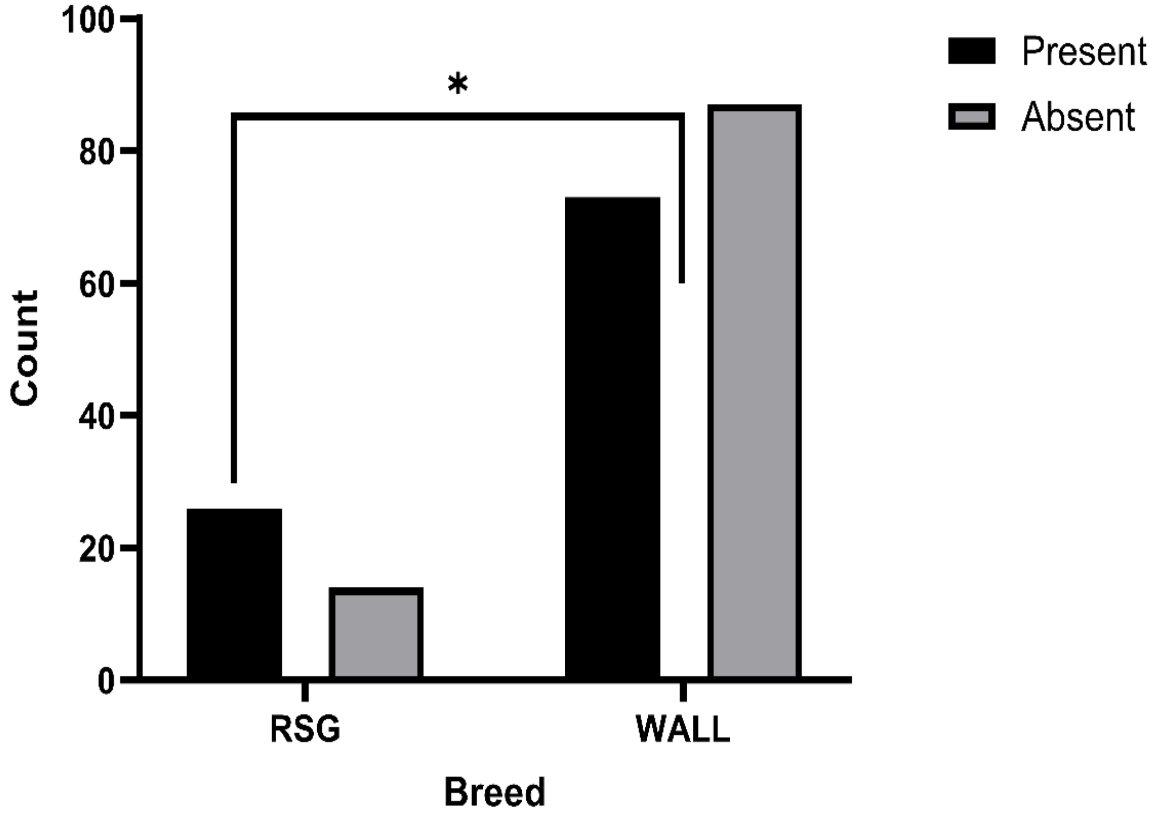

Figure 4.12: Cross-Tabulation for the Prevalence of *Eimeria* spp. Across Goat Breeds

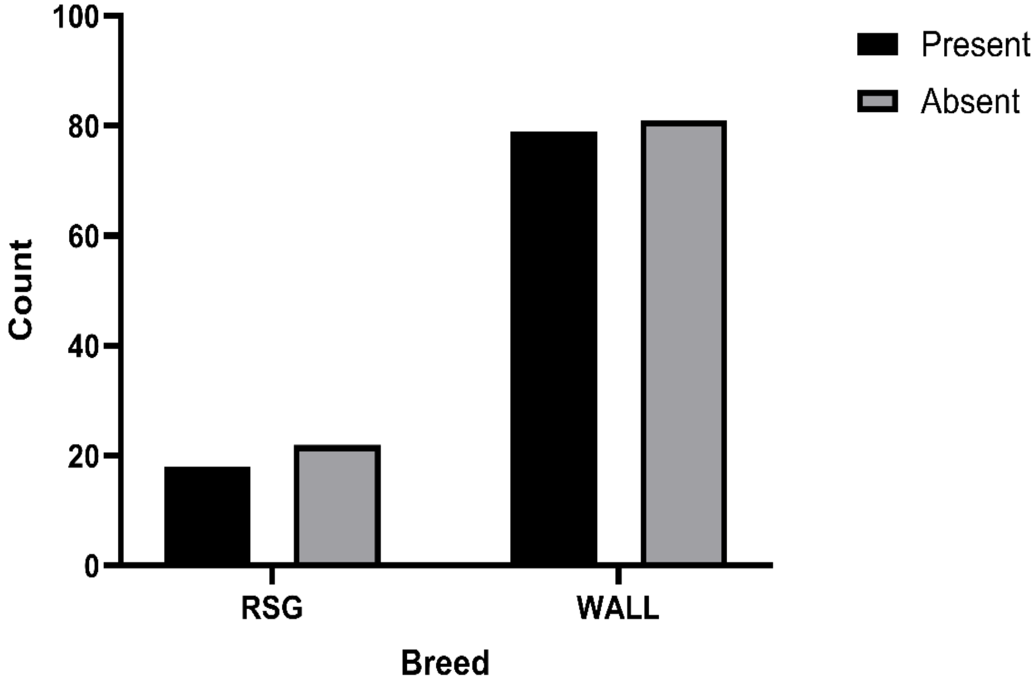

Figure 4.13: Cross-Tabulation for the Prevalence of *Haemonchus* spp. Across Goat Breeds

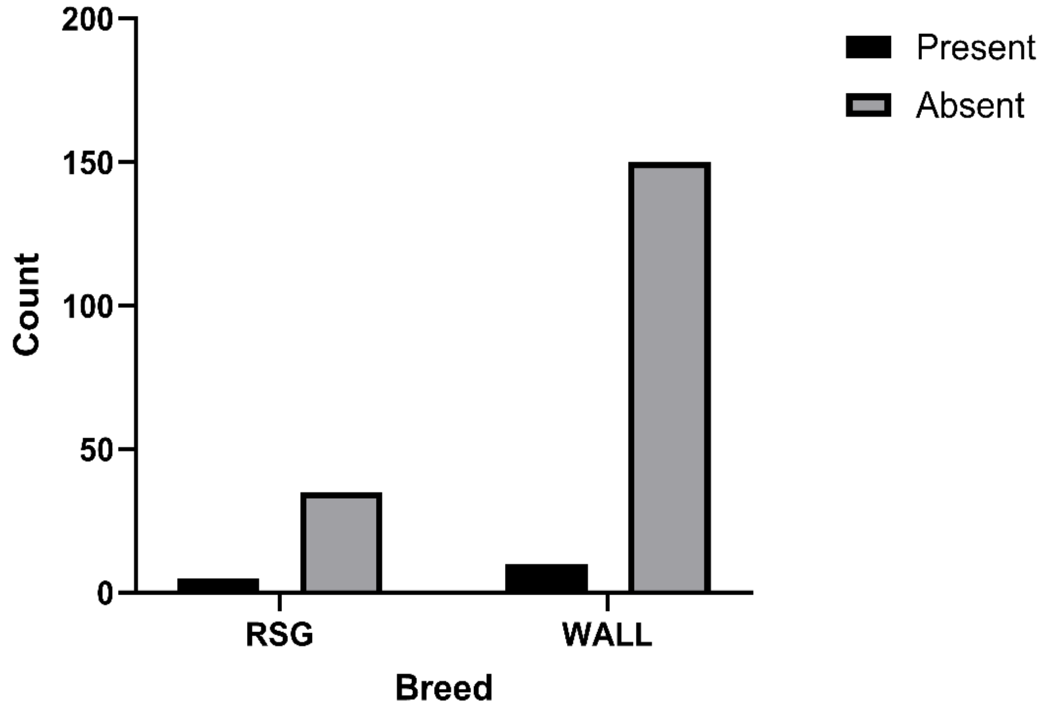

Figure 4.14: Cross-Tabulation for the Prevalence of *Paramphistomum* spp. Across Goat Breeds

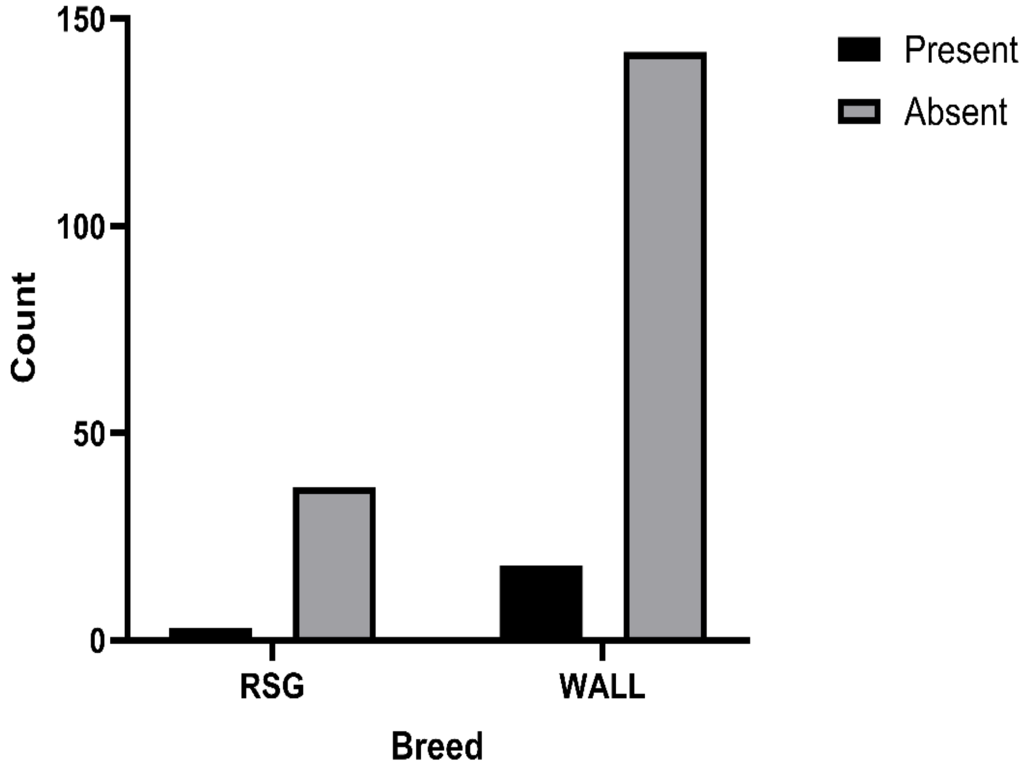

Figure 4.15: Cross-Tabulation for the Prevalence of *Taenia* spp. Across Goat Breeds

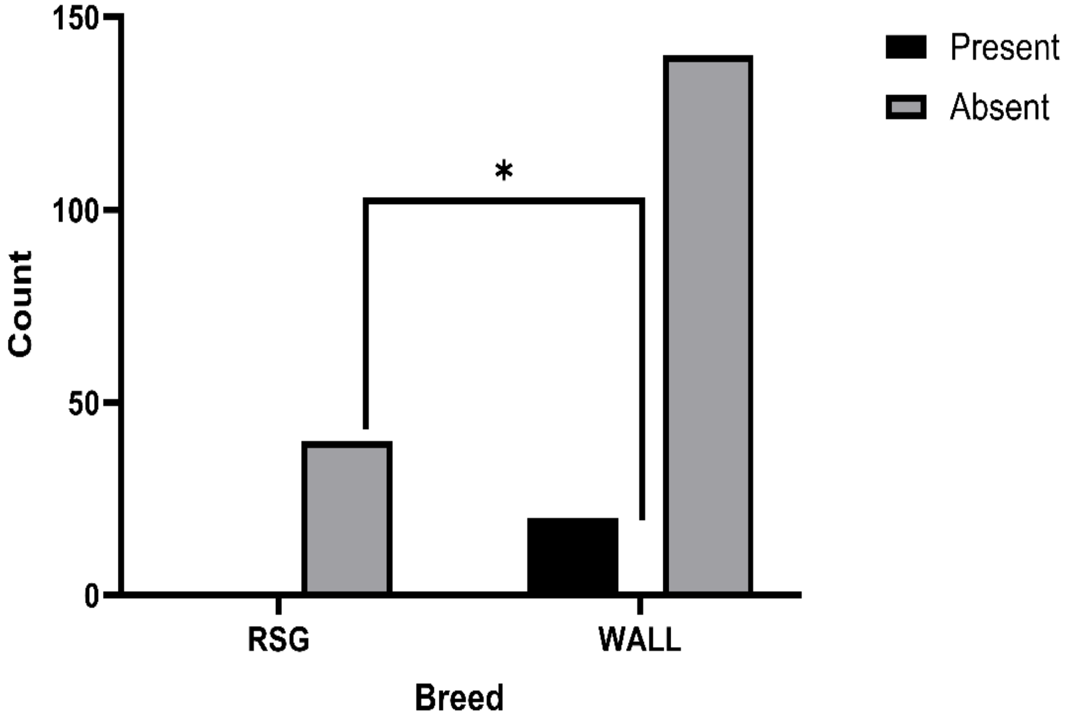

Figure 4.16: Cross-Tabulation for the Prevalence of *Trichuris* spp. Across Goat Breeds

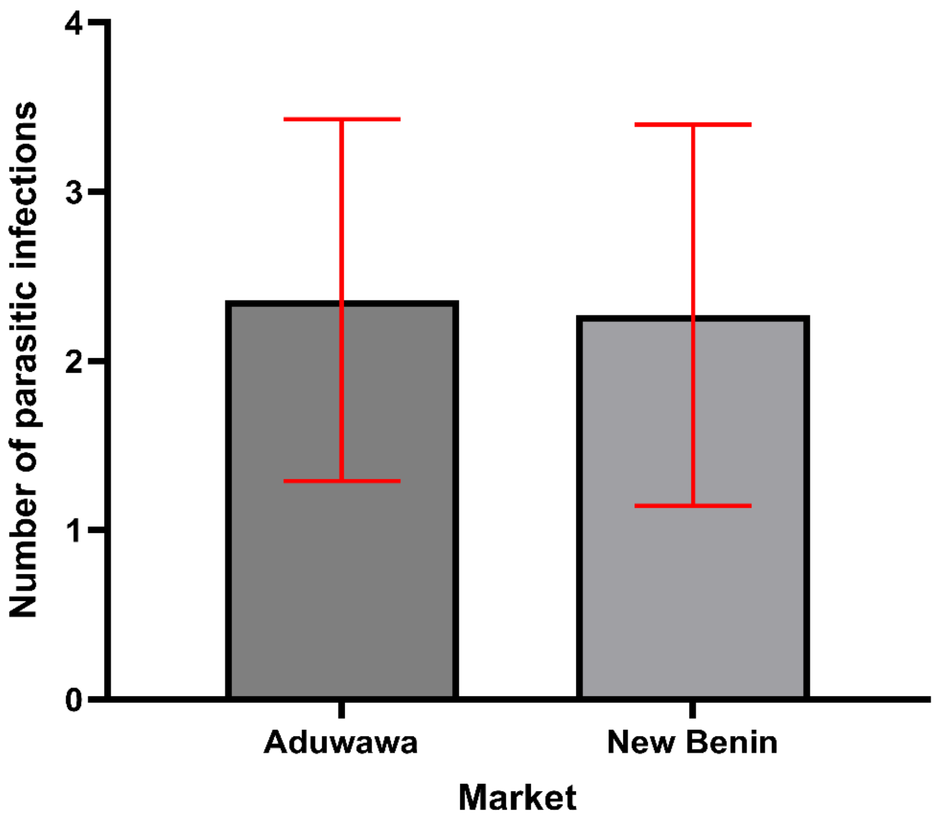

Figure 4.17: Independent t-Test for the Influence of Market Environment on Number of Parasitic Infections

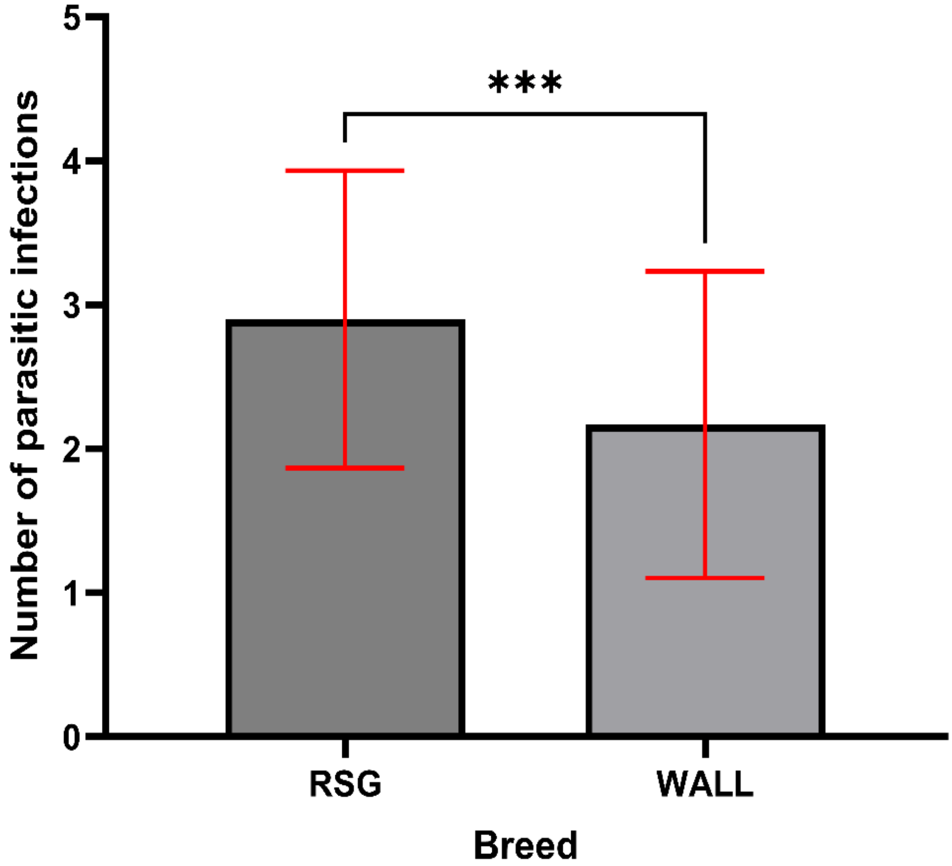

Figure 4.18: Independent t-Test for the Influence of Goat Breed on Number of Parasitic Infections

CHAPTER FIVE

5.0 DISCUSSION AND CONCLUSION

5.1 Discussion

The study indicates a high prevalence of gastrointestinal parasites in goats, with *Eimeria spp.* and *Haemonchus spp.* emerging as the most prominently detected parasites, accounting for 49.5% and 48.5%, respectively.Importantly, *Eimeria spp.* represents a protozoan parasite, whereas *Haemonchus spp*. and *Strongyloides papillosus* are helminths, showing that both protozoan and helminthic infections contribute significantly to the overall parasitic burden in goats. Comparatively, Previous studies have reported varying prevalence rates depending on geographical locations and climatic conditions. A systematic review of *Eimeria spp.* infections among goats in China Diao *et al*. (2022) indicated an infection prevalence range of 20-80% across various studies, underscoring the important observation of the prevalence variance associated with specific regions and management practices.

The prevalence rates observed in Aduwawa and New Benin abattoirs align with global estimates, suggesting high levels of gastrointestinal parasitism in goat populations, oscillating from 60% to over 90% depending on environmental factors and farming systems (Sharma *et al*., 2023). These findings illustrate the importance of localized studies as emphasized by previous research, indicating that interventions must rely on data specific to the regions they intend to serve. While this study provides essential prevalence data, corroborating regional studies that highlight trends in gastrointestinal parasitism among livestock can strengthen extrapolations regarding management practices and control measures across the agricultural landscape.

Significantly, parasitic infection prevalence differed notably across goat breeds. Red Sokoto goats showed a prevalence of 85.0% for *Strongyloides papillosus*, whereas West African Long-Legged goats exhibited a prevalence of 38.8% for the same parasite. This discrepancy supports findings from a systematic review that reported breed-specific variances in susceptibility to gastrointestinal parasites, suggesting that genetic factors play a crucial role in infection susceptibility (Ali *et al*., 2025). Notably, Ali *et al*. reported an overall prevalence of 62.9% for *Eimeria spp.*, further correlating the significant burden of these parasites in goat populations overall.

Moreover, statistical analysis showed a significant relationship between environmental factors and the occurrence of certain parasites. Specifically, *Strongyloides papillous* and *Haemonchus* spp. were strongly associated with environmental conditions. This agrees with previous studies (Wondimu and Bayu, 2022), which also reported that management practices and environmental factors significantly influence parasites prevalence in goats.

The study identified critical risk factors such as poor husbandry practices, which contribute to elevated parasitic loads in goat populations. This is consistent with prior observations from studies in rural areas observing similar patterns linked to inadequate management of livestock (Sharma *et al*., 2023). Previous studies emphasize that insufficient awareness about parasite management among farmers leads to increased susceptibility to infections, inhibiting their ability to mitigate losses effectively.

Goats serve as crucial income and food sources in the region, these findings significantly imply economic implications. Hassan *et al*. (2022) state that managing gastrointestinal parasites is increasingly linked to economic viability in livestock farming. The urgency to address these parasitic infections sustainably is critical for both animal health and the economic stability of farming communities.

5.2 Conclusion

The prevalence of gastrointestinal parasites among goats in Benin City, Edo State is a pressing concern that aligns with global trends observed in similar geographical contexts. The study's findings highlight significant statistical associations between environmental factors and the presence of various parasitic infections in goats, advocating for improved awareness and management practices among farmers. By addressing the identified gaps in knowledge and formulating strategic interventions, the potential for improving livestock health outcomes and enhancing agricultural productivity can be realized. Furthermore, reinforcing the connection between local research and agricultural policy enhances holistic agricultural planning, ensuring that livestock farmers in Benin City can contribute positively to the food security landscape.

5.3 Recommendations

1. Enhanced Farmer Education and Awareness

It is paramount to implement educational programs focused on best husbandry practices and the importance of regular deworming. This could mitigate infection rates. Extension services should be established to keep farmers informed about emerging trends and advancements in parasite control technologies.

2. Monitoring and Surveillance Programs

In light of the health issues stemming from prevalent parasites among goat populations, it is recommended to initiate ongoing monitoring and surveillance programs directed at identifying outbreak patterns and risk factors associated with significant parasitic infections. Future studies should continue to build on the data provided by the current research, establishing a robust database to inform policy and management decisions.

3. Research on Resistance Patterns

Considering the observed and reported cases of anthelmintic resistance, ongoing research should focus on resistance patterns of gastrointestinal parasites within local goat populations. Such data would serve as a valuable resource for tailored treatment and control interventions.

4. Collaborative Approaches

Strengthening collaborations between veterinary services and agricultural extension services can enhance comprehensive management strategies. Sharing local epidemiological data with wider networks can promote data-driven decisions in public health and veterinary medicine.

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APPENDICES

Appendix I: Pictures of Parasites Seen

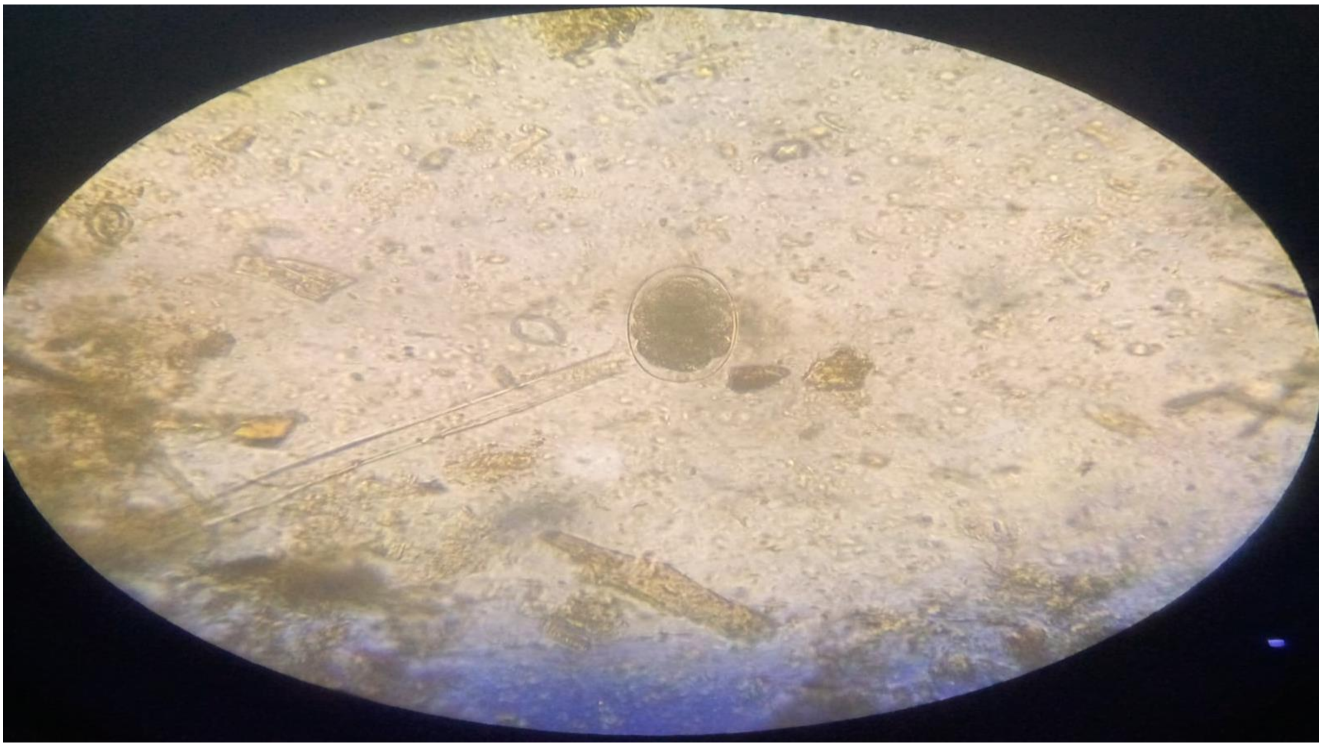

Plate I.1: Ova of *Trichostrongylus spp.*

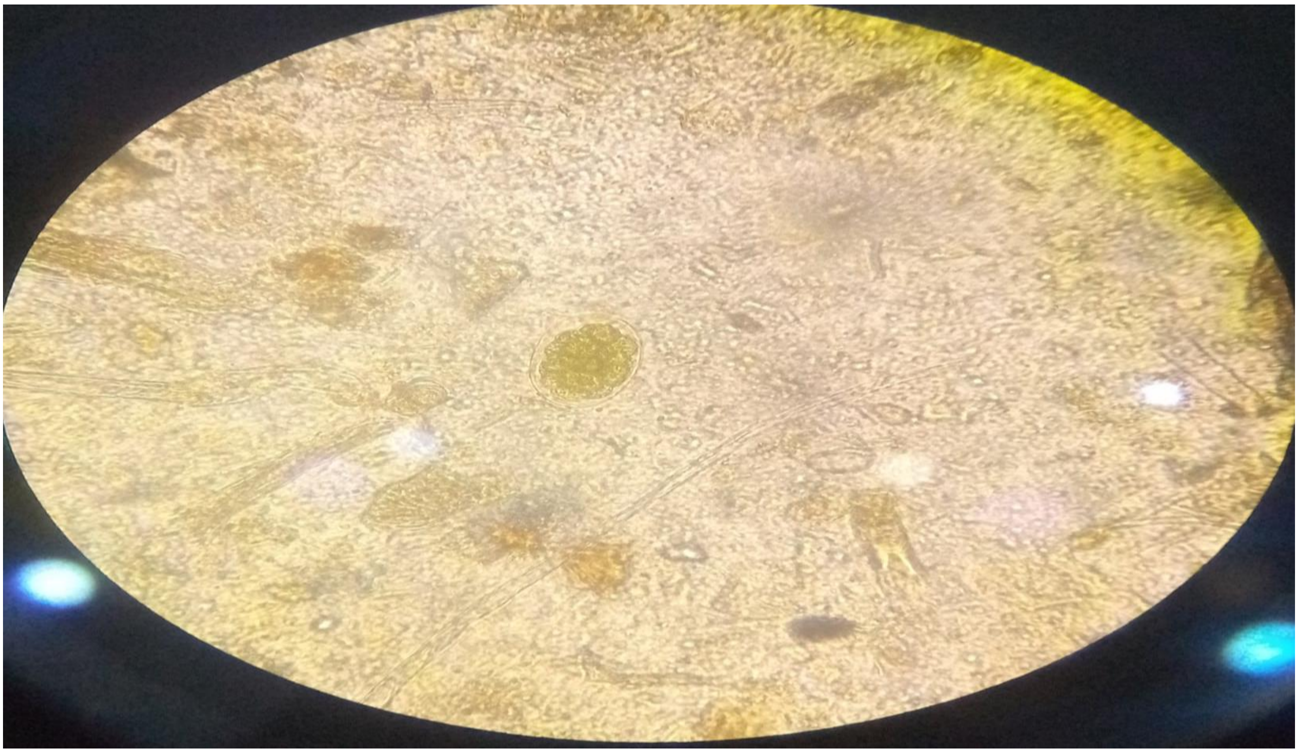

Plate I.2: Ova of *Haemonchus spp.*

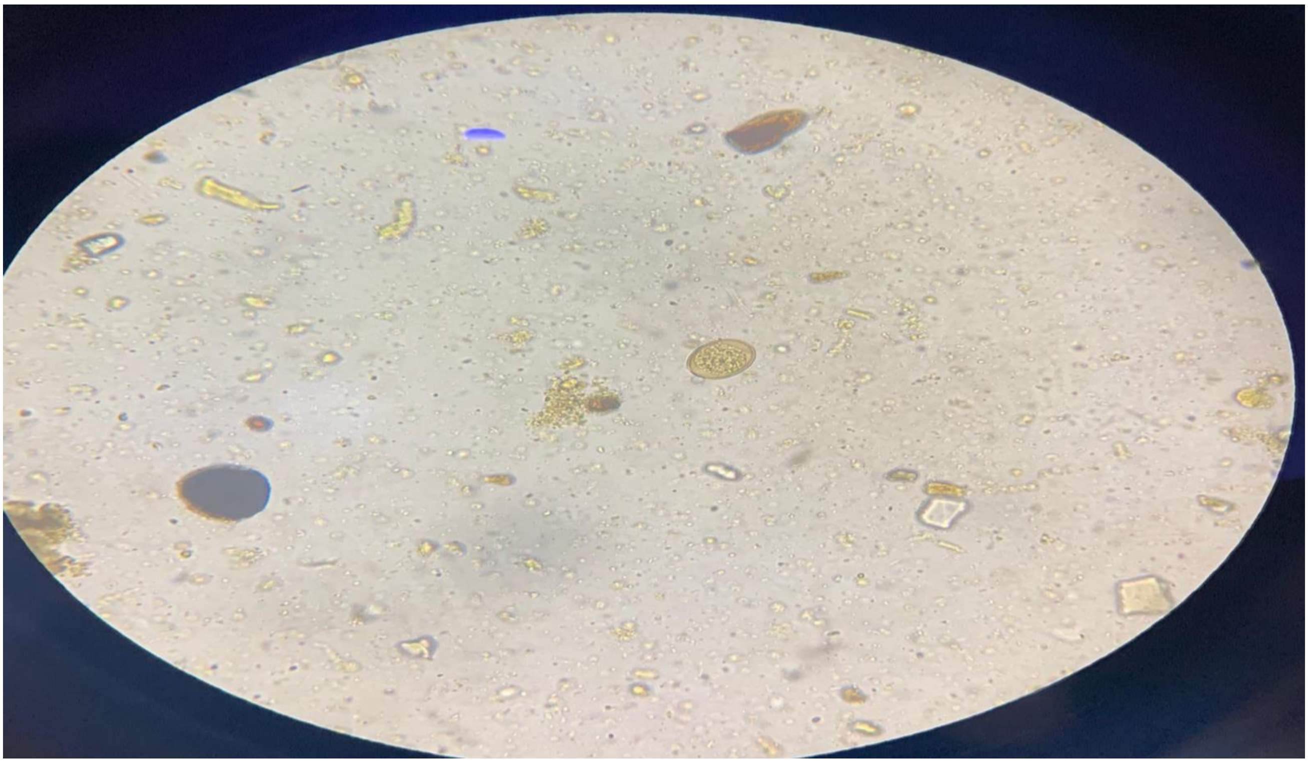

Plate I.3: Oocyst of *Eimeria* spp.

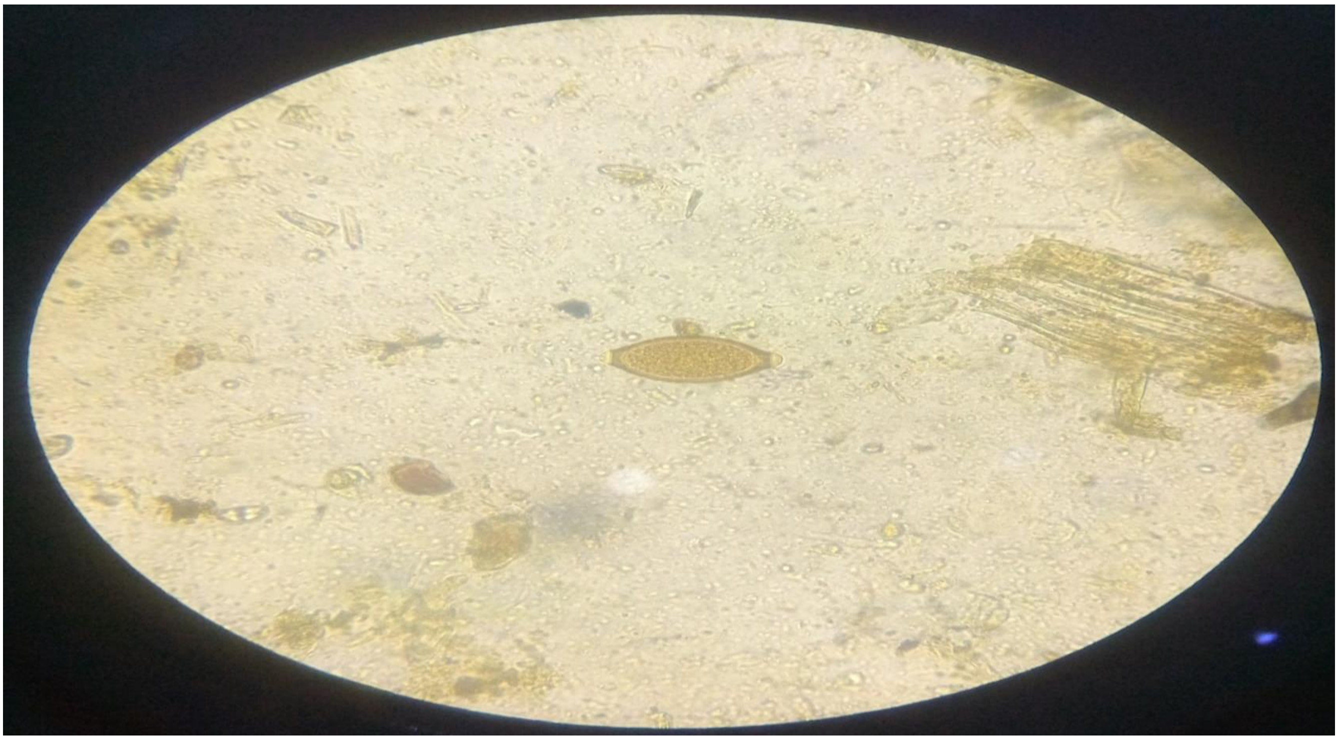

Plate I.4: Ova of *Trichuris* spp.

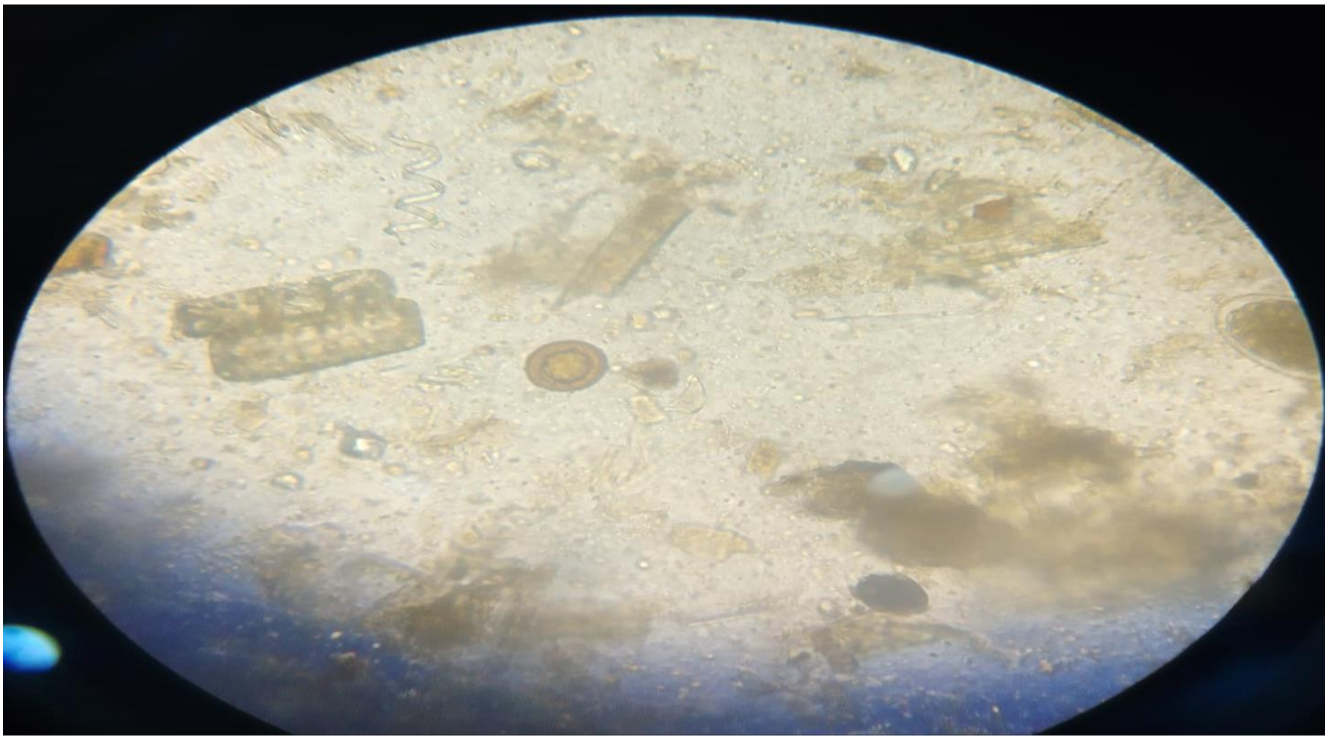

Plate I.5: Ova of *Taenia* spp.

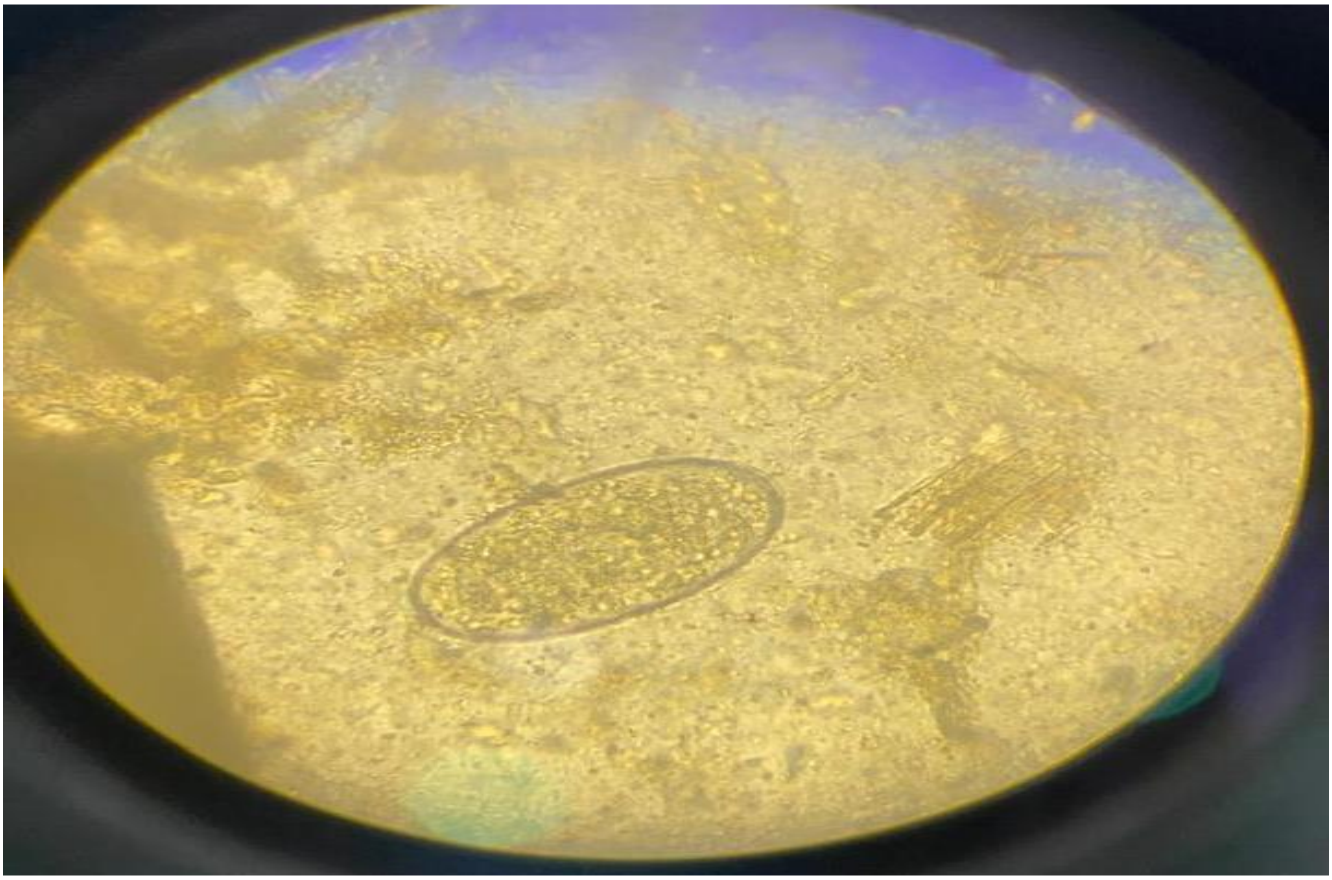

Plate I.6: Ova of *Paramphistomum* spp.

Plate I.7: Ova of *Strongyloides papilosus*

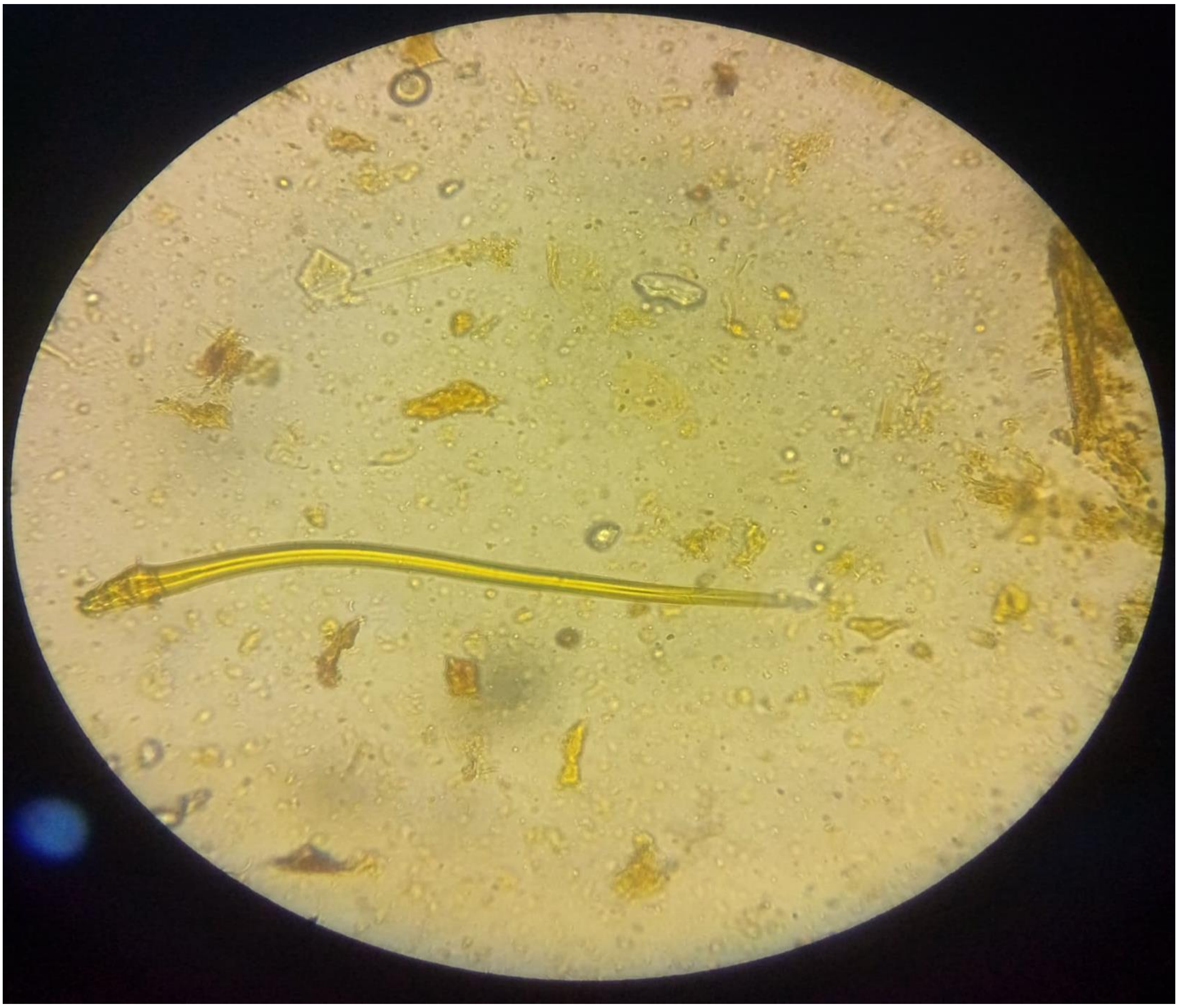

Plate I.8: Larva of *Strongyloides papilosus*

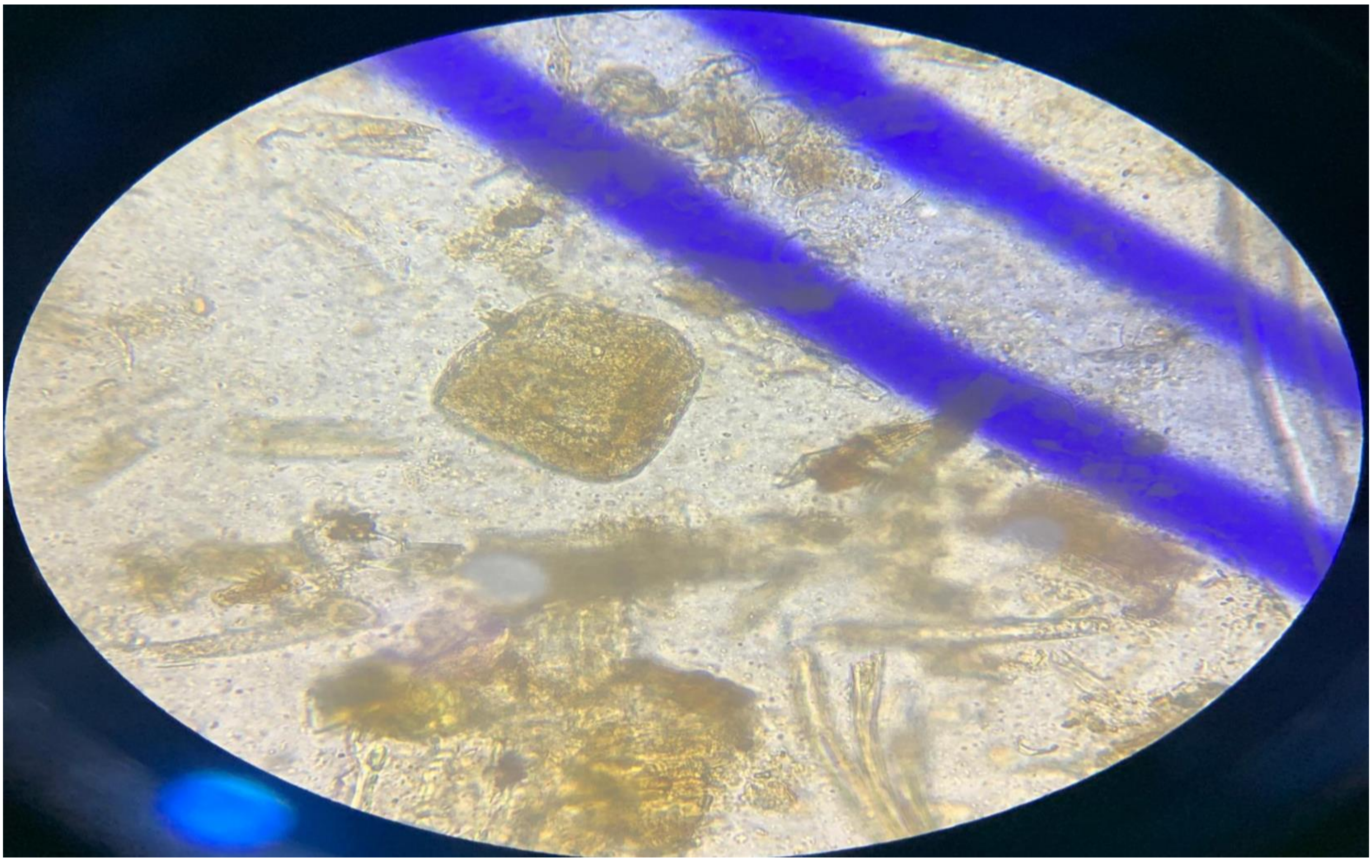

Plate I.9: Ova of *Moneizia* spp.

Appendix II: Student Working in the Laboratory

Appendix III: Raw Parasitology Data

Sample ID	Location	Breed	Parasite Seen	
1	ADUWAWA	RSG	*Strongyloides papillosus, Trichostrongylus spp..*	
2	ADUWAWA	WALL	*Strongyloides papillosus, Haemonchus spp.*	
3	ADUWAWA	WALL	*Strongyloides papillosus, Trichostrongylus spp., Haemonchus spp., Eimeria spp.*	
4	ADUWAWA	RSG	*Strongyloides papillosus, Trichostrongylus spp., Haemonchus spp., Eimeria spp.*	
5	ADUWAWA	WALL	*Strongyloides papillosus, Trichostrongylus spp., Haemonchus spp., Moniezia spp.*	
6	ADUWAWA	WALL	*Strongyloides papillosus, Haemonchus spp.*	
7	ADUWAWA	WALL	*Strongyloides papillosus, Taenia spp.*	
8	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp.*	
9	ADUWAWA	RSG	*Strongyloides papillosus, Eimeria spp., Taenia spp.*	
10	ADUWAWA	WALL	*Strongyloides papillosus, Trichostrongylus spp., Haemonchus spp.*	
11	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp., Eimeria spp., Trichuris spp.*	
12	ADUWAWA	WALL	*Strongyloides papillosus, Haemonchus spp., Eimeria spp.*	
13	ADUWAWA	RSG	*Eimeria spp.*	

14	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp., Eimeria spp.*	
15	ADUWAWA	WALL	*Haemonchus spp., Eimeria spp.*	
16	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp., Eimeria spp., Taenia spp.*	
17	ADUWAWA	RSG	*Strongyloides papillosus, Trichostrongylus spp., Haemonchus spp., Eimeria spp.*	
18	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp., Eimeria spp., Paramphistomum spp.*	
19	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp., Eimeria spp.*	
20	ADUWAWA	WALL	*Strongyloides papillosus, Trichostrongylus spp., Haemonchus spp., Eimeria spp., Trichuris spp.*	
21	ADUWAWA	RSG	*Strongyloides papillosus, Haemonchus spp., Eimeria spp.*	
22	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp., Eimeria spp., Taenia spp.*	
23	ADUWAWA	WALL	*Strongyloides papillosus, Haemonchus spp., Eimeria spp.*	
24	ADUWAWA	WALL	*Trichostrongylus spp., Eimeria spp., Moniezia spp., Paramphistomum spp.*	
25	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp., Eimeria spp.*	
26	ADUWAWA	WALL	*Strongyloides papillosus, Trichostrongylus spp., Haemonchus spp., Eimeria spp., Moniezia spp.*	
27	ADUWAWA	WALL	*Strongyloides papillosus, Eimeria spp.*	
28	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp., Taenia spp.*	
29	ADUWAWA	WALL	*Haemonchus spp., Eimeria spp.*	

30	ADUWAWA	WALL	*Strongyloides papillosus, Trichostrongylus spp., Haemonchus spp., Eimeria spp.*	
31	ADUWAWA	WALL	*Trichostrongylus spp., Eimeria spp.*	
32	ADUWAWA	WALL	*Strongyloides papillosus, Trichostrongylus spp., Moniezia spp., Taenia app.*	
33	ADUWAWA	WALL	*Strongyloides papillosus, Haemonchus spp.*	
34	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp., Trichuris spp.*	
35	ADUWAWA	WALL	*Strongyloides papillosus, Trichostrongylus spp., Haemonchus spp., Eimeria spp., Trichuris spp.*	
36	ADUWAWA	WALL	*Strongyloides papillosus, Haemonchus spp.*	
37	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp., Trichuris spp.*	
38	ADUWAWA	WALL	*Haemonchus spp.*	
39	ADUWAWA	WALL	*Haemonchus spp.*	
40	ADUWAWA	WALL	*Haemonchus spp., Moniezia spp., Trichuris spp.*	
41	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp., Trichuris spp.*	
42	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp., Eimeria spp.*	
43	ADUWAWA	WALL	*Trichostrongylus spp.*	
44	ADUWAWA	WALL	*Haemonchus spp.*	
45	ADUWAWA	WALL	*Eimeria spp.*	
46	ADUWAWA	WALL	*Strongyloides papillosus, Haemonchus spp.*	

47	ADUWAWA	WALL	*Eimeria spp.*	
48	ADUWAWA	WALL	*Strongyloides papillosus, Trichostrongylus spp.*	
49	ADUWAWA	WALL	*Strongyloides papillosus*	
50	ADUWAWA	WALL	*Strongyloides papillosus, Haemonchus spp.*	
51	ADUWAWA	WALL	*Eimeria spp.*	
52	ADUWAWA	RSG	*Strongyloides papillosus, Haemonchus spp.*	
53	ADUWAWA	WALL	*Trichostrongylus spp., Paramphistomum spp*	
54	ADUWAWA	WALL	*Haemonchus spp., Eimeria spp.*	
55	ADUWAWA	WALL	*Trichostrongylus spp.*	
56	ADUWAWA	WALL	*Strongyloides papillosus, Taenia spp.*	
57	ADUWAWA	RSG	*Strongyloides papillosus, Eimeria spp.*	
58	ADUWAWA	WALL	*Eimeria spp.*	
59	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp., Trichuris spp.*	
60	ADUWAWA	WALL	*Taenia spp., Trichuris spp.*	
61	ADUWAWA	WALL	*Trichostrongylus spp., Eimeria spp., Moniezia spp., Paramphistomum spp*	
62	ADUWAWA	RSG	*Strongyloides papillosus, Trichostrongylus spp., Haemonchus spp., Paramphistomum spp*	
63	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp.*	
64	ADUWAWA	WALL	*Eimeria spp.*	

65	ADUWAWA	RSG	*Strongyloides papillosus, Eimeria spp.*	
66	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp.*	
67	ADUWAWA	RSG	*Strongyloides papillosus, Paramphistomum spp*	
68	ADUWAWA	WALL	*Haemonchus spp.*	
69	ADUWAWA	WALL	*Eimeria spp., Taenia spp.*	
70	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp.*	
71	ADUWAWA	WALL	*Eimeria spp.*	
72	ADUWAWA	RSG	*Strongyloides papillosus*	
73	ADUWAWA	WALL	*Trichostrongylus spp., Eimeria spp.*	
74	ADUWAWA	WALL	*Eimeria spp., Trichuris spp.*	
75	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp.*	
76	ADUWAWA	WALL	*Haemonchus spp.*	
77	ADUWAWA	RSG	*Strongyloides papillosus, Trichostrongylus spp., Eimeria spp.*	
78	ADUWAWA	WALL	*Paramphistomum spp, Haemonchus spp.,*	
79	ADUWAWA	RSG	*Strongyloides papillosus, Moniezia spp.*	
80	ADUWAWA	RSG	*Strongyloides papillosus, Taenia spp.*	
81	ADUWAWA	WALL	*Trichostrongylus spp.*	

82	ADUWAWA	WALL	*Haemonchus spp., Eimeria spp.*	
83	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp., Taenia spp.*	
84	ADUWAWA	RSG	*Haemonchus spp., Eimeria spp.*	
85	ADUWAWA	WALL	*Strongyloides papillosus, Haemonchus spp., Eimeria spp.*	
86	ADUWAWA	WALL	*Haemonchus spp., Eimeria spp.*	
87	ADUWAWA	RSG	*Eimeria spp.*	
88	ADUWAWA	WALL	*Haemonchus spp., Trichuris spp.*	
89	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp.*	
90	ADUWAWA	RSG	*Strongyloides papillosus, Eimeria spp.*	
91	ADUWAWA	RSG	*Strongyloides papillosus, Trichostrongylus spp., Haemonchus spp., Paramphistomum spp*	
92	ADUWAWA	WALL	*Taenia spp.*	
93	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp.*	
94	ADUWAWA	WALL	*Haemonchus spp.*	
95	ADUWAWA	WALL	*Trichostrongylus spp., Haemonchus spp.*	
96	ADUWAWA	RSG	*Strongyloides papillosus, Trichostrongylus spp., Haemonchus spp., Paramphistomum spp*	
97	ADUWAWA	WALL	*Haemonchus spp., Eimeria spp.*	
98	ADUWAWA	WALL	*Strongyloides papillosus*	
99	ADUWAWA	WALL	*Trichostrongylus spp., Moniezia spp.*	

100	ADUWAWA	WALL	*Haemonchus spp., Trichuris spp.*	
Sample ID	**Location**	**Breed**	**Parasite Seen**	
1	NEW BENIN	WALL	*Strongyloides papillosus, Trichostrongylus spp., Haemonchus spp., Paramphistomum spp*	
2	NEW BENIN	WALL	*Trichostrongylus spp.*	
3	NEW BENIN	WALL	*Trichostrongylus spp.*	
4	NEW BENIN	WALL	*Eimeria spp.*	
5	NEW BENIN	WALL	*Strongyloides papillosus, Eimeria spp., Trichostrongylus spp., Haemonchus spp., Trichuris spp.*	
6	NEW BENIN	WALL	*Trichostrongylus spp., Eimeria spp., Strongyloides papillosus*	
7	NEW BENIN	WALL	*Trichostrongylus spp., Eimeria spp., Haemonchus spp.*	
8	NEW BENIN	WALL	*Trichostrongylus spp.*	
9	NEW BENIN	WALL	*Strongyloides papillosus, Eimeria spp., Haemonchus spp., Trichostrongylus spp.*	
10	NEW BENIN	WALL	*Moniezia spp.*	
11	NEW BENIN	WALL	*Taenia spp.*	
12	NEW BENIN	WALL	*Strongyloides papillosus, Eimeria spp., Trichostrongylus spp.*	

13	NEW BENIN	WALL	*Strongyloides papillosus, Eimeria spp., Haemonchus spp., Trichostrongylus spp. Taenia spp.*	
14	NEW BENIN	WALL	*Strongyloides papillosus, Haemonchus spp., Trichostrongylus spp.*	
15	NEW BENIN	WALL	*Trichostrongylus spp., Eimeria spp. Taenia spp.*	
16	NEW BENIN	WALL	*Eimeria spp., Taenia spp.*	
17	NEW BENIN	WALL	*Strongyloides papillosus, Trichostrongylus spp., Eimeria spp. Trichuris spp., Haemonchus spp.*	
18	NEW BENIN	RSG	*Strongyloides papillosus, Eimeria spp., Moniezia spp.*	
19	NEW BENIN	RSG	*Strongyloides papillosus, Eimeria spp., Moniezia spp.*	
20	NEW BENIN	WALL	*Strongyloides papillosus, Eimeria spp.*	
21	NEW BENIN	RSG	*Trichostrongylus spp., Haemonchus spp.*	
22	NEW BENIN	WALL	*Strongyloides papillosus, Haemonchus spp., Trichostrongylus spp.*	
23	NEW BENIN	WALL	*Strongyloides papillosus, Moniezia spp., Eimeria spp., Haemonchus spp.*	
24	NEW BENIN	RSG	*Strongyloides papillosus, Haemonchus spp., Trichostrongylus spp., Eimeria spp.*	
25	NEW BENIN	WALL	*Strongyloides papillosus, Eimeria spp.*	
26	NEW BENIN	WALL	*Strongyloides papillosus Eimeria spp., Trichostrongylus spp.*	
27	NEW BENIN	WALL	*Strongyloides papillosus, Eimeria spp.*	
28	NEW BENIN	WALL	*Strongyloides papillosus, Moniezia spp.*	
29	NEW BENIN	WALL	*Strongyloides papillosus, Moniezia spp.*	

30	NEW BENIN	WALL	*Strongyloides papillosus, Eimeria spp.*	
31	NEW BENIN	WALL	*Strongyloides papillosus, Haemonchus spp., Moniezia spp.*	
32	NEW BENIN	RSG	*Strongyloides papillosus, Moniezia spp., Haemonchus spp., Eimeria spp.*	
33	NEW BENIN	WALL	*Trichostrongylus spp.*	
34	NEW BENIN	RSG	*Strongyloides papillosus, Trichostrongylus spp., Haemonchus spp., Eimeria spp.*	
35	NEW BENIN	WALL	*Strongyloides papillosus, Eimeria spp.*	
36	NEW BENIN	WALL	*Strongyloides papillosus*	
37	NEW BENIN	RSG	*Strongyloides papillosus, Paramphistomum spp, Eimeria spp., Haemonchus spp.*	
38	NEW BENIN	WALL	*Strongyloides papillosus, Haemonchus spp., Eimeria spp.*	
39	NEW BENIN	WALL	*Haemonchus spp., Eimeria spp., Paramphistomum spp*	
40	NEW BENIN	RSG	*Strongyloides papillosus, Moniezia spp., Trichostrongylus spp., Eimeria spp., Haemonchus spp.*	
41	NEW BENIN	RSG	*Strongyloides papillosus Trichostrongylus spp., Haemonchus spp., Eimeria spp.*	
42	NEW BENIN	RSG	*Strongyloides papillosus, Eimeria spp., Trichostrongylus spp.*	
43	NEW BENIN	RSG	*Strongyloides papillosus, Haemonchus spp., Taenia spp.*	
44	NEW BENIN	RSG	*Strongyloides papillosus Trichostrongylus spp., Eimeria spp.*	

45	NEW BENIN	RSG	*Strongyloides papillosus, Moniezia spp., Trichostrongylus spp., Eimeria spp.*	
46	NEW BENIN	RSG	*Moniezia spp., Haemonchus spp., Trichostrongylus spp., Eimeria spp.*	
47	NEW BENIN	RSG	*Moniezia spp., Eimeria spp., Trichostrongylus spp., Haemonchus spp.*	
48	NEW BENIN	RSG	*Strongyloides papillosus, Moniezia spp.*	
49	NEW BENIN	WALL	*Strongyloides papillosus, Eimeria spp.*	
50	NEW BENIN	WALL	*Strongyloides papillosus, Eimeria spp., Trichuris spp., Haemonchus spp.*	
51	NEW BENIN	WALL	*Strongyloides papillosus, Eimeria spp.*	
52	NEW BENIN	WALL	*Eimeria spp.*	
53	NEW BENIN	WALL	*Strongyloides papillosus*	
54	NEW BENIN	WALL	*Trichostrongylus spp.*	
55	NEW BENIN	WALL	*Haemonchus spp., Trichostrongylus spp.*	
56	NEW BENIN	WALL	*Trichostrongylus spp., Eimeria spp.*	
57	NEW BENIN	RSG	*Trichostrongylus spp., Eimeria spp., Strongyloides papillosus*	
58	NEW BENIN	WALL	*Haemonchus spp.*	
59	NEW BENIN	WALL	*Eimeria spp.*	
60	NEW BENIN	WALL	*Strongyloides papillosus, Eimeria spp.*	

61	NEW BENIN	WALL	*Eimeria spp.*	
62	NEW BENIN	WALL	*Trichostrongylus spp.*	
63	NEW BENIN	WALL	*Strongyloides papillosus, Paramphistomum spp*	
64	NEW BENIN	WALL	*Taenia spp.*	
65	NEW BENIN	WALL	*Trichostrongylus spp., Haemonchus spp.,*	
66	NEW BENIN	WALL	*Strongyloides papillosus, Eimeria spp.*	
67	NEW BENIN	WALL	*Trichostrongylus spp.*	
68	NEW BENIN	WALL	*Trichostrongylus spp., Haemonchus spp.*	
69	NEW BENIN	WALL	*Eimeria spp.*	
70	NEW BENIN	RSG	*Strongyloides papillosus, Moniezia spp.*	
71	NEW BENIN	WALL	*Paramphistomum spp.*	
72	NEW BENIN	WALL	*Trichuris spp. Trichostrongylus spp.*	
73	NEW BENIN	WALL	*Trichuris spp.*	
74	NEW BENIN	WALL	*Strongyloides papillosus*	
75	NEW BENIN	WALL	*Eimeria spp., Haemonchus spp.*	
76	NEW BENIN	WALL	*Trichostrongylus spp., Taenia spp.*	
77	NEW BENIN	RSG	*Strongyloides papillosus, Trichostrongylus spp., Moniezia spp.*	
78	NEW BENIN	WALL	*Strongyloides papillosus, Taenia spp.*	
79	NEW BENIN	WALL	*Haemonchus spp., Eimeria spp.*	

80	NEW BENIN	WALL	*Trichuris spp., Eimeria spp.*	
81	NEW BENIN	WALL	*Strongyloides papillosus, Trichostrongylus spp., Eimeria spp., Haemonchus spp.*	
82	NEW BENIN	WALL	*Strongyloides papillosus*	
83	NEW BENIN	WALL	*Moniezia spp.*	
84	NEW BENIN	WALL	*Trichostrongylus spp., Eimeria spp.*	
85	NEW BENIN	WALL	*Haemonchus spp.*	
86	NEW BENIN	RSG	*Strongyloides papillosus, Eimeria spp.*	
87	NEW BENIN	WALL	*Haemonchus spp., Paramphistomum spp.*	
88	NEW BENIN	WALL	*Trichostrongylus spp., Taenia spp.*	
89	NEW BENIN	WALL	*Strongyloides papillosus*	
90	NEW BENIN	WALL	*Trichuris spp., Haemonchus spp.*	
91	NEW BENIN	WALL	*Strongyloides papillosus*	
92	NEW BENIN	WALL	*Eimeria spp.*	
93	NEW BENIN	WALL	*Trichostrongylus spp., Haemonchus spp.*	
94	NEW BENIN	WALL	*Strongyloides papillosus, Trichostrongylus spp.*	
95	NEW BENIN	WALL	*Eimeria spp.*	
96	NEW BENIN	WALL	*Haemonchus spp.,Trichuris spp.*	
97	NEW BENIN	WALL	*Strongyloides papillosus, Moniezia spp.*	
98	NEW BENIN	WALL	*Strongyloides papillosus, Eimeria spp.*	

99	NEW BENIN	WALL	*Trichostrongylus spp., Strongyloides papillosus*	
100	NEW BENIN	WALL	*Eimeria spp., Strongyloides papillosus*	

Appendix IV: Ethical Approval Letter

EDO STATE MINISTRY OF HEALTH
HEALTH RESEARCH ETHICS COMMITTEE

PROTOCOL NUMBER	HA/737/25/D/07180811 (PLEASE QUOTE IN ALL ENQUIRIES)
APPROVAL NUMBER	HA/737/25/D/09180811
TITLE OF RESEARCH PROPOSAL	PREVALENCE OF GASTROINTESTINAL PARASITES IN GOATS AT SELECTED ABATTOIRS IN BENIN CITY, EDO STATE
PRINCIPAL INVESTIGATOR (S)	IYOHA VERA OSAHENRUMWEN
DATE CONSIDERED	18TH SEPTEMBER, 2025.
DECISION OF THE COMMITTEE	APPROVED

THIS APPROVAL DATES 18/09/2025 TO 18/09/2026. IF THERE IS A DELAY IN STARTING THE RESEARCH, PLEASE INFORM THE HREC EDO SMoH SO THAT THE DATES OF APPROVAL CAN BE ADJUSTED ACCORDINGLY

REMARK: Please kindly note that the HREC Edo SMoH seal authenticates this approval

DR (MRS) Omonyemen B. BELLO
(MBBS, MPH, FPHCM) *(CHAIRMAN)* **SIGNATURE & DATE** 29/9/2025

SUPERVISOR(S) ....

ATTESTATION BY INVESTIGATOR(S)

No participant accrual or activity related to this research may be conducted outside of the approval dates. All informed consent forms used in this study must carry the Edo SMoH HREC-assigned number and duration of your research. No changes are permitted in the research without prior approval of the Edo SMoH HREC except in circumstances outlined in the Code. The Edo SMoH HREC reserves the right to conduct compliance visits to your research site without previous notification.

Signature & Date..........

Original copy collected

edohrec@edostate.gov.ng   Room 16, Block D, 2nd floor, State secretariat building.