

**AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND  
ENTREPRENEURIAL**

**ASSESSING THE ANTHELMINTIC EFFICACY OF PAPAYA SEEDS AND  
MORINGA LEAVES IN SHEEP AT TECHIMAN DISEASE INVESTIGATION  
FARM: A CASE STUDY**

**BY:**

**DWAAH PRINCE KYERE**

**2025**

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**BY:**

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**A thesis submitted to the Department of Public Health Education of the Faculty of  
Environment and Health Education, Akenten Appiah-Menka University of Skills  
Training and Entrepreneurial Development, in partial fulfilment of the  
requirements for the award of a Master of Philosophy degree in Public Health.**

**MAY, 2025**

**DECLARATION**

I hereby declare that this thesis, except for quotations and references contained in published works, which have been duly acknowledged, is the result of my own original work and that no part of it has been presented for another degree at this university or elsewhere

Candidate's Name: **DWAAH PRINCE KYERE**

Signature: ..... Date: .....

**Supervisor(s)' Declaration**

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development.

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Signature: ..... Date: .....

## ABSTRACT

Intestinal helminths, including *Haemonchus contortus* and *Moniezia spp.*, pose significant health and economic challenges in livestock farming, particularly with the rise of anthelmintic resistance. This study, therefore, assessed the anthelmintic efficacy of papaya seeds (*Carica papaya*) and moringa leaves (*Moringa oleifera*) in controlling intestinal nematodes in sheep, focusing on their effectiveness as alternatives to conventional dewormers. This study also assessed the effect of these treatments on weight gain and faecal consistency in sheep. A randomized controlled trial was conducted with 33 sheep divided into four groups: untreated control (distilled water), papaya seed treatment, moringa leaf treatment, and conventional dewormer. Faecal samples and weight measurements were taken pre- and post-treatment. The McMaster technique was used to determine the worm load, which is faecal egg counts (FEC), and the Faecal Egg Count Reduction Test (FECRT) was performed to evaluate how effective the treatments were. The association between the treatments and faecal consistency and growth rate was likewise determined by statistical analysis. Key findings revealed that papaya seeds and moringa leaves significantly reduced the FEC by up to 82% and 92%, respectively, for *Moniezia spp.*, and 51% and 61% for *Haemonchus spp.* Moringa leaves demonstrated greater efficacy against *Moniezia spp.* compared to papaya seeds and conventional dewormer. Weight gain and improved faecal consistency were observed in treated groups, highlighting the dual benefits of parasite control and enhanced nutrition. The study concludes that papaya seeds and moringa leaves are cost-effective and sustainable alternatives for managing intestinal helminths in sheep, addressing challenges of anthelmintic resistance. Further research is recommended to optimize dosages and assess long-term effects. **Keywords: Anthelmintics, Papaya Seeds, Moringa Leaves, Sheep, Intestinal Helminths, Faecal Egg Count**

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Thank you all for your support and belief in this work.

## **DEDICATION**

This work is dedicated first and foremost to Almighty God, whose divine guidance, strength, and grace have sustained me throughout this academic journey. Without Him, none of this would have been possible.

To my dear wife, Dorothy Momo Laryea, your unwavering love, support, and sacrifices have been a constant source of encouragement. Your faith in me kept me going, even in the most challenging times.

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"Quitting was never an option. "May this accomplishment be a testament to the power of faith, love, and perseverance.

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## ACRONYMS AND ABBREVIATIONS

<b>AAMUSTED</b>	Akenten Appiah-Menka University of Skills Training Entrepreneurial Development
<b>AMR</b>	Antimicrobial Resistance
<b>APD</b>	Animal Production Department
<b>CHRPE</b>	Ethics Committee on Human Research Publication and Ethics
<b>DIF</b>	Disease Investigation Farm
<b>EPG</b>	Egg per Gram
<b>FAO</b>	Food and Agriculture Organization
<b>FEC</b>	Faecal Egg Count
<b>FECR</b>	Faecal Egg Count Reduction
<b>FECRT</b>	Faecal Egg Count Reduction Test
<b>Fig</b>	Figure
<b>GSS:</b>	Ghana Statistical Services
<b>H<sub>0</sub></b>	Null Hypothesis
<b>H<sub>1</sub></b>	Alternative Hypothesis
<b>IACUC</b>	Institutional Animal Care and Use Committee
<b>MVC</b>	Metropolitan Veterinary Clinic
<b>RVL</b>	Regional Veterinary Laboratory
<b>SDG</b>	Sustainable Development Goals
<b>SOPs</b>	Standard Operating Procedures
<b>Tab</b>	Table
<b>UNEP</b>	United Nations Environment Programme
<b>VSD</b>	Veterinary Service Department/Directorate
<b>WHO</b>	World Health Organization
<b>WAAVP</b>	World Association for the Advancement of Veterinary Parasitology
<b>WOAH</b>	World Organization of Animal Health

## DEFINITIONS AND EXAMPLES OF TERMS

- 1. Anthelmintics:** Anthelmintics are natural remedies used to treat infections caused by parasitic worms by either killing them (vermicides) or expelling them from the host's body.  
Example: Albendazole is a common synthetic anthelmintic.
- 2. Antimicrobial:** Antimicrobials are drugs used to kill or prevent the growth of microorganisms. Example: Anthelmintics like Albendazole target worms.
- 3. Antimicrobial Resistance (AMR):** AMR is when microorganisms build resistance to antimicrobial drugs, making treatments ineffective. Example: *Haemonchus contortus* (a gastrointestinal nematode in sheep) has developed resistance to commonly used anthelmintics like ivermectin and benzimidazoles.
- 4. Disease:** Is the abnormal functioning of an organism. Example: Ascariasis, caused by the roundworm *Ascaris lumbricoides*.
- 5. Ecto-parasites:** They are organisms that live on the skin of the host. eg ticks, lice, fleas
- 6. Endo-parasites:** They are organisms that live in the internal organs or tissues of the host. eg tapeworm, flukes, *Ascaris* (roundworm) and the rest.
- 7. Helminth:** Helminths are parasitic worms that infect the body of hosts, including humans and animals, affecting their health and productivity. Examples: Roundworms (*Ascaris lumbricoides*), tapeworms (*Taenia solium*), and flukes (*Fasciola hepatica*).
- 8. Helminthiasis:** Helminthiasis refers to infections caused by helminths, leading to symptoms such as anaemia, malnutrition, and organ damage. Example: Hookworm infection in humans, causing iron deficiency anaemia.

- 9. Intestinal Helminths:** Intestinal helminths are parasitic worms that specifically inhabit the gastrointestinal tract of their hosts. Example: *Haemonchus contortus* and *Moniezia spp.* infect the intestines of sheep.
- 10. Investigation:** It refers to systematically studying or examining a subject or problem to discover facts or obtain data. Example: Conducting a study on the efficacy of papaya seeds as an anthelmintic involves laboratory and field investigations.
- 11. Microbial:** Relating to microorganisms, such as bacteria, fungi, viruses, and protozoa. Example: *Salmonella* are found in the gut to enable digestion, but may be pathogenic.
- 12. Resistance:** Resistance is the ability of a pathogen to survive or thrive despite exposure to a drug or treatment designed to kill or inhibit it. Example: Drug resistance in *Haemonchus contortus* against ivermectin is a growing concern in livestock farming.
- 13. Veterinary:** A surgeon concerned with diseases of animals and domestic animals.



**December 30, 2024**

**Our Ref: AAMUSTED/IERC/2024/031**

**Mr Dwaah Prince Kyere**

Department of Public Health Education

Asante-Mampong

Dear Mr. Kyere

**LETTER OF APPROVAL**

**Protocol Title: Assessing the anthelmintic efficacy of papaya seeds and moringa leaves in sheep at the Disease Investigation Farm**

Your submission to the AAMUSTED Institutional Ethics and Research Committee on the above-named personnel refers. The Committee reviewed the following documents:

- An Application Letter dated 4<sup>th</sup> December, 2024 from Mr. Dwaah Prince Kyere
- A completed AAMUSTED-IERC Application Form for ethical clearance of a new proposal
- Informed Consent Form
- A completed Checklist
- Research Instruments
- Abridged CV of Investigators

The Committee has considered the ethical merit of your submission and approved the protocol. The approval begins on 20<sup>th</sup> December, 2024. The Committee may, however, suspend or withdraw ethical approval at any time if your research is found to contravene the approval protocol.

Data gathered for the research should be used for the approved purpose only. Permission should be sought from the Committee if any amendment to the protocol or use, other than submitted, is made to your research data.

The Committee should be notified of the actual start date of the project and would expect a report of your research, annually or at the close of the project, whichever one comes first. It should also be informed of any publication arising from the research.

**Thank you.**

**Prof. Humphrey Danso (PhD)**

Chairman, Institutional Ethical Review Committee

## CHAPTER ONE

### INTRODUCTION

#### 1.1 Background of the study

Globally, the production of sheep and their health are seriously threatened by parasitic diseases, particularly gastrointestinal parasites (Salem et al., 2020; Santos et al., 2019), with anthelmintic drug resistance emerging as a major challenge (Ng'etich, 2023; Chimbwali, 2022; Jamil et al., 2022; Olounladé et al., 2021; Idris et al., 2019). According to Jamil et al. (2022), "the decrease in medication efficacy and its corresponding factor of high financial losses for farmers is critical". In 2023, the World Health Organization (WHO) included antimicrobials (anthelmintics) among the first ten threats to global well-being. Drug resistance poses a threat to the health and welfare of living things and their environment, economic development and social security (Van Hamelsveld, 2022).

In Africa, raising ruminants is an essential source of revenue for most individuals in rural areas (Chimbwali, 2022; Adegbeye et al., 2020) and ensures food security (Adesola et al., 2019). Julienne et al. (2021) reported that parasitic diseases adversely affect sheep production. According to Lakshmi et al. (2022), Hartady et al. (2021), Kumari et al. (2021), and Idris et al. (2019), numerous parasites that harm livestock, cause major economic losses, and hinder agricultural development are widespread across the continent (Krueger, 1979). Controlling parasites in ruminant husbandry has become increasingly difficult, as the Food and Agriculture Organization (FAO, 2020) reports rising anthelmintic resistance in several African countries.

Sheep farming has been an essential component of Ghana's agricultural landscape, supporting the nation's economy and providing many rural populations with a means of

subsistence (Asante-Kwatia et al.,2021). However, according to the 2023 annual report from the Ghana Veterinary Service Directorate (VSD), endoparasites affecting the intestines, like *Haemonchus contortus* (*H. contortus*) and *Moniezia* spp., have significantly challenged sheep production in Ghana. The observation is due to the resistance of anthelmintics in Ghana, which underscores the need to find alternative approaches to controlling intestinal endoparasites, according to VSD, 2023.

Plants have served as a source of food and medication and are gaining attention due to their efficiency and sustainability (Asunción et al., 2022; El-Ghany, 2020; Saif et al., 2019; April 2018). In recent years, the use of herbal medicines have increased significantly in rural communities (Pareek et al., 2023; Saeed, 2023; Cabardo and Portugaliza, 2017). However, endoparasites affecting the intestines, like *Haemonchus contortus* (*H. contortus*) and *Moniezia* spp., have significantly challenged sheep production in Ghana. Research indicates that various plants are utilized in ethnomedical practices for human health because of their pharmacological properties and can also be utilized in ethnoveterinary medicine (Pareek et al., 2023). Research on herbal remedies in Ghana, including *Carica papaya*, *Allium sativum*, *Areca catecha*, *Ananas comosus*, *Nicotiana tabacum*, *Cucurbita moschata*, and *Moringa oleifera*, is limited (Effendy et al., 2014). According to them, papaya seeds and moringa leaves, both native to the Philippines, are known for their pharmacological properties, including their potential for anthelmintic activity.

A report from Daagema et al. (2020a, 2020b) and Sugiharto (2020) shows that papain is the crucial active ingredient in papaya seed, which has anthelmintic properties. In the

Moringa leaves, alkaloids, flavonoids and tannins are noticed to have anthelmintic effects in various studies (Pareek et al. 2023; Saif et al. 2019; Abd El-Hack et al. 2018).

Clinical trials and laboratory analyses will help establish the benefits, safety and potential of these natural remedies. As a result, developing alternative methods for endoparasite control that align with permaculture practices is essential for enhancing sheep health and welfare. To that end, the study aimed to evaluate the effectiveness of natural anthelmintics, particularly papaya seeds and moringa leaves, against intestinal nematodes in sheep.

## **1.2 Problem Statement**

Parasites found in the intestines of sheep are a long-lasting and widespread problem that significantly impacts animal health and production for the past five years (Bono East Regional Veterinary Laboratory in Techiman [VSD, 2023]). In Techiman, nematodes such as *H. contortus*, *Ascaris lumbricoides* and *Strongyloides stercoralis*, and cestodes such as *Taenia* spp. and *Moniezia* spp. are the main source of parasitic intestinal helminth infections. A survey by the Livestock Division of the Animal Production Division and the Metropolitan Veterinary Clinic (MVC) in 2022 showed notable economic losses due to reduced growth rates, lower wool and meat output, and higher mortality rates.

The Regional Veterinary Laboratory (RVL) indicated a concerning, persistent high level of helminthiasis in sheep treated with conventional dewormers for less than a month. According to the officer in charge, "There is an indication of helminths developing resistance to commonly prescribed anthelmintic drugs in the market". The drug resistance reduces the effectiveness of conventional anthelmintics, making it more

difficult and expensive to control parasites. Farmers experience a pattern of regular and unsuccessful treatments that result in increased expenses and decreased animal wellness. Because of this, about forty-five percent of the farmers in Techiman have started using natural herbs to treat their small ruminants. Of these farmers, thirty-three percent use moringa leaves and papaya seeds to control worms (VSD, 2023). Papaya seed, moringa leaves and Aidan fruit ("Perekese") are the plants or plant parts used in treating small ruminants suffering from helminths besides other diseases, according to a 2023 report from the RVL.

The Techiman Disease Investigation Farms and Regional Veterinary Laboratory (DIF/RVL) aims to investigate alternative methods for controlling intestinal endoparasites. These methods should be efficient, sustainable, and cost-effective to help address the challenges faced by farmers in Techiman and its surrounding areas. Remedies from plants, like the seeds of papaya and leaves of moringa, have been recognized as potential alternatives because of their anthelmintic properties. However, there is insufficient empirical research in the Ghanaian environment on the efficiency and safety of these involvements in sheep; therefore, there is a need for this study.

### **1.3 Objectives of the Study**

**General Objective:** To assess the anthelmintic efficacy of papaya seeds and moringa leaves against intestinal nematodes in sheep.

#### **1.3.1 Specific Objectives:**

1. To determine the anthelmintic efficacy of papaya seeds and moringa leaves in reducing the faecal egg count (FEC) in sheep.

2. To compare the efficacy of papaya seeds and moringa leaves with a conventional anthelmintic.
3. To assess the faecal consistency after applying the natural remedy.
4. To determine weight after the application of a natural remedy.

#### **1.4 Research Hypothesis**

1. To determine the anthelmintic efficacy of papaya seeds and moringa leaves in reducing FEC in sheep.
  - **Null Hypothesis (H<sub>0</sub>):** When papaya seeds and moringa leaves are applied to sheep production, there is no significant reduction of FEC.
  - **Alternative Hypothesis (H<sub>1</sub>):** There is a significant reduction in FEC when Papaya seeds and Moringa leaves are applied to sheep production.
2. To compare the efficacy of papaya seeds and moringa leaves with a conventional anthelmintic.
  - **Null Hypothesis (H<sub>0</sub>):** There is no significant reduction of FEC when a natural remedy is applied in sheep production compared to a conventional anthelmintic.
  - **Alternative Hypothesis (H<sub>1</sub>):** **When** a natural remedy is applied in sheep production, FEC is significantly reduced compared to conventional anthelmintics.
3. To assess the faecal consistency after applying the natural remedy.
  - **Null Hypothesis (H<sub>0</sub>):** There is no significant faecal consistency when a natural remedy is applied in sheep production.
  - **Alternative Hypothesis (H<sub>1</sub>):** There is significant faecal consistency when a natural remedy is applied in sheep production.

4. To assess weight after the application of a natural remedy.
  - **Null Hypothesis (H<sub>0</sub>):** The application of papaya seeds and Moringa leaves did not significantly affect the weight gain in sheep.
  - **Alternative Hypothesis (H<sub>1</sub>):** Applying papaya seeds and Moringa leaves significantly affected weight gain in sheep.

### **1.5 Significance of the study**

The findings will serve as a source of evidence for farmers and veterinary authorities as they provide significant insights into how to address the ongoing threat of AMR. AMR is a serious threat to the health of living things and their environment, and also implies the development of the economy and social stability, according to the WHO (2023). The findings emphasize the possibility of long-term and cost-effective helminths control in livestock, which is critical for reducing these hazards.

Furthermore, reducing dependency on conventional anthelmintic medications is predicted to improve animal welfare and health while also providing economic benefits and reducing environmental effects.

### **1.6 Justification of the Study**

Reports from the DIF indicate frequent detection of *Moniezia* spp. and *Strongyle* spp. during post-mortem examinations, highlighting a persistent parasitic burden in sheep. This suggests potential challenges such as anthelmintic resistance, ineffective deworming strategies or poor management practices. To address this, the study will evaluate the anthelmintic efficacy of papaya seeds and moringa leaves in sheep, providing empirical data on their effectiveness as alternative dewormers. Findings will

contribute to sustainable parasite control strategies, reduce reliance on conventional anthelmintics and improve livestock (sheep) health and productivity.

Also, the available and easily cultivable substances such as papaya seeds and Moringa leaves could be the source of potential cost-effectiveness of utilising local products, which are sustainable solutions for farmers, particularly in resource-constrained settings.

In addition, this research is aligned with several United Nations Sustainable Development Goals (SDGs) according to the United Nations (2015). Below are clarifications of how this study will contribute to some SDGs;

### **SDG 2: Zero Hunger**

Promoting the use of natural anthelmintics in the management of small ruminants can significantly enhance their overall health and productivity. Healthier animals yield higher quantities of meat, milk, and other valuable by-products, contributing directly to improved household nutrition and food availability, particularly in rural communities. This approach supports Target 2.3 by increasing agricultural productivity and incomes of small-scale food producers. Moreover, reducing reliance on synthetic chemical treatments aligns with Target 2.4 by fostering more sustainable livestock practices. It minimizes environmental contamination and builds climate resilience in the agricultural sector through eco-friendly health interventions.

### **SDG 3: Good Health and Well-being**

Target 3.3: Emerging and reemerging zoonotic diseases prevention and improving public health when parasitic infections are appropriately managed in small ruminant production.

As natural remedies are used, the risk of drug residues in animal products will be reduced, promoting small ruminants' health and well-being.

Target 3.9: Reduction in the usage of conventional anthelmintics can decrease environmental contamination and human exposure to harmful substances, thereby contributing to a healthier environment.

### **SDG 12: Responsible Consumption and Production**

In alignment with SDG 12, this research promotes the safe handling and reduction of chemical and waste pollutants, aiming to minimize negative effects on human health and the environment (Audan Padaria Gram Panchayat, 2023). Incorporating natural alternatives, such as papaya seeds and moringa leaves, also reduces pharmaceutical-related waste and supports more sustainable and eco-friendly consumption practices.

### **SDG 15: Life on Land**

Promoting agricultural practices that minimize chemical inputs supports the preservation of biodiversity and the integrity of ecosystems. Specifically, Target 15.1 underscores the importance of reducing dependency on synthetic substances in farming to safeguard terrestrial ecosystems. Additionally, addressing the environmental footprint of livestock farming through the use of natural deworming agents contributes to ecosystem restoration and helps slow biodiversity decline, as advocated in Target 15.5.

## **1.7 Scope of the Study**

The present study aims to evaluate the anthelmintic efficacy of papaya seeds and moringa leaves in sheep by assessing their capacity to reduce faecal egg counts (FEC) both before and following treatment. This investigation includes a comparative analysis between

treated sheep and an untreated control group to ascertain the extent of endoparasitic egg reduction. Furthermore, the study seeks to identify optimal dosages for effective deworming, alongside an evaluation of potential adverse effects to ensure the safety of these natural remedies.

Additionally, the study examines the duration of anthelmintic effects, determining whether the treatments provide sustained parasite control over time. Practical applications, such as their use as cost-effective, easy-to-administer deworming agents in livestock farming, will be explored to evaluate their feasibility for broader agricultural use.

### **1.8 Limitations of the study**

The key limitation of this study was the different drug usage during the study period. The administration of additional medications like mineral salt, multivitamins, dexamethasone and the rest could have introduced variables that influenced the study outcomes, making it challenging to isolate the effects of the primary treatment being investigated.

Another drawback was combining the sheep's nutritional state and immunity with the anthelmintic medication. These intrinsic characteristics may have differed between animals and impacted therapy effectiveness, altering study outcomes. Environmental and meteorological conditions also influenced the study's findings. Temperature, humidity and feed availability are likely to have influenced treatment efficacy and contributed to variations in research outcomes.

## **Need for larger sample sizes and standardized dosages in future**

### **Justification for Sample Size Selection**

The total number of available animals ( $n = 33$ ) limited the study design. The statistical model by Levecke et al. (2022) allows for smaller groups if appropriate statistical adjustments are made. To compensate for the reduced sample size per group, multiple post-treatment assessments (Day 5, Day 10, and Day 30) were incorporated into the study design. As a result, the final sample allocation struck a balance between statistical rigour and practical feasibility in the study.

### **1.9 Organization of the Thesis**

The thesis for this study consists of six chapters. Chapter one is the introduction of this thesis work or study. Chapter two reviews relevant literature, including journals, articles, research reports, bulletins, books and other documents related to the study's thematic areas. Chapter three deals with the methodology employed to address the objectives of this research. This methodology section describes the study area, study design, sample size, sampling technique, the study population, risk assessment on the usage of the natural remedy, treatment preparation, examination of faeces and methods of data analysis (analytical tools). Chapter Four presents the results obtained from the experiment, and Chapter Five discusses the results obtained from the experiment and presents results in tables, succeeding in the objectives. Chapter six summarises the results discussed, concludes and suggests the recommended policies suggested in this study.

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

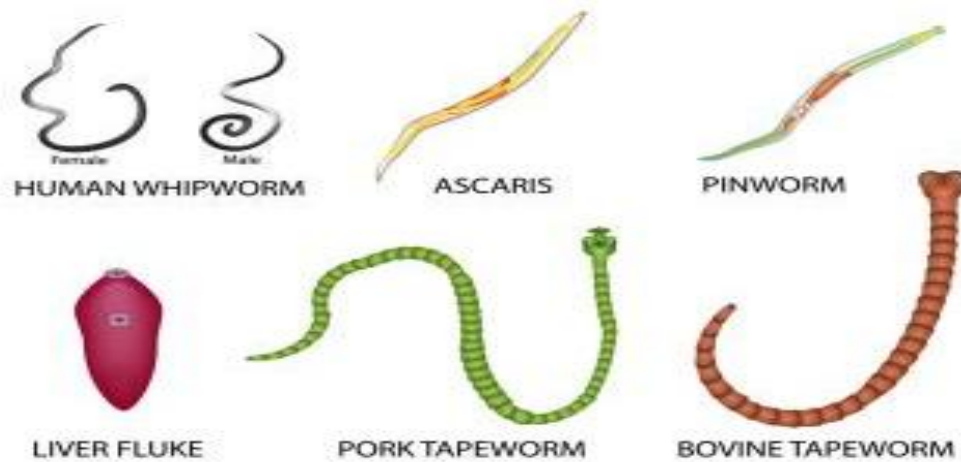
According to the United Nations Environment Programme (UNEP) (2023) and Basith et al. (2024), antimicrobial refers to the application of agents such as antibiotics, antivirals, antifungals, and antiparasitics while in Machamacha (2023) master's thesis wrote that it is used in the prevention and treatment of infections or diseases in humans, aquaculture, livestock, and crops. The DIF/RVL (2023) report showed that the prolonged usage of antimicrobials in treating animals has made them less effective. Microorganisms have developed resistance against these antimicrobials. AMR occurs when microbes are resistant to most antimicrobials. In 2023, UNEP published the AMR Forum: Improving Environmental Action on Antimicrobials in a Healthy Environment.

Anthelmintics are also an urgent problem in human and livestock production, and other methods to control this parasite need to be investigated (UNEP, 2023). This literature review will explore the anthelmintic properties of papaya seeds and Moringa leaves, two natural herbs known for their ability to prevent intestinal infections in sheep.

#### **2.2 Helminths and Helminthiasis**

Profile (2019) and April (2018) defined helminths (parasitic helminths) as a diverse group that can affect humans and many other animals, such as cattle, sheep, goats, pigs and chickens. These helminths can spread to many body parts, including the intestine, liver, lungs and blood vessels (Amin, 2021). Various types of helminths exist, and these include nematodes (roundworms/ascaris, lungworms, filarial nematodes, pinworms and

others), cestodes (tapeworms) and trematodes (liver and rumen flukes), according to Effendy et al. (2014).



**Fig 2.1: Images of some Gastrointestinal Helminthes** (shutterstock.com)

While Papadopoulos et al. (2021) focused on the well-being issues of sheep-like anaemia and the decrease in production caused by helminths, such as *H. contortus* and *Teladorsagia circumcincta*. Ahmed et al. (2022) focused on the economic impact in sheep production due to *Fasciola hepatica* infections, observing that these flukes lead to liver malfunction and overall health, and Sargison et al. (2023) focused on the impact of *Moniezia* spp. in sheep, stating that cestodes are less pathogenic than nematodes (the *Moniezia* are less pathogenic than flukes); these parasitic exposures can affect endo-intestinal health and overall production in sheep flocks.

In work by Pareek et al. (2023), Saeed (2023), Asunción et al. (2022), Ahiadorme & Morhe (2020), and Amin (2021), worms cause helminthiasis, which FAO/OIE/WB (2010) described as the primary concern in animal production in Africa. Helminthiasis can affect humans and animals (health, welfare, sanitation and production) but is classified as *Fasciola hepatica* and *Paramphistomum cervi* as part of the Neglected

Tropical Disease according to Nyindo & Lukambagire, 2015 and Pokharel & Sharma, 2023, respectively.

In animal production, according to Amin (2021), helminthiasis can cause many health problems in animals, including reduced growth, milk or egg production, poor growth and in severe cases death. Profile (2019) reported that parasites can also weaken the immune systems of infected animals, making them susceptible to other diseases that can lead to death.

According to Taylor et al., (2020), *Moniezia spp.* is a ribbon-like, segmented tapeworm with a broad, dorsoventrally flattened body, typically several meters long, and possessing unarmed scolex with suckers for attachment whiles Gordon & Whitlock, 1939 describe *H. contortus*, as a barber's pole worm which is a cylindrical, slender and twisted gastrointestinal nematode with a barber's pole appearance due to the intertwining of the white ovaries and red intestinal tract in females, is an endo-intestinal parasite primarily affecting small ruminants like sheep.

### **2.3 Anthelmintics**

Anthelmintics are chemical or biological agents used to eliminate parasitic worms (helminths) from the host's gastrointestinal tract. They remain the primary method of controlling gastrointestinal nematodes and cestodes in livestock, as they are relatively cheap, effective, and offer both therapeutic and prophylactic protection (Verma et al., 2018). However, their extensive and often indiscriminate use has led to the widespread emergence of anthelmintic resistance, now considered a global challenge for sustainable livestock production (Amulya et al., 2015).

Resistance to all major classes of synthetic anthelmintics has been documented in ruminants, including benzimidazoles, imidazothiazoles, and macrocyclic lactones (Borji, 2022). This has prompted research into alternative strategies, including the use of plant-derived bioactive compounds and integrated parasite management practices (Boylu & Önder, 2020). Natural remedies, such as moringa and papaya seeds, are gaining attention due to their potential to reduce parasite load while minimizing risks of toxicity and drug resistance.

### **2.3.1 Conventional Anthelmintics**

According to Amin (2021) and Ahiadorme & Morhe (2020), drugs used to treat infections caused by helminths are known as anthelmintics. Daagema et al. (2020) indicated that these drugs ultimately kill the worms (vermifuges) or paralyze them and get rid of them more easily (vermicides). Effendy et al. (2014) describe Albendazole, Ivermectin, Mebendazole and Praziquantel as some common conventional anthelmintics used in Ghana and Africa. However, in the case of rural settlements, ethnoveterinary drugs are used, according to Pedersen (2018).

Helminths should be controlled effectively to achieve Goal 3 of the SDGs by increasing the amount of food (protein) obtained from animal production. However, conventional medications are becoming less effective because of their resistance, prompting farmers to explore alternative methods. Hence, Natural remedies, such as papaya seeds and Moringa leaves, offer a sustainable and potentially effective approach for helminth and other infections in animal control in sheep.

According to the 2023 annual report from DIF, using natural anthelmintics derived from plants, such as papaya seeds and Moringa leaves, is gaining popularity among farmers in

Techiman. Few or limited risks are associated with using these natural alternatives, and their development makes them resistant and often more environmentally friendly than conventional drugs.

### **2.3.2 Natural Herbs/Remedies**

Thirteen plants, including *Carica papaya*, *Allium sativum*, *Areca catecha*, *Ananas comosus*, *Nicotiana tabacum*, *Cucurbita moschata*, and *Oleifera*, can be used as natural remedies in controlling worms, according to Ameen (2020). Among these plants, nine have been used to prevent helminth infections in livestock (Challaton et al., 2024; Gagman et al., 2022; Dansou et al., 2021; Degla et al., 2021; Tchetan et al., 2021). A study by Asante-Kwatia et al. (2021) and Bravo-Ramos et al. (2021) revealed that among these plants, *Carica papaya* (Papaya) and *Moringa oleifera* (Moringa) may be more suitable than others as ethno-veterinary medicines for animals in tropical regions because of their adaptability and agroecological considerations for controlling helminths. Efforts to control ruminant helminthiasis in Ghana are due to the development of parasites resistant to conventional anthelmintic drugs, which are expensive; therefore, there must be cheaper and more accessible alternatives. The use of alcohol in the extraction of anthelmintic elements from Papaya seeds and Moringa leaves has been evaluated as an anthelmintic agent against intestinal infections, but this has not been fully confirmed in sheep when whole seeds or leaves are used. In Techiman, farmers of small ruminant farming reported using available plants or natural remedies to combat endoparasites. The anthelmintic activity of papaya seeds and moringa leaves against helminths in sheep production was studied.

### 2.3.2.1 *Papaya Seeds*

Bioactive compounds like carpaine, papain, and benzyl isothiocyanate found in papaya seeds have shown their ability to control helminths or reduce helminths in faecal egg count, as reported by Radwan et al. (2023). Papain affects the metabolism of parasites, causing them to be removed from the host. Hence, papaya seeds can be a viable alternative to helminth control. According to a recent report from the DIF, farmers in Techiman have reported that incorporating ground papaya seeds into sheep feed helps reduce parasitic worm loads.

### 2.3.2.2 *Moringa Leaves*

Moringa leaves are rich in flavonoids, tannins and alkaloids and have anthelmintic activity (Pareek et al. 2023; Radwan et al. 2023; Saeed, 2023; Daagema et al. 2020; Sugiharto 2020). Abd El-Hack et al. (2018) showed decreased egg production and fewer worms in sheep treated with moringa leaf extract. The flavonoids, tannins, and alkaloids prevent the hatching of helminth eggs and interfere with the parasite. Hence, these findings demonstrate the ability of moringa leaves to control helminths in sheep production.

Moringa leaves (*Moringa oleifera*) have also been reported to be another natural remedy used by small ruminant farmers in Techiman to control helminths in sheep. Farmers' anecdotal evidence suggests that moringa leaves can significantly reduce worm burden when regularly included in sheep diets.

## **2.4 AMR in Helminthes**

UNEP (2023) and Tahir (2024) defined AMR as when microbes, such as bacteria, viruses, fungi or parasites, develop resistance to previously exposed antimicrobial drugs. According to Dwaah and Oppong (2024), “the use and misapplication of antimicrobials and other microbial stressors (e.g., infections) have created favourable conditions for microbial progress in animals, humans and the environment”. For example, water, soil and air bacteria can become contagious after entering the immune system. Animals are exposed to antibodies in the environment through contaminated water and food, and the inhalation of fungal pathogens.

According to Pareek et al. (2023), although AMR is "usually related to bacteria, it can also occur in helminths, although in different media". Geary and Moreno (2012) wrote that AMR is due to factors such as excessive or inappropriate use of anthelmintics, which causes worm genetic mutations and strains, parasites may become resilient to anthelmintics, and parasites may adapt to their environment and the drug. The treatment of helminth infections is problematic due to the increasing resistance of helminths, leading to failure in treatment and the risk of reinfection in humans and animals (Pareek et al., 2023).

The RVL officer in charge confirmed that papaya seeds and moringa leaves have been used to control helminths in Techiman. Hence, these findings highlight the need for further scientific validation and exploration of these natural anthelmintics.

Additionally, comprehensive programs and preventive measures, such as improved sanitation, hygiene, and vector control, should be combined with drug therapy to control helminths.

## **2.5 Faecal Consistency**

Faecal consistency is widely used as a practical and non-invasive measure of gastrointestinal health in livestock. Loose or watery faeces are often associated with gastrointestinal parasitism, malabsorption, and digestive upset, whereas firmer faeces indicate improved gut stability and nutrient assimilation. The incorporation of plant-based therapies, such as Moringa leaves and Papaya seed, has been shown to not only reduce parasite burdens but also improve faecal quality. For instance, supplementation with moringa has been linked to enhanced microbial balance in the gut and firmer faeces in dairy cattle (Sun et al., 2017). Nutritional studies further demonstrate that moringa leaves, rich in protein and bioactive compounds, contribute to both gut function and faecal consistency, reducing diarrhoeal risks in ruminants (Sasu et al., 2023)

### **2.5.1 Papaya Seeds**

Empirical studies show how faecal consistency improves when small ruminants are fed papaya seeds. Endo-intestinal parasites commonly cause loose stools or diarrhoea due to the irritation and damage to the intestinal lining of the small ruminant. Research by Talabis et al. (2019) reported a reduction in faecal egg count (FEC) when poultry was fed with papaya seed extracts, which improved stool quality, suggesting that similar benefits could be observed in small ruminants.

Similar work by Ameen et al. (2010) also demonstrated improvement in faecal consistency and a significant reduction in FEC due to commercial layers fed with papaya seed extracts, suggesting a similar study on small ruminants.

### **2.5.2 Moringa Leaves**

Moringa has been increasingly recognized not only for its nutritional and medicinal properties but also for its effects on gastrointestinal health in livestock. Beyond its documented anthelmintic activity, moringa leaves may influence faecal consistency, thereby contributing to improved gut function and overall animal welfare.

Faecal consistency serves as a vital indicator of gastrointestinal health, particularly in ruminants exposed to parasitic infections. Infections with gastrointestinal nematodes often manifest as diarrhoea and watery stools due to mucosal irritation and impaired nutrient absorption. Studies suggest that the inclusion of moringa leaves in ruminant diets is associated with firmer faeces and reduced diarrhoea, highlighting its role in stabilizing digestive processes.

The underlying mechanism is attributed to bioactive compounds such as tannins, flavonoids, and saponins, which enhance gut barrier function and reduce excessive fluid secretion. Tannins form protective protein complexes at the intestinal lining, while flavonoids exert antioxidant and anti-inflammatory effects, thereby mitigating mucosal damage. Moreover, moringa supplementation has been shown to influence the gut microbiota. For instance, dairy cows fed *Moringa* silage displayed significant shifts in faecal microbial communities, with beneficial bacterial taxa linked to improved digestive stability (Sun et al., 2017).

Nutritional evaluations confirm that moringa leaves are rich in crude protein (310 g/kg DM) and possess high relative feed value (177), which supports digestive efficiency and reduces diarrhoeal tendencies (Sasu et al., 2023). Similarly, *in vitro* fermentation studies have shown that inclusion of moringa leaves improves fibre digestibility and reduces gas production, further supporting gut stability (Sánchez-Santillán et al., 2022).

Taken together, these findings underscore the dual role of moringa leaves as both a nutritional supplement and a gut health enhancer. Their ability to reduce watery faeces and promote digestive stability is of particular relevance in parasite management programs, where maintaining faecal consistency reduces dehydration risk and improves animal resilience.

## **2.6 Weight Gain**

Weight gain is a key indicator of livestock productivity and reflects the efficiency of nutrient utilization, health status, and resilience to parasitic infections. Gastrointestinal parasites impair nutrient absorption and often lead to reduced growth rates, making weight gain an important parameter in evaluating both conventional and alternative parasite control strategies. Studies have shown that the use of herbal and homoeopathic remedies can improve weight gain outcomes when parasite burdens are reduced. For example, cattle treated with phytotherapeutics such as neem and eucalyptus demonstrated improved parasite control and modest gains in body weight compared to untreated animals (Paixão et al., 2021). Similarly, beef heifers receiving alternative parasite treatments showed differences of up to 22-30 kg in final body weights compared to controls, underscoring the importance of parasite management in growth performance (Catto et al., 2013).

### **2.6.1 Papaya Seeds**

In small ruminant production, weight gain indicates health and production rate, often compromised by parasite infection. Papaya seeds' anthelmintic properties reduce animal parasite burden, improving nutrient absorption and promoting weight gain. Talabis et al. (2019) observed improved weight profiles in animals fed with papaya seed extracts, linking enhanced growth to reduced parasitic load.

Reducing endo-intestinal parasites induced by nutrient loss following papaya seed treatment could directly translate to better weight gain in small ruminants. According to Hernandez et al. (2021), natural remedies like papaya seeds could be significant in supporting small ruminant management by supporting healthy weight gain through improved gastrointestinal function.

### **2.6.2 Moringa Leaves**

Moringa leaves contain many proteins, vitamins, and minerals, which can improve the weight gain of small ruminants. A paper by Mahfuz and Piao (2019) reported significant weight gain when animals were fed with moringa leaves as a supplement, which was linked to improved nutrient absorption due to a reduction in endo-intestinal parasites.

Leone et al.'s (2021) research further highlighted that feeding small ruminants leaves like Moringa improves their weight and overall health due to the provision of essential nutrients and reduction in the endo-intestinal parasite load. These benefits could be primarily noticeable in small ruminant production, improving their health and production rate.

## **2.7 World Association for the Advancement of Veterinary Parasitology (WAAVP) Guidelines on Timing for Faecal Egg Count Reduction Test (FECRT) using Albendazole**

### **2.7.1 Introduction**

According to Abbas et al. (2024) and Kaplan et. al. (2023), the Faecal Egg Count Reduction Test (FECRT) is a widely used method for evaluating the efficacy of anthelmintics in livestock. Kaplan et. al. (2023) and Daniels (2018) provide standardized guidelines for conducting FECRT to ensure accuracy and reliability in detecting anthelmintic resistance, which is in accordance with the WAAVP.

### **2.7.2 WAAVP Recommended Timing for FECRT Using Albendazole**

According to WAAVP guidelines, when using albendazole (a benzimidazole-class anthelmintic), the recommended post-treatment faecal sample collection period is between 10 to 14 days after administration. This interval allows for the complete expulsion of eggs from deceased female worms and ensures that any surviving worms have resumed normal egg production, thereby providing an accurate assessment of the drug's efficacy. While the range is 10 to 14 days, a 14-day interval is often preferred for consistency and reliability (Kaplan et al., 2023).

Additionally, in cases where animals have been previously treated with anthelmintics, WAAVP suggests a waiting period of at least 8 to 12 weeks before conducting the FECRT to minimize biases arising from prior treatments. This precaution helps in obtaining a more accurate measure of the anthelmintic's effectiveness.

### **2.7.3 Recommended Timing for FECRT Using Natural Remedies**

The timing of the faecal egg count reduction test (FECRT) is crucial when assessing the efficacy of natural remedies against gastrointestinal nematodes. In contrast to synthetic anthelmintics, which have well-established pharmacokinetics and withdrawal periods, natural products often demonstrate a slower onset of action and variable efficacy due to differences in active phytochemical concentrations.

Based on the literature and current findings, it is advisable to conduct the FECRT between 10 and 14 days post-treatment when utilizing plant-based or natural remedies. This timeframe allows sufficient duration for the bioactive compounds to exert measurable effects on parasite load while minimizing the confounding influence of reinfection. Sampling conducted earlier (e.g., within 7 days) may underestimate efficacy, whereas delayed sampling (beyond 21 days) risks reinfection and underestimates the true reduction attributable to the remedy (Coles et al., 1992; Wood et al., 1995).

Furthermore, when remedies with suspected slower pharmacological action are employed, such as tannin-rich forages, papaya seeds, or moringa extracts, a follow-up sampling at 30 days post-treatment is recommended to capture delayed anthelmintic effects (Ademola et al., 2007; Zirintunda et al., 2021).

In practice, adopting a dual sampling strategy at Days 10 to 14 and Day 30 provides a more robust assessment of efficacy and accommodates the variability inherent in natural product metabolism (Höglund et al., 2009). Therefore, the recommended timing for FECRT with natural remedies is a primary evaluation at 10 - 14 days post-treatment,

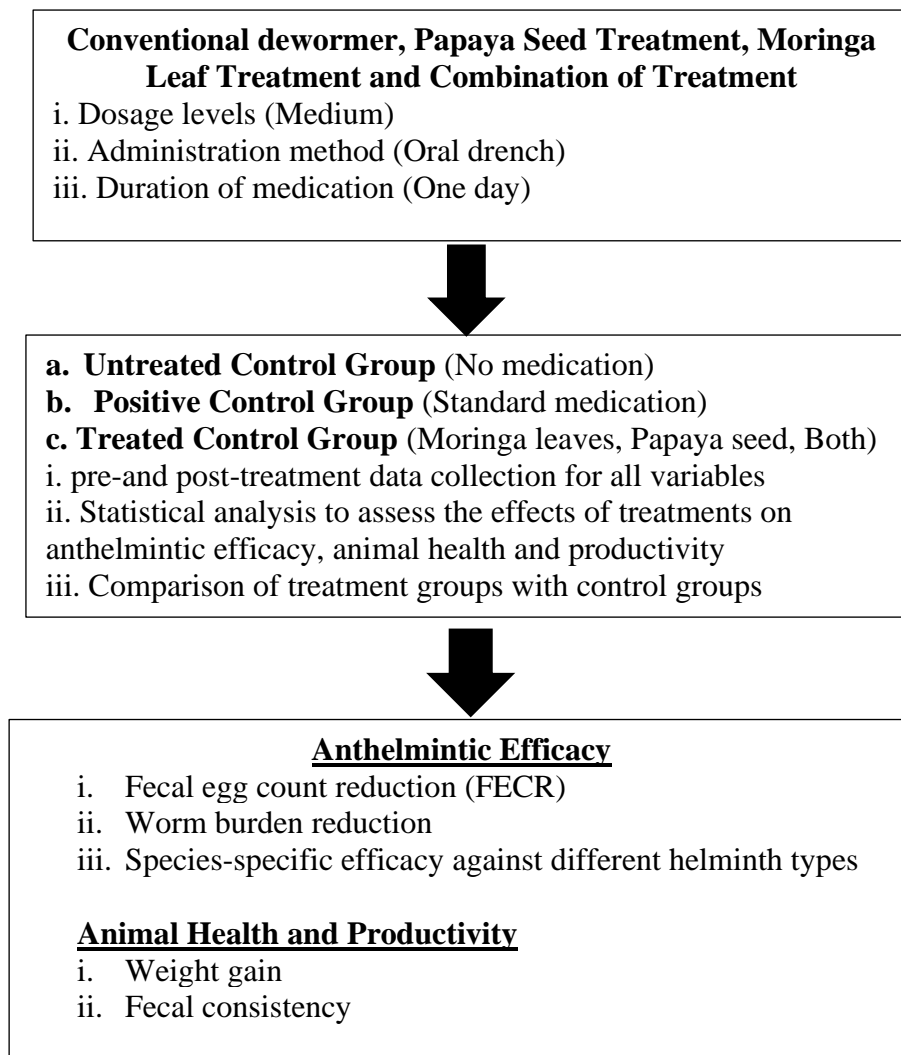
supplemented by an additional evaluation at 30 days in cases where delayed effects are anticipated. This protocol ensures accurate estimation of efficacy while aligning with international WAAVP guidelines adapted for plant-based therapies (Coles et al., 1992).

## **2.8 Comparative Studies: Filling Knowledge Gaps**

The effectiveness of papaya seeds and moringa leaves as sources of antihelminth has been confirmed by some empirical studies as the two best alternatives for endo-intestinal parasites when small ruminants are fed with extracts from them. A paper by Rahman et al. (2020) indicated the effects of the extraction of the activity ingredients for papaya seeds and moringa, left to be used as an antihelminth in small ruminants, and suggested that similar studies should be conducted in small ruminants without using the extracts. A comparative analysis will clarify the relative efficiency, nutrition and possible benefits of these natural antihelminths in small ruminants over conventional antihelminths.

Based on empirical studies, papaya seeds and moringa leaves are the two natural remedies for controlling endo-intestinal parasites in small ruminants. Due to the numerous bioactive compounds found in the seeds of papaya (Okeniyi et al., 2007) and leaves of moringa (Siddhuraju & Becker, 2003), they can serve as a source of anthelmintics that can affect endo-intestinal parasitic metabolism and inhibit their hatching and growth. However, further comparative studies are needed to fully understand their dosage in small ruminants and incorporate them into justifiable helminth control strategies.

## 2.9 Conceptual Framework



**Source:** Author's construct (2024)

## 2.10 Theoretical Framework

Due to the availability of some plants in Africa and some parts of the world, they are used as a source of medication for humans and animals based on their effectiveness in controlling disease. Plants like papaya seeds and Moringa leaves contain some antihelminth properties that will be supported by a theoretical framework that can be obtained from two central concepts and theories.

### **2.10.1 Phytotherapy Theory (Anshuman, 2023)**

**Summary:** Plants containing bioactive compounds are used to treat humans and animals in some parts of the world, like rural areas in Ghana. Hence, this theory suggests that plants containing bioactive compounds like papaya seeds and moringa leaves may have anthelmintic properties.

**Application:** Certain bioactive compounds found in papaya seeds and Moringa leaves may eliminate endo-intestinal parasites, making their use for controlling parasite-related issues well-grounded. This theory supports the investigation of plant-based alternatives to conventional anthelmintics in countries with AMR.

### **2.10.2 Anthelmintic Resistance Theory (Fissiha & Zemene, 2021)**

**Overview:** This theory is derived from how anthelmintic drugs are not effective against parasites when used. In most cases, the means used to develop this form of resistance is through selective pressure from the overuse or misuse of such drugs.

**Application:** The theory is that alternative treatments, which are natural remedies, should be sought to counter this resistance problem. Due to their bioactive compounds, papaya seeds and moringa leaves can support the AMR problem.

## **2.11 Summary**

Plants such as papaya and moringa have been used as cost-effective alternatives to anthelmintic drugs for livestock. According to Khan et al. (2023), Babalola et al. (2022), Adebayo et al. (2021), Okeniyi et al. (2007) and Siddhuraju & Becker (2003), "These plants, rich in bioactive compounds such as benzyl cyanate", exhibit anthelmintic properties by reducing helminth eggs in sheep. Farmers in Techiman have reported that ground papaya seeds and Moringa leaves effectively reduce parasites. Research on

natural solutions has grown owing to their resistance to synthetic drugs. Increased immunity and the effectiveness of natural remedies, such as papaya seeds and Moringa leaves, are under study for their ability to combat AMR in helminths.

A review of the existing literature underscores the potential of combining papaya seeds and Moringa leaves as anthelmintics (Goku et al., 2020; Cabardo & Portugaliza, 2017). This study aims to build on these findings by employing rigorous methodologies to assess their efficacy in the Ghanaian context.

## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.1 Study Site and Population**

##### **3.1.1 Study Site**

The study was conducted in Techiman, located at a historical crossroads of trade routes and the Tano River and serves as the capital of the Bono East Region, with the coordinates of 07°34'38"N 01°55'45"W. Techiman covers a land area of 647.6 km<sup>2</sup> with a Population Density of 375.8 km<sup>2</sup> (GSS, 2021).

The Techiman Metropolitan covers three major vegetation zones: Guinea-Savanna woodland in the northwest, the Semi-Deciduous Zone in the South, and the Transitional Zone from the southeast and west to the north (GSS, 2021). The main occupations include crop and livestock production. Aquaculture is on the edge of progress, and a small percentage of the land is replanted to join the Asubima Forest Reserve (GSS, 2021).

Techiman is one of Ghana's busiest cities (Ali, 2023) and is generally considered one of the country's top commercial centres, according to the Ghana Health Service (2024) report for Bono East. Techiman is home to West Africa's most significant traditional market (GSS, 2021). In the annual report by Techiman Municipal Assembly (2023), Techiman is visited by traders from Togo, Benin, Côte d'Ivoire, Burkina Faso, and Mali. Techiman is commonly called the "Food Basket of Ghana" (GSS, 2021) because its market operations occur from Tuesday through Friday every week of the year, attracting traders from around West Africa. Due to the city's socioeconomic structure, Techiman's population is very cosmopolitan, consisting of individuals from many racial, economic, and sociopolitical backgrounds (GSS, 2021). The metropolitan area has a total human



### **3.1.2 Ethical Approval**

After submitting “**Appendix H**”, the Ethics Review Committee of the Akenten Appiah-Menka University of Skill Training and Entrepreneurial Development gave ethical approval, with the Approval Number **AAMUSTED/IERC/2024/031**, before the commencement of the study.

Before the commencement of the study, formal permission was sought from the Ghana Veterinary Service Directorate through the DIF farm manager.

### **3.1.3 Study Population**

The study was conducted on a population of crossbred sheep at the Disease Investigation Farms (DIF) in Techiman. At the DIF, sheep are managed under a semi-intensive system, which combines controlled feeding with periodic access to grazing areas. The flock consists predominantly of thirty-three (33) Cross-breed sheep, a breed known for its adaptability to the local climate, resistance to diseases, and ability to thrive on low-quality forage (Fyobe, Kwaku, & Koloina, 2019). The sheep are categorized into two different age groups that is, young ewe/ram (below six months) and adult ewe/ram (above six months). The Inclusion and Exclusion Criteria are attached as “**Appendix I**”.

### **3.1.4 Study Design**

This type of study employed a Parallel Design under the randomised controlled trial (RCT) framework of experimental research, as described by Adams & Agbenyo (2023) and Mafi et al. (2022). RCT was chosen as it is regarded as the gold standard in clinical and public health research, as it provides the most robust evidence for testing the effectiveness of interventions such as new drugs, vaccines, health programs, and

behavioural strategies. Their methodological strength lies in randomization, which minimizes bias and ensures comparability between groups, thereby enhancing the validity of causal inferences (Lopez-Pintado & Canay, 2024; Fergusson et al., 2020; Ugwueze et al., 2020). However, WAAVP describe this kind of design as a “Paired design” (Vercruysse et al., 2018). With the use of Power Analysis, the sample size of this study was determined, and to ensure statistical validity, sample allocation took into account expected medication efficacy ( $\geq 95\%$ ), variability in FEC within the study population, and a 95% confidence level. The statistical program provided by Levecke et al. (2022) was used to confirm the feasibility of using eight animals per group, except for group 1, which had nine animals, while maintaining an acceptable confidence interval.

### **3.1.5 Sample Size Determination**

#### *3.1.5.1 Sample Size*

The sample size for this investigation was established using the statistical framework proposed by Levecke et al. (2022), which includes criteria for estimating sample sizes for FECRT in livestock. This approach bases the required number of animals per group on parameters such as estimated treatment efficacy, lower efficacy threshold, and faecal egg count variability.

For this study, a total of 33 animals were available, which were randomly assigned into four groups as follows:

**Table 3.1 Sample Size Determination**

<b>Group</b>	<b>Number of Animals (n)</b>	<b>Treatment</b>
G1 (Control Group - Untreated)	9	Distilled water
G2 (Treatment A)	8	Papaya seeds
G3 (Treatment B)	8	Moringa leaves
G4 (Treatment C)	8	Conventional dewormer

The allocation was based on the lowest sample size required per group to achieve relevant statistical power, taking into account the available animal population. According to Kaplan et al. (2023), “the WAAVP recommendations require a minimum of 10-15 animals per group for robust FECRT.” Levecke et al. (2022) argue that studies with fewer animals can still generate reliable results if suitable statistical methods are used.

### **3.2 Animals for the Study and Preparation for Treatment**

#### **3.2.1 Animals**

The animals used were sheep of different ages and sexes from DIF, following the approach adapted in a similar study by Sharma et al. (2022). Thirty-three (33) sheep (Thirty-three: twenty-five Ewes and eight Rams) were used in the study.

#### **3.2.3 Preparation of the Papaya Seeds**

Fully matured *Carica papaya* fruits were sourced from papaya plants at DIF/RVL. The fruits were meticulously opened, and the seeds were manually extracted. Subsequently, these seeds underwent thorough washing with clean water to eliminate mucilage and pulp residues (Jiwuba & Kadurumba, 2019). Post-washing, excess water was removed using a fine mesh sieve. For the drying procedure, the cleaned papaya seeds were arranged in

a single layer on trays lined with a clean white cloth. Drying was conducted in the shade at ambient temperature (~25–30°C) for two weeks (14 days) to prevent the degradation of active compounds such as alkaloids and flavonoids (Rosa et al., 2021). The seeds were turned twice daily to ensure uniform drying. To verify complete drying, a few seeds were tested by pressing them between fingers; fully dried seeds were characterized by their hardness and brittleness.



**Fig 3.2** How powdered pawpaw seeds were obtained. Picture by Author, 2024

### 3.2.4. Preparation of the *Moringa* Leaves

Fresh *Moringa oleifera* leaves were collected from mature trees at DIF/RVL, with only healthy, disease-free specimens selected to ensure optimal quality. The leaves were meticulously detached from the stems and placed in a clean, ventilated area for subsequent processing (Makkar & Becker, 1996). During the drying process, the harvested leaves were air-dried in a shaded, well-ventilated environment at ambient temperature (~25°C) for five days to preserve their phytochemical integrity (Nouman et al., 2014). The leaves were evenly distributed on drying racks to ensure uniform exposure to airflow. Daily inspections were conducted to monitor moisture reduction, and any mouldy or discoloured leaves were discarded to maintain quality. This process took ten (10) days to completely dry.



**Fig 3.3** How powdered *Moringa* leaves were obtained Picture by (Author, 2024)

### **3.2.5. Grinding and Powdering of Papaya and Moringa**

The dried papaya seeds and moringa leaves were ground using a mortar and pestle into a fine powder (Krah et al., 2022). Afterwards, the powder was passed through a 1 mm sieve to ensure uniform particle size. The final product was stored in airtight glass containers or zip bags at room temperature to prevent moisture absorption and away from direct sunlight to maintain potency.

### **3.2.6. Preparation of Papaya and Moringa Aqueous Extract**

An electronic balance was used to measure 50 g of papaya seeds and moringa leaf powder each into a sterilized glass beaker. The powder was combined with 500 ml of distilled water (1:10) for extraction (Nouman et al. 2014). The mixture was steeped overnight (12 hours) at room temperature, according to Nouman et al. (2014). The extract was filtered through a muslin cloth to eliminate solid residue. To prevent microbial growth, the liquid extract was stored in sterile vials at 4°C for 72 hours before being used.

### **3.2.7 Proprietary Anthelmintic (Conventional Dewormer)**

According to Pinkrah (2017), “The dosage of conventional dewormer for therapeutic use in Ghana is 10 ml/kg body weight. An animal weighing 1kg will receive 25 mg of the active ingredient daily”.

### **3.2.8 Animal Groupings and Treatment**

Each sheep was tagged and assigned a unique identification number. Using Microsoft Excel’s RAND () function, a random number was generated for each animal. These numbers were then sorted in ascending order, and animals were sequentially assigned into one of the four groups based on the sorted list, ensuring unbiased group allocation.

This approach eliminated selection bias and preserved the integrity of group comparisons.

The sheep were grouped into four. Each group had six ewes and two rams. The exact Group 1 had Seven Ewes and two rams, for a total of nine sheep.

**Table 3.2. Groups of sheep and treatment given or received**

<b>GROUP</b>	<b>TREATMENT GIVEN OR RECEIVED</b>
1	Negative Control was drenched with distilled water at 1:10ml body weight
2	Drenched with the papaya seeds at 1:10 ml (w/v) of water /kg body weight
3	Drenched with <i>Oleifera</i> leaves at 1:10 ml (w/v) of water per kg body weight
4	Postive Control was drenched with Conventional dewormer (Albendazole 10%), administered at 10 mg/kg body weight

Adopted from Ameen et al. 2020 and 2018

The conventional anthelmintic used in this study was Albendazole 10% because it is the commonest conventional anthelmintic used in Techiman, according to the veterinary officers in Techiman South Metropolitan.

### **3.3 Risk Assessment**

Risk assessment in this study was used to identify and manage the possible risks to the sheep, the principal investigator, and the integrity of the study results during and after the research. Key areas include:

### **3.3.1. Animal Health and Welfare Risks:**

The administration of natural remedies could pose a risk of adverse effects, particularly when optimal dosages are not well-established. To mitigate this risk, a pilot test was conducted to determine safe dosage levels, and the health of the sheep was regularly monitored for potential side effects. Additionally, veterinary guidelines were consulted, and professionals were involved to minimize health risks and ensure the welfare of the animals.

### **3.3.2 Researcher Safety Risks:**

Handling sheep and administering natural remedies could expose researchers to potential zoonotic diseases and physical injuries. To address these risks, protective equipment such as gloves and masks was used during animal handling and sample collection. Established protocols for safe animal handling helped reduce the risk of injuries. Moreover, all team members underwent training on best practices for administering treatments and collecting samples safely.

### **3.3.3 Environmental Risks:**

The disposal of faecal samples presented a risk of environmental contamination. To prevent hazards, waste disposal was conducted in accordance with local regulations on waste management, ensuring the proper handling of all materials. The tools and materials used during the study were thoroughly cleaned and disinfected before and after sample collection and treatment to minimize any environmental impact.

### **3.3.4 Risks to Study Integrity**

Factors such as variations in sheep diets, environmental conditions, and stress levels could potentially impact the study's results. To control these risks, all sheep were provided with consistent feeding, housing, and care conditions throughout the study period. Efforts were made to minimize environmental disturbances to reduce stress, which could affect the immune responses and FEC results.

### **3.3.5 Risk Assessment of the Natural Remedies**

Before the main study on the anthelmintic efficacy of papaya seeds and moringa leaves in small ruminants, a thorough Risk Assessment was conducted for the animals and researchers to ensure their safety and well-being throughout the research process. The risk assessment evaluated the potential health risk of the Primary Investigator and the Investigating Organisms, employed preventive measures, and created a protocol for monitoring and responding to adverse events.

#### *3.3.5.1 Preliminary Health Screening*

This was essential because animals with underlying diseases could skew results and increase the likelihood of adverse reactions to the treatment. To mitigate this risk, each sheep underwent a comprehensive health examination, including physical checks, to screen for any underlying conditions.

The screening included physical examination of body condition, coat quality, posture, and behavior; measurement of vital signs (rectal temperature, heart rate, and respiratory rate); inspection of mucous membranes for pallor or discharge; body condition scoring

on a standard 1–5 scale; visual assessment of fecal consistency; and examination for external parasites such as ticks and lice.

Only sheep deemed healthy were included in the study.

#### *3.3.5.2 Determining Safe Dosage Levels of Natural Remedies*

High or low dosages could lead to toxicity, endo-intestinal parasite distress, or other health issues. The pilot dose-ranging study was conducted on safe dosage levels for sheep. This medium involved administering low doses (1 and 2) ml in a pilot test to observe any adverse effects and gradually increasing (3, 4, and 5) until an effective but safe dose (10) ml was identified.

#### *3.3.6.3 Risk of Nutritional Imbalance*

Excessive amounts of these natural ingredients could interfere with normal nutrient absorption or cause imbalances, negatively affecting the sheep's health. A supplement of wheat bran, rich in necessary nutrients, was added to the animals' diet to prevent this. Additionally, the sheep's weight and other health parameters were closely monitored throughout the study to detect and address any imbalances promptly.

#### *3.3.5.4 Monitoring for Adverse Reactions*

Digestive distress and other side effects could threaten the sheep's well-being. To address this, a daily health monitoring protocol was implemented to observe signs of distress, such as changes in appetite, lethargy, or digestive issues. If adverse reactions were detected, a predefined criterion was established to remove any affected sheep from the study.

#### *3.3.5.5 Protocol for Emergency Veterinary Intervention*

Unexpected complications may arise that require immediate veterinary intervention. To mitigate this risk, an on-call veterinarian or direct access to a veterinary clinic was arranged for emergencies. Specific criteria were set for stopping the treatment or withdrawing affected animals from the study. Emergency medications and treatments prescribed by the veterinarian were prepared in advance to handle any serious issues.

#### *3.3.5.6 Ethical Approval and Compliance*

Non-compliance could result in ethical violations and harm to the animals involved. Approval was obtained from an institutional review board to address this, and all protocols were designed to align with local and international animal welfare guidelines. Care protocols were documented and regularly reviewed to maintain compliance throughout the study.

### **3.4 Quality Control**

In this study, how the data was collected, how the natural remedy for treatment was applied and how outcome measurements were done accurately and consistently. Critical quality control measures include:

#### **3.4.1 Randomization Process:**

Each sheep was tagged and assigned a unique identification number. Using Microsoft Excel's RAND function, a random number was generated for each animal. These numbers were then sorted in ascending order, and animals were sequentially assigned into one of the four groups based on the sorted list, ensuring unbiased group allocation.

This approach eliminated selection bias and preserved the integrity of group comparisons.

#### **3.4.2 Treatment Preparation and Dosage Accuracy:**

The natural remedy was prepared under controlled conditions to ensure even dosage and to evade cross-contamination. Precise weighing and measurement tools to administer consistent doses, reducing variability that could affect results.

#### **3.4.3 Sample Collection and Analysis of Faecal Consistency:**

Faecal Sample Collection: Personnel who collected faecal samples were trained to collect them simultaneously (6:30 am – 7:00 am) each day to ensure consistency in FEC measurements.

##### ***Justification for Early Morning Faecal Sample Collection (6:30 am – 7:00 am)***

Collecting faecal samples from animals between 6:30 am and 7:00 am ensures the freshness and integrity of the specimens or samples, which is crucial for accurate parasitological analysis. This timing minimizes the risk of environmental contamination and degradation of parasitic elements, thereby enhancing the reliability of diagnostic results. Additionally, early morning collection aligns with standard practices in parasitology, facilitating consistency and comparability across studies.

#### **3.4.4 Documentation and Record Keeping**

Rigorous documentation practices were implemented, including a daily log of each sheep's health and weekly faecal consistency and weight to ensure all data was accounted for. From the protocol, all unexpected events (e.g., illness or injury) were documented and considered during data analysis.

### **3.4.5 Regular Data Validation**

Data was reviewed periodically to avoid incorrect entries. Measurements like FEC, weight, and faecal consistency were checked twice to identify potential errors or patterns that needed correction.

### **3.4.5 Calibration and Maintenance of Equipment**

The light microscopes and other equipment were calibrated and maintained throughout the study to ensure accurate measurements.

## **3.5 Examination of Faeces**

### **3.5.1 Collection of Faecal Samples**

The fresh faecal samples were collected directly from the rectum of each animal in the morning before administering treatments (Charles Sturt University, 2024) following DIF's Standard Operating Procedures (SOPs) for anthelmintic resistance in livestock (sheep) that is Day 0 (pre-test), Day 5, Day 10 and Day 30. Each sample was then kept in a discrete faecal cup and was transported to the laboratory under proper sterile conditions (Tagesu 2018).

In addition to the above, reasonable sampling procedures were followed under the DIF sampling procedures.

### **3.5.2 Concentration Method**

The concentration method enhances parasite detection by removing excess faecal material (Garedaghi, 2020) and includes flotation and sedimentation techniques. For flotation, about 3 g of faeces was mixed with a saturated salt solution, strained, and

topped to form a meniscus. A coverslip was placed on the surface for 10-15 minutes, then transferred to a microscope slide for examination. This technique allows most parasite eggs and cysts to float while heavier debris sinks; however, some heavier or delicate eggs may not float or may be damaged. In sedimentation, denser solutions concentrate parasites in the sediment via centrifugation, though some debris may remain.

### **3.5.3 McMaster egg counting technique**

McMaster is a quantitative method for determining the number of nematode and cestode eggs per gram of faeces to estimate an animal's worm burden (Tagesu, 2018). This technique is quick, as the eggs are floated free of debris before counting (University of Saskatchewan, 2021). Full procedures are shown in “Appendix B”.

## **3.6 Visual Scoring System for Faecal Consistency in Sheep**

In experimental studies involving ovine subjects, faecal consistency is frequently evaluated utilizing a visual scoring system to monitor gastrointestinal health and the effects of various treatments. A commonly employed scale ranges from 1 to 5, with each score representing a specific consistency:

Score 1: Soft

Score 2: Semi-formed faeces

Score 3: Firm and Well Formed

Score 4: Pellet-like

Score 5: Dry pellets

### 3.7 VSD guidelines for helminth infestation

The World Organization of Animal Health (WOAH) (2024a, 2024b) guides helminth infections and their management in sheep, but specific limits for faecal egg count (FEC) vary by country and environment. In general, the following levels are used to assess the severity of helminth infection in livestock (sheep).

**Table 3.3 Guidelines for Helminth Determination**

<b>Rate of Infection</b>	<b>Faecal Egg Count</b>	<b>Symptoms</b>
Typical (Low infection)	Below 200 eggs per gram of faeces (EPG)	The sheep are healthy or in good physical condition and have no obvious symptoms
Moderate Infection	200-500 EPG	Mild symptoms of anaemia, slight weight loss or reduced growth
High Infection (Abnormal)	500-1000 EPG	Obvious signs of anaemia, loss of appetite, growth retardation, decreased wool quality and diarrhoea
Severe Infection (Severely Abnormal)	More than 1000 EPG	Severe anaemia and loss of weight, fatigue and, in extreme cases, death

**Source:** Ghana VSD Guideline on Helminth Infestation

In cases where animals are infected with more than one helminth species and one of the helminths are less than 200Egg Per Gram (200 EPG) but the other is more than 200EPG, the animal is dewormed. In the absence of a standardized and well-documented protocol also for the use of natural remedies, all animals were administered the designated treatment.

### 3.8 Statistical Analysis

Per a similar study conducted by Ameen et al. (2020), this statistical analysis was adopted. Data generated from the experimental treatments were subjected to both descriptive and inferential statistical analyses. FEC values were first log-transformed  $\log(x+1)$  to normalize distributions prior to analysis. Mean FEC and percentage FECR% were calculated according to the WAAVP guidelines. The percentage reduction in FEC was computed using the formula:

$$\text{FECRT (\%)} = \frac{(\text{Mean FEC before treatment}) - (\text{Mean FEC after treatment})}{(\text{Mean FEC before treatment})} \times 100,$$

where FEC before treatment represents baseline egg counts (Day 0) and FEC after treatment represents counts taken on Days 10 and 30 after treatment.

Analysis of variance (ANOVA) was employed to compare mean FEC reductions across treatment groups (papaya seeds, moringa leaves, albendazole, and untreated control). Where significant differences were detected, means were separated using Tukey's Honest Significant Difference (HSD) test at a significance level of  $p < 0.05$ .

Data were presented in tabular form (Tables 4.2–4.3) and illustrated graphically (Figures 4.1–4.4) to highlight treatment effects on *H. contortus* and *Moniezia* spp. Specifically, comparative reductions between natural remedies and the conventional anthelmintic

were emphasized. Statistical outputs were interpreted to show the relative efficacy of treatments, with moringa leaves generally outperforming papaya seeds against both parasite species. All analyses were performed using IBM SPSS Statistics Version 26, ensuring reproducibility and appropriate statistical rigour.

## CHAPTER FOUR

### RESULTS

#### 4.1 Helminth Load before Treatment

The Helminth load before treatment is presented in Table 4.1

The majority of the animals were concurrently infected with both helminths under investigation, indicating a prevalence of multi-infection within the DIF, as seen in Table 4.1. Furthermore, most sheep were categorized as having an abnormally high level of helminth infection, as per the VSD guidelines for helminth infestation in Ghana. This suggests a significant parasite burden among the study population before the administration of the natural remedy and conventional dewormer. During the pre-treatment phase, rams demonstrated the highest level of worm infection relative to other groups, as evidenced by FEC analysis. This indicates that rams were the most heavily infested with helminths before the natural remedy and other medications were administered. Twenty (20) out of the thirty-three sheep were affected with both helminths, as shown in *Table 4.2*

**Table 4.1: Helminths Load Pre–Treatment**

		<i>H. contortus</i> (EPG)	<i>Moniezia spp</i> (EPG)
<b>GROUP 1</b>	<b>SEX/AGE GROUP</b>	<b>Day 0</b>	<b>Day 0</b>
A	Ram	1500	300
B	Young Ram	1000	100
C	Young Ewe	800	150
D	Ewe	950	0
E	Ewe	800	100
F	Ewe	200	50
G	Ewe	850	0
H	Ewe	700	0
I	Ewe	300	150
<b>GROUP 2</b>			
A	Ram	1000	400
B	Young Ram	800	0
C	Young Ewe	700	100
D	Ewe	650	0
E	Ewe	1000	100
F	Ewe	700	0
G	Ewe	300	100
H	Ewe	500	150
<b>GROUP 3</b>			
A	Ram	1000	300
B	Young Ram	900	0
C	Young Ewe	900	600
D	Ewe	700	300
E	Ewe	800	0
F	Ewe	0	500
G	Ewe	850	0
H	Ewe	600	200
<b>GROUP 4</b>			
A	Ram	1100	500
B	Young Ram	1000	100
C	Yonug Ewe	0	300
D	Ewe	950	150
E	Ewe	800	450
F	Ewe	0	200
G	Ewe	800	500
H	Ewe	700	0

Field Data (2025)

**Table 4.2: Summary of Helminth load by species**

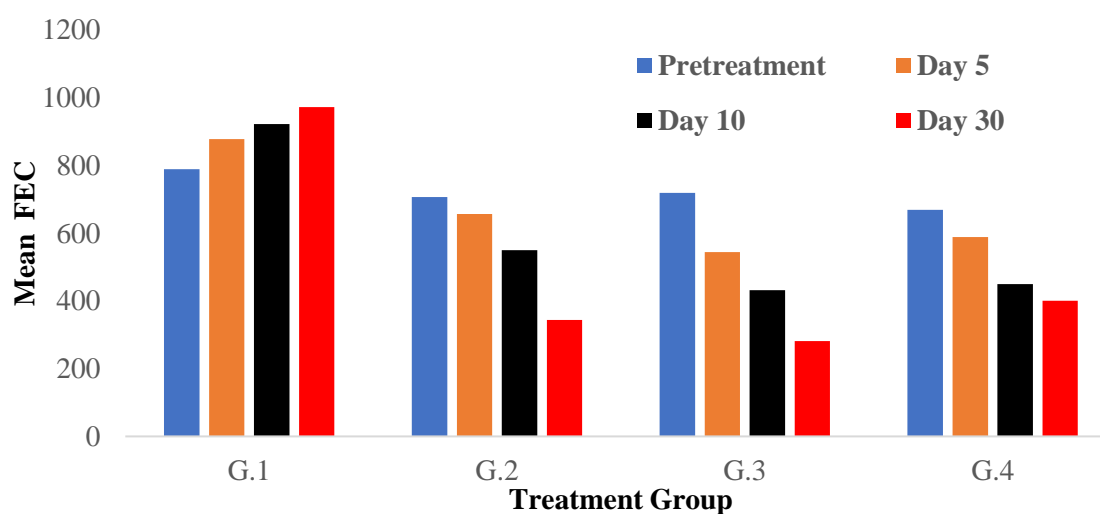
Sex and Age	No. Sheep	Type of infection		
		<i>H. contortus</i>	<i>Moniezia</i> spp.	Both
Ram	4	-	-	4
Ewe	21	8	2	11
Young Ram	4	2	-	2
Young Ewe	4	-	1	3
<b>n (%)</b>	<b>33 (100)</b>	<b>10 (30.3)</b>	<b>3 (9.1)</b>	<b>20 (60.6)</b>

**Footnote:** Both the *Moniezia benedeni* and *Moniezia expansa*, hence *Moniezia* spp., was used

## 4.2 Anthelmintic Efficacy of papaya seeds and moringa leaves.

### 4.2.1 Efficacy of Papaya Seeds and Moringa Leaves against *H. contortus*

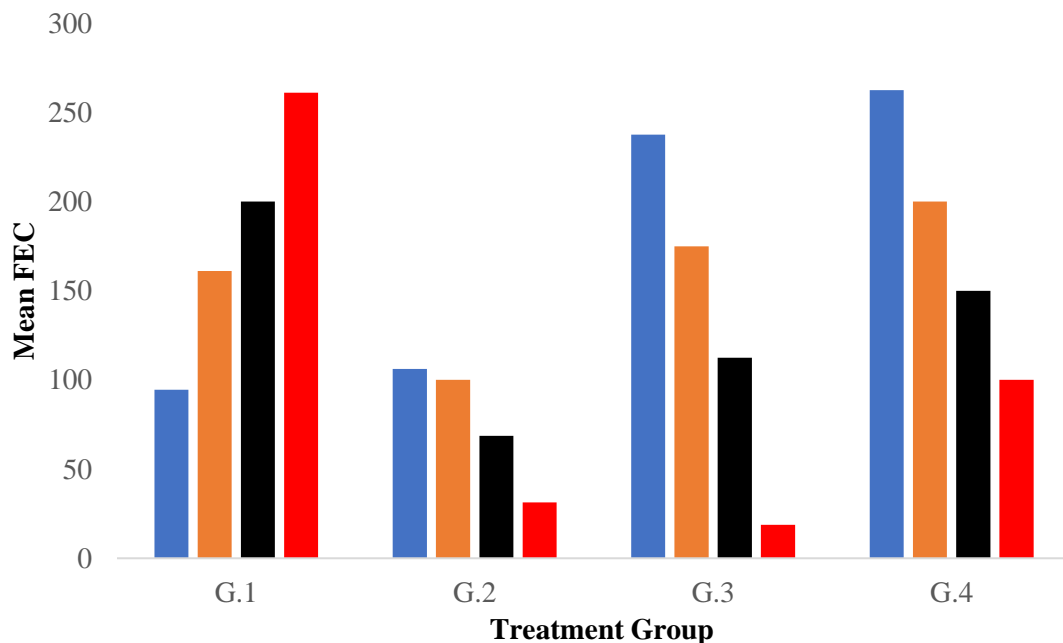
**Figure 4.1** showed that both papaya seeds (G. 2) and moringa leaves (G. 3) exhibited notable anthelmintic properties against *H. contortus*. Animals treated with G. 3 extracts demonstrated a significant reduction in FEC compared to the control groups (G. 1 and 4), indicating strong ovicidal and larvicidal effects. G. 2 also reduced egg counts, though to a lesser degree than G. 3, suggesting that while effective, their potency was relatively lower. These findings highlight the potential of G. 3 as a more promising natural remedy for gastrointestinal nematode control.



**Figure 4.1:** Efficacy of treatments against *H. contortus*

#### 4.2.2 Efficacy of Papaya Seeds and Moringa Leaves against *Moniezia* spp.

Against *Moniezia* spp., both plant treatments again reduced FEC values relative to untreated controls (G. 1 and 4), as shown in **Figure 4.2**. Moringa leaves (G. 3) showed a comparatively higher efficacy, reflecting their strong anti-cestodal activity. Papaya seeds (G. 2) produced moderate reductions in egg counts, indicating some effectiveness but not at the same level as G. 3. This differential effect suggests that while both plants have beneficial roles, G. 3 may serve as a more robust intervention for cestode infections.



**Figure 4.2** :Efficacy of treatments against *Moniezia* spp

#### 4.3 FECRT for *H. contortus* and *Moniezia* spp.

According to Hassan and Ghazy (2022), Kipp (2020) and Lester (2015), the FECRT was performed to assess the efficacy of the treatment on *H. contortus* and *Moniezia* spp. The FECRT values were computed with the use of Wondimu and Bayu (2022) and Denwood et al. (2023) formula on Day 0 and Day 10, which is accepted by WAAVP for using

Albendazole in FECRT (Kaplan et. al., 2023), but Day 30 was included because the natural remedies that are papaya and moringa were used.

$$\text{FECRT (\%)} = \frac{(\text{Mean FEC before treatment}) - (\text{Mean FEC after treatment})}{(\text{Mean FEC before treatment})} \times 100,$$

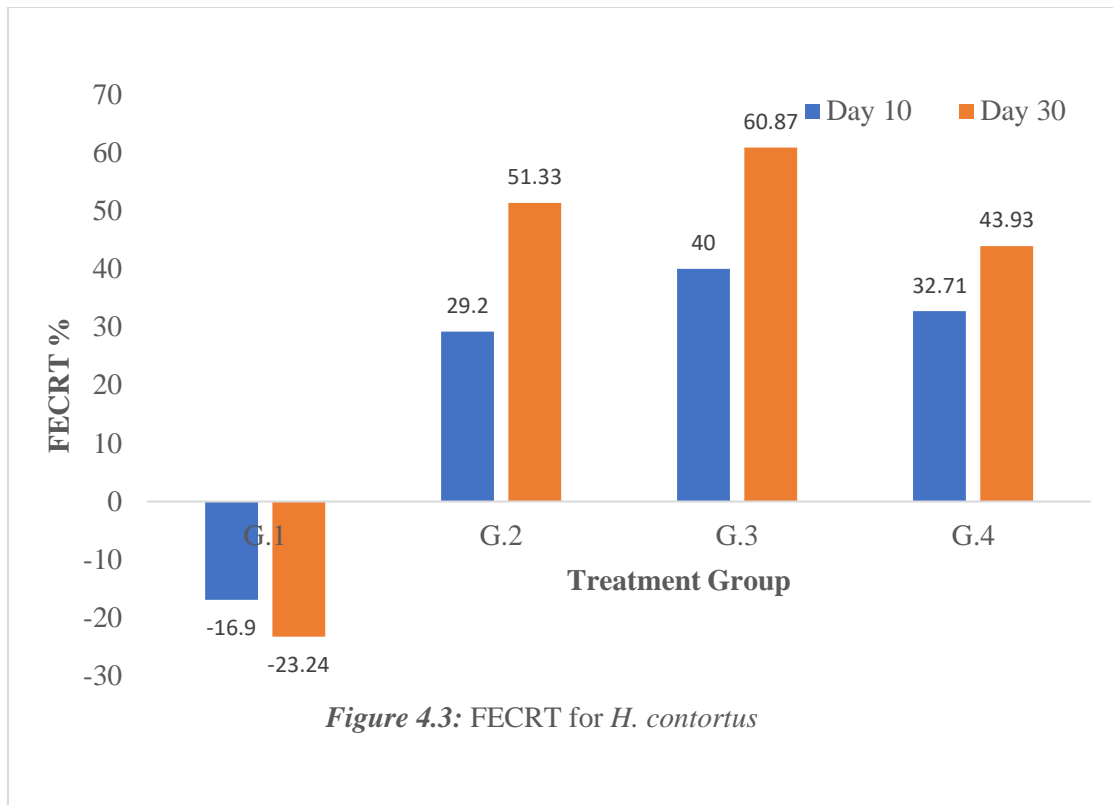
where the mean FEC before treatment was on Day 0, and the mean FEC after treatment was on Day 10 and Day 30.

The FECRT of *H. contortus* and *Moniezia* spp. was recorded on Day 10 and Day 30 across four groups, as shown in **Figure 4.3** and **Figure 4.3** But for the FECRT, Day 10 was used as recommended by WAAVP.

#### **4.3.1. FECRT of *H. contortus***

The FECRT revealed that both papaya seeds (G. 2) and moringa leaves (G.3) exerted measurable anthelmintic effects against *H. contortus*. As illustrated in **Figure 4.3** reductions in egg counts were recorded across the treatment groups. By Day 10 post-treatment, sheep treated with G. 2 demonstrated a 51% reduction, while those treated with G. 3 achieved a slightly higher reduction of 61%. The conventional anthelmintic (Albendazole 10% or G. 4) produced a moderate efficacy, although evidence of reduced sensitivity was noted. The untreated control or negative group (G. 1), on the other hand, exhibited persistently high egg counts throughout the experimental period, confirming the presence of active infection.

These findings suggest that both natural remedies (G.2 and 3) possess ovicidal and larvicidal activity, with G. 3 showing comparatively higher suppression of *H. contortus* egg output than G. 2 and 4.

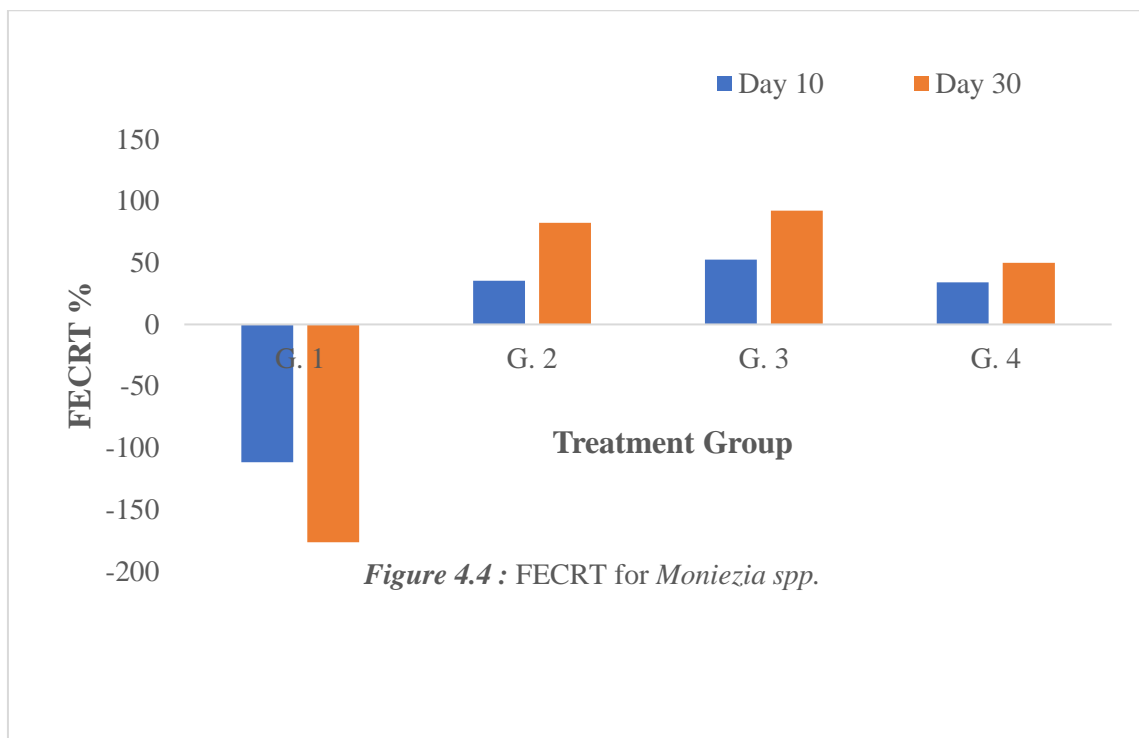


## Field Survey (2025)

### 4.3.2 FECRT of *Moniezia spp.*

The G. 1 (Negative control group) again exhibited an increase in egg count (-111.77%), as shown in **Figure. 4.3**, indicating that in the absence of treatment, parasite loads continued to escalate. Among the treatments, G. 3 extract demonstrated the highest FECRT (52.63%), followed by G. 2 (35.29%) and G. 1 (34.09%). These reductions indicate moderate efficacy, but none achieved the  $\geq 90\%$  benchmark for strong anthelmintic effectiveness on the recommended Day 10 until Day 30, where G. 3 achieved the WAAVP threshold. Noticing as more effective after prolonged usage since it was high at Day 30 instead of the ideal 10 days. FECRT percentages indicate the efficacy of different treatments for *Moniezia spp.* From the **Figure. 4.4**, G. 3 exhibited the highest efficacy against *Moniezia spp.* but achieved the  $\geq 90\%$  benchmark for strong anthelmintic effectiveness (92.13%) on Day 30, followed by G.2, while G. 4 was less

effective than moringa, and G. 1 showed a negative impact, indicating a worsening infection.



## Field Survey (2025)

### 4.4 Statistical Variation

#### 4.4.1 *H. contortus* Egg Among Study Groups

Controlling *H. contortus* load in sheep effectively using the natural remedy under study. There was a different reduction in FEC within the various treatment groups at multiple times, as shown in the **Table. 4.3**. The decline in FEC among treated groups demonstrates the potential of these natural remedies in reducing endo-intestinal parasitic burden, thereby contributing to justifiable parasite management strategies.

**Tab. 4.3 Comparative *H. contortus* Egg Counts Showing Statistical Variation**

Treatment	Days				P-value
	0	5	10	30	
<b>G. 3</b>	668.75±152.6 <sup>c</sup>	481.25±109.4 <sup>bc</sup>	250.0±65.5 <sup>ab</sup>	37.5±18.3 <sup>a</sup>	<0.001
<b>G. 2</b>	718.75±111.8 <sup>b</sup>	543.75±105.4 <sup>ab</sup>	431.3±89.1 <sup>ab</sup>	281.3±86.5 <sup>a</sup>	0.029
<b>G. 4</b>	706.25±124.8	656.25±125.5	550.0±130.6	343.8±151.0	0.249
<b>G. 1</b>	788.9±144.0	877.8±166.7	922.2±163.3	972.2±164.4	0.87

**N.B.:** Values with different superscripts in the same row are statistically different ( $P>0.05$ )

Field Data (2025)

#### 4.4.2 *Moniezia* spp. Egg Among Study Groups

*Table 4.4* presents the efficacy of papaya seeds and moringa leaves against *Moniezia* spp., demonstrating the reduction in worm burden over time. The recorded FEC values at various intervals elucidate the treatments' effectiveness, corroborating the antiparasitic properties attributed to these natural substances and emphasizing their potential as viable alternatives to synthetic anthelmintics for *Moniezia* control in ovine populations.

**Tab. 4.4 Comparative *Moniezia* spp. Egg Counts Showing Statistical Variation**

Treatment	Days				P-value
	0	5	10	30	
<b>G. 3</b>	262.5±63.2 <sup>c</sup>	200.0±53.4 <sup>bc</sup>	100.0±42.3 <sup>ab</sup>	25.0±16.4 <sup>a</sup>	<0.007
<b>G. 2</b>	237.5±82.2	175.0±62.7	112.5±39.8	18.8±9.1	0.057
<b>G. 4</b>	106.3±46.7	100.0±43.3	68.8±26.6	31.3±16.2	0.434
<b>G. 1</b>	94.4±32.7	161.1±54.5	200.0±55.9	261.1±66.0	0.188

**N.B.:** Values with different superscripts in the same row are statistically different ( $P>0.05$ )

Field Data (2025)

#### 4.5 Effect of Treatment on Faecal Consistency

**Table 4.5** shows that only three (3) parameters regarding faecal consistency were recorded: soft, firm and well-formed, and Pellet-like, in this study; In Group 1, the sheep had a variety of faecal consistency, with some (C, E) remaining soft for the entire 30 days, while others (A, B, F, H) began with well-formed stools and gradually deteriorated to soft stools by the conclusion of the observation period.

In Group 2, the sheep had fairly consistent faecal consistency, with the majority of sheep (B, F, H) keeping well-formed stools throughout the 30 days, while a few (A, E) began with soft stools and improved to well-formed stools by the end of the observation period.

In Group 3, the sheep had more variety in their faecal consistencies, with some sheep (A, B, E, and H) beginning with soft stools and progressing to well-formed stools by the conclusion of the observation period.

In Group 4, the sheep had relatively constant faecal consistency, with the majority of sheep having firm or well-formed stool throughout the 30 days, although one sheep (E) began with soft stools and improved to well-formed stools by the conclusion of the observation period. But **Table 4.6** shows the distribution of faecal consistency between treatment groups (Distilled Water, Papaya Seeds, *Oleifera* Leaves and Conventional Dewormer) at various time points (Days 0, 5, 10 and 30). The data shows that *moringa oleifera* had the highest proportion of firm and well-formed faeces (56.2%), followed by *Carica papaya* seeds (50.0%) and Conventional dewormer (31.2%). The distilled water group had the poorest faecal consistency, with only 16.7% of the sheep exhibiting firm faeces and the highest proportion (44.4%) showing soft faeces.

This study illuminates the potential benefits of papaya seeds and *oleifera* leaves as alternative deworming agents, adding to the larger conversation about sustainable and natural anthelmintic remedies.

**Table. 4.5: Faecal consistency of various sheep**

<b>G. 1</b>	<b>Day 0</b>	<b>Day 5</b>	<b>Day 10</b>	<b>Day 30</b>
A	4	1	1	1
B	4	4	1	1
C	1	1	1	1
D	4	4	4	4
E	1	1	1	1
F	4	3	3	1
G	4	4	4	4
H	4	4	1	1
I	3	3	3	3
<b>G. 2</b>				
A	1	4	4	4
B	4	4	4	4
C	4	4	3	3
D	3	3	3	3
E	1	4	4	4
F	4	4	4	4
G	3	3	3	3
H	4	4	4	4
<b>G. 3</b>				
A	1	3	3	4
B	3	3	4	4
C	3	3	3	4
D	3	3	3	3
E	1	1	1	4
F	3	4	4	4
G	3	3	3	3
H	1	4	4	4

**Table. 4.5.: Faecal consistency of various sheep (Con't)**

<b>G. 1</b>	<b>Day 0</b>	<b>Day 5</b>	<b>Day 10</b>	<b>Day 30</b>
A	4	4	4	4
B	3	3	3	3
C	3	3	3	3
D	4	3	4	3
E	1	1	4	4
F	4	3	3	3
G	4	4	3	3
H	4	3	3	3

Field Survey, 2025

**Tab. 4.6** Mean of Faecal consistency at different time points across treatments

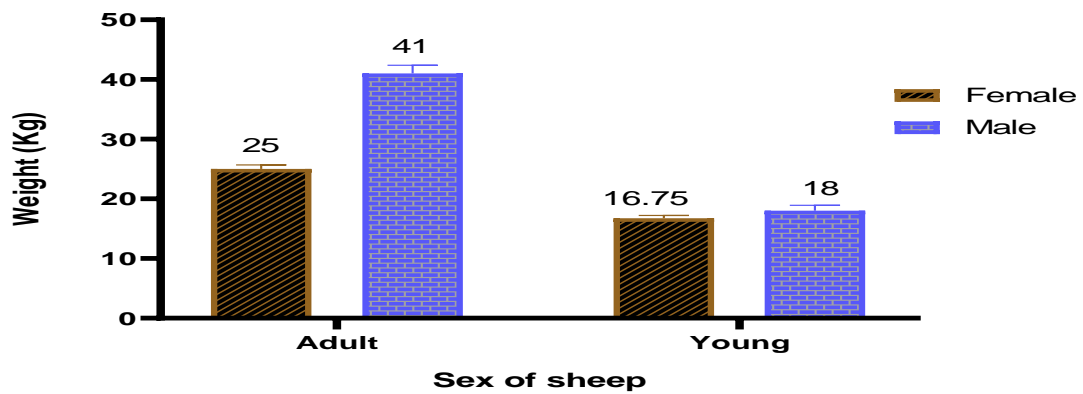
<b>Treatment</b>	<b>n (%)</b>	<b>Firm and Well</b>		
		<b>Formed n (%)</b>	<b>Pellet-like n (%)</b>	<b>Soft n (%)</b>
<b>G. 1</b>	36 (100)	6 (16.7)	14 (38.9)	16 (44.4)
<b>G. 2</b>	32 (100)	16 (50.0)	11 (34.4)	5 (15.6)
<b>G. 3</b>	32 (100)	18 (56.3)	12 (37.5)	2 (6.2)
<b>G. 3</b>	32 (100)	10 (31.2)	20 (62.5)	2 (6.2)

Field Survey, 2025

#### **4.6 Effect of Treatment on Weight Gain**

**Table 4.6** shows there was weight gain by sheep following treatments with the studied natural remedies, but the observed associations were not statistically significant since there is a substantial possibility (0.770, 0.720, 0.886, and 0.995, respectively) that the reported results may have been caused by chance. Hence, the null hypothesis was not rejected in all cases. This indicates there was no direct link between animal growth and health and the reduction of endo-intestinal parasites. **Figure 4.6** demonstrates the weight difference between male and female sheep, as well as adult and young sheep of the same

sex. The data allows me to compare and comprehend the weight features of the various groups of sheep.



**Fig. 4.5: Weight Gain at Pre-treatment according to sex and age.**  
Field Data (2025)

**Table. 4.7:** Mean of Weight gain at different time points across treatments

Treatment	Days				P-value
	0	5	10	30	
<b>G. 4</b>	24.13±2.5	25.06±2.5	26.13±2.4	27.63±2.4	0.770
<b>G. 3</b>	24.5±2.9	25.63±3.0	27.06±3.1	29.19±3.1	0.720
<b>G. 2</b>	26±2.9	27.06±2.8	28.06±2.8	29.06±2.9	0.886
<b>G. 1</b>	26±2.6	25.44±2.5	26.22±2.7	26.39±2.8	0.995

Field Survey, 2025

## CHAPTER FIVE

### DISCUSSION OF RESULTS

#### 5.1 Anthelmintic Efficacy of Papaya Seeds and Moringa Leaves

The increasing threat of AMR to conventional anthelmintics such as albendazole and ivermectin has intensified the search for sustainable alternatives in livestock management. In this context, papaya seeds and moringa leaves have attracted growing scientific attention due to their traditional ethnoveterinary use and phytochemical profiles rich in alkaloids, flavonoids, tannins, and proteolytic enzymes. The present findings demonstrate that both remedies significantly reduced FEC of *Haemonchus contortus* and *Moniezia* spp., aligning with earlier studies that confirmed the anthelmintic activity of papaya and moringa in small ruminants (Pareek et al., 2023; Radwan et al., 2023). Compared with conventional drugs, which face diminishing efficacy due to resistant parasite strains (Kaplan et al., 2023), these plant-based alternatives showed promising levels of parasite suppression, with moringa exhibiting particularly strong effects against *Moniezia* spp. This observation is consistent with its long historical role in traditional medicine and supported by reports that tannins and flavonoids interfere with parasite metabolism and egg hatching. Papaya seeds similarly corroborate earlier research by Daagama et al. (2020), where papain and benzyl isothiocyanate were identified as key bioactive compounds contributing to parasite clearance. Notably, the current study also recorded improvements in weight gain among treated sheep, echoing previous reports (Mahfuz & Piao, 2019; Leone et al., 2021) that phyto-genic remedies not only control parasites but also enhance nutrient utilization. However, while earlier evidence often placed papaya as more effective, this study suggests moringa may offer superior efficacy against certain helminth species, highlighting the need for further comparative trials, dosage standardization, and long-term evaluations relative to conventional anthelmintics.

## **5.2 FECRT for *H. Contortus* and *Moniezia* spp.**

The increasing prevalence of anthelmintic resistance has prompted a heightened interest in exploring plant-based alternatives for the management of gastrointestinal parasites in livestock (Chimbwali, 2022; Jamil et al., 2022; Craven et al., 1999). This study assessed the efficacy of FECR using a conventional dewormer (Albendazole 10%), aqueous extracts of moringa leaves, aqueous extracts of papaya seeds, and distilled water in sheep infected with *H. contortus* and *Moniezia* spp.

The findings from this study revealed that moringa leaves were the most promising natural treatment, eventually achieving the recommended 90% FECRT threshold against *Moniezia* spp. by Day 30. This delayed effect contrasts sharply with published literature, where conventional dewormers typically reach this benchmark within 10–14 days (Kaplan et al., 2023). Such discrepancies suggest that phytochemical-based remedies may act more gradually, possibly due to lower bioactive compound concentrations, slower absorption rates, or interactions with host immunity.

In comparison, papaya seeds exhibited moderate efficacy, reducing FEC substantially but failing to meet the WAAVP threshold within the recommended timeframe. This aligns with prior reports by Radwan et al. (2023), which demonstrated variable outcomes depending on the extraction method and dosage. The conventional dewormer included in this study performed below expectations, further reinforcing growing concerns of resistance among gastrointestinal parasites in Ghana.

These outcomes highlight both the promise and limitations of herbal remedies. On one hand, moringa's superior efficacy suggests its potential as a viable, locally available

alternative for sustainable parasite control. On the other hand, the slower onset of action raises concerns for its use in acute or high-burden infections where rapid parasite clearance is critical.

A key strength of this study lies in its controlled design, which allowed for direct comparison of natural remedies with synthetic drugs and controls. However, limitations include the relatively small sample size, which may have reduced statistical power, and the exclusive use of aqueous extracts, which might not fully capture the potency of the bioactive compounds.

The broader implications of these findings are significant. The ability of moringa to achieve a  $\geq 90\%$  FECRT, albeit delayed, suggests that it may be most effective when integrated into long-term herd health strategies rather than as a stand-alone emergency treatment. Furthermore, the nutritional benefits of moringa, particularly its protein and micronutrient content, may enhance overall animal health and productivity, offering a dual advantage.

Future research should prioritize optimizing dosage and extraction methods, testing the combined use of papaya and moringa, and exploring potential synergies with reduced doses of synthetic anthelmintics. Such approaches could improve both efficacy and sustainability while reducing the risk of resistance development.

In summary, while moringa demonstrated strong potential as a natural dewormer, its delayed action compared to conventional drugs underscores the need for further refinement before widespread adoption. Papaya seeds, though moderately effective, may

serve as a supplementary rather than primary treatment. Together, these findings contribute valuable insight into the role of natural remedies in combating rising anthelmintic resistance.

### **5.3 Effectiveness of Natural Remedies Against *H. Contortus* and *Moniezia* spp.**

#### **5.3.1 Papaya Seeds and Moringa Leaves**

The results highlight a clear difference in the performance of the two natural remedies. Moringa leaves consistently showed stronger efficacy against *Moniezia* spp., surpassing the 90% FECRT threshold by Day 30, while papaya seeds demonstrated only moderate activity. This reinforces findings by Abd El-Hack et al. (2018) and Pareek et al. (2023), who attributed the activity of moringa to its rich phytochemical profile, including tannins, flavonoids, and alkaloids. These compounds interfere with parasite reproduction and metabolism, ultimately reducing egg counts.

Papaya seeds, though less potent, still achieved meaningful reductions in faecal egg counts. Their anthelmintic activity has been linked to bioactive compounds such as papain and benzyl isothiocyanate (Radwan et al., 2023), but the inconsistency observed in different studies suggests that extraction methods, dosage, and host-specific factors strongly influence their effectiveness. In this study, papaya's comparatively modest effect may also have been compounded by the aqueous preparation method, which could yield lower concentrations of active compounds than alcohol-based extractions reported elsewhere.

### **5.3.2 Comparison with Conventional Anthelmintics**

The conventional dewormer used in this trial showed lower-than-expected efficacy, falling below the WAAVP threshold. This outcome is consistent with reports of growing resistance among gastrointestinal parasites, particularly *H. contortus*, to benzimidazole-based drugs in many parts of Africa. The poor performance of the conventional drug in this study underscores the urgent need for alternative control strategies and validates the relevance of exploring plant-based remedies.

Interestingly, while moringa was slower to reach its full effect compared to synthetic drugs, its eventual achievement of the efficacy threshold indicates that natural remedies may still play an important role in long-term parasite management. In contrast, papaya's moderate activity suggests it may be better suited as a supplementary measure, potentially in combination with moringa or reduced doses of conventional drugs.

### **5.3.3 Strengths and Limitations**

The major strength of this study lies in its comparative design, which allowed a head-to-head evaluation of two widely available ethnoveterinary plants against a conventional benchmark. However, the limited sample size and short follow-up period constrained the ability to detect subtler treatment differences and long-term reinfection patterns. Another limitation was the sole reliance on aqueous extracts, which may not reflect the full pharmacological potential of the plants.

### **5.3.4 Implications and Future Directions**

These findings have both practical and scientific implications. From a practical perspective, moringa could provide farmers in resource-limited settings with an

affordable, sustainable, and locally available option for parasite management, particularly where resistance to conventional drugs is widespread. Its added nutritional benefits could further enhance livestock productivity. Papaya, although less potent, could still contribute to integrated parasite management programs when combined with moringa or other treatments.

Future studies should investigate:

- i. The effect of different extraction methods (e.g., ethanolic or methanolic extracts) on efficacy.
- ii. Synergistic use of papaya and moringa together, or alongside low-dose conventional drugs.
- iii. Longer-term trials to assess reinfection rates and sustained efficacy.
- iv. Nutritional and immune-boosting effects of moringa as complementary benefits to its anthelmintic activity.

In summary, while moringa emerges as a more effective natural dewormer than papaya, both remedies hold potential value in integrated parasite management. Their role is not to fully replace conventional drugs in the short term, but rather to reduce dependence on them and mitigate the growing problem of resistance.

#### **5.4.1 Faecal Consistency**

Faecal consistency is a significant indicator of gastrointestinal health in sheep (Smith et al., 2023; Scott et al., 2007). Afterwards, it may indicate parasitic infection, nutritional quality and health status. Common gastrointestinal parasites involved are those of *H. contortus*, followed by *Moniezia spp.*, which generally provoke digestive perturbations,

loss the faeces and cause diarrhoea or change the faecal texture as symptoms of intestinal irritation and damage to the gut lining. Whereby consistent quality of faeces is necessary since chronic diarrhoea or loss of faeces will lead to dehydration, lack of nutrient absorption and eventually weight loss, which reduces sheep productivity and welfare. In such a context, the efficacy of some natural remedies, like the seeds of papaya and moringa leaves, to improve faecal consistency has gained interest from the research community, specifically in locations with high resistance to conventional anthelmintic drugs and in places with low availability of conventional anthelmintic drugs. Papaya seeds and Moringa leaves denote a viable means of controlling endo-intestinal helminths by reducing their load and lessening the faecal quality.

#### **5.4.2 Conventional Anthelmintics and Faecal Consistency**

The conventional dewormer demonstrated an improvement in faecal consistency, which aligns with existing literature highlighting its effectiveness in reducing the helminth burden and restoring normal gastrointestinal function (Effendy et al., 2014). A reduced FEC observed in the conventional dewormers, such as the Albendazole group, likely contributed to the improved faecal consistency.

#### **5.4.3 Papaya Seeds on Faecal Consistency**

The findings on papaya seeds indicate a moderate improvement in faecal consistency, with 31.2% (**Tab. 4.2.4**) of the treated sheep exhibiting firm and well-formed faeces. Studies by Radwan et al. (2023) and Talabis et al. (2019) have reported the anthelmintic properties of papaya seeds, attributing their efficacy to bioactive compounds such as papain and benzyl isothiocyanate. However, the lower efficacy observed in this study

compared to Albendazole suggests that while papaya seeds contribute to helminth reduction, they may not fully restore gut integrity within the study period.

#### **5.4.3 Moringa Leaves on Faecal Consistency**

Moringa leaves showed better faecal consistency outcomes than papaya seeds, with 50.0% (*Tab. 4.2.4*) of the treated sheep displaying firm faeces. This result aligns with research by Pareek et al. (2023) and Abd El-Hack et al. (2018), which highlight the presence of flavonoids, tannins, and alkaloids in moringa, compounds known for their anti-inflammatory and gastrointestinal-protective effects. In *Tab. 4.2.4*, there is a higher proportion of pellet-like faeces (34.4%) which is in line with a study by Farrag (2024) to find other benefits of adding moringa leaves to the feed of goats, in the moringa group as compared to the conventional dewormer group (37.5%), suggesting that while moringa leaves are effective, their impact on firm faecal consistency may require longer administration or combination with other interventions.

#### **5.4.4 Negative Control (Distilled Water)**

The poor faecal consistency in the distilled water group, with 44.4% (*Tab. 4.2.4*) of sheep having soft faeces, confirms the impact of gastrointestinal parasitism on faecal quality. Studies by Amin (2021) and FAO (2020) highlight that severe helminth infections can lead to diarrhoea, nutrient malabsorption, and weight loss in sheep, supporting the observed outcomes in this study.

#### **5.4.5 Safety and Side Effects**

FAO and WOAHA say that helminth infestation is a long-lasting disorder caused by small ruminants. Papaya seeds and moringa leaves have related safety profiles, making them

potential contenders, especially in rural settings with resource-poor conditions (Kassai, 1999).

There have been adverse effects of papaya seed dosage when it is administered, according to Radwan et al. (2023). Alternatively, the leaves of moringa are nutritious and safe for sheep when given at levels within recommendations (Zirintunda et al., 2022; Leone et al., 2021). The only downside of either treatment could be mild gastrointestinal distress due to overconsumption of either treatment, which again can be minimized by titration of dosage. In conclusion, for faecal consistency purposes, papaya seeds and moringa leaves provide a safe and, in specific ways, more effective alternative to synthetic anthelmintics with additional benefits of decreased parasitic resistance and improved internal organ health. Based on the assessment of their safety, combining papaya seed and moringa leaves will be an appropriate component in integrating helminth management strategies that will aim to improve faeces' consistency and sheep's general health.

### **5.5.1 Anthelmintic Efficacies Against Weight Gain**

The impact of parasitic control on weight gain is a critical measure of treatment effectiveness because gastrointestinal helminths compromise nutrient absorption and overall growth performance. In this study, both moringa leaves and papaya seeds contributed to weight improvement, though moringa showed a more pronounced effect. This outcome can be linked not only to its higher anthelmintic activity but also to its well-documented nutritional value, being rich in proteins, vitamins, and minerals (Mahfuz & Piao, 2019; Leone et al., 2021). These dual benefits may explain why sheep treated with moringa exhibited steady weight gains throughout the trial.

Papaya seeds also promoted weight gain, albeit to a lesser extent. Their partial reduction of worm burden likely improved nutrient utilization, which translated into moderate growth. Similar findings have been reported in poultry studies (Talabis et al., 2019), where papaya supplementation improved weight and feed conversion efficiency. However, the effect in sheep appears weaker, suggesting species differences or the need for optimized dosages.

The conventional dewormer, despite being a standard treatment, showed relatively limited effects on weight gain. This reflects the reduced efficacy observed in the FECRT results, supporting the conclusion that resistance may be diminishing its utility in improving both health and productivity outcomes.

### **5.5.2 Long-Term Significance**

The observed weight gains, particularly in the moringa group, highlight the potential of natural remedies not only for parasite control but also for enhancing production efficiency in small ruminant farming. Over time, this dual action could reduce farmers' reliance on costly supplements while improving profitability. Importantly, integrating nutritional and medicinal benefits within a single plant-based intervention aligns with sustainable livestock practices in resource-limited settings.

Nonetheless, the long-term sustainability of these effects remains uncertain. The study's relatively short timeframe did not allow for the assessment of reinfection cycles, seasonal variations, or whether repeated administration might be necessary to maintain benefits.

## CHAPTER SIX

### SUMMARY

#### 6.1 Conclusions

This study set out to evaluate the anthelmintic efficacy of papaya seeds (*Carica papaya*) and moringa leaves (*Moringa oleifera*) in sheep under controlled conditions, with reference to four specific objectives. The key conclusions are as follows:

##### **Efficacy in Reducing FEC:**

Both moringa leaves and papaya seeds reduced faecal egg counts, with moringa showing stronger efficacy, particularly against *Moniezia spp.*, where it achieved the  $\geq 90\%$  FECRT threshold by Day 30. Papaya seeds demonstrated moderate reductions but did not reach the threshold within the study period. This confirms the anthelmintic potential of both plants, though moringa proved superior.

##### **Comparison with Conventional Anthelmintic:**

The conventional dewormer (Albendazole 10%) performed below the expected WAAVP efficacy threshold, consistent with growing concerns about anthelmintic resistance in Ghana. The relatively higher efficacy of moringa compared with Albendazole highlights its potential as a sustainable alternative for parasite management.

##### **Faecal Consistency:**

Improvements in faecal consistency were observed in both moringa- and papaya-treated groups, with moringa showing greater impact. This suggests that beyond reducing parasite loads, these remedies improve gut health, reducing diarrhoea and other helminth-related clinical signs.

### **Weight Gain:**

Sheep treated with moringa showed more consistent weight gain compared to those treated with papaya or Albendazole. This may reflect moringa's dual role as an anthelmintic and a nutrient-rich feed supplement, offering added benefits beyond parasite control.

Overall, the study demonstrates that moringa leaves, and to a lesser extent papaya seeds, can serve as cost-effective, locally available alternatives to conventional dewormers. Their use aligns with sustainable livestock production strategies, particularly in areas burdened by drug resistance and limited veterinary resources.

## **6.2 Recommendations**

Based on these findings, the following recommendations are made:

### **6.2.1 For Farmers:**

- i. Moringa leaves should be considered as a supplementary feed to improve both parasite control and overall sheep productivity.
- ii. Papaya seeds may still be used as part of integrated parasite management, but not as a standalone treatment for heavy infections.

### **6.2.2 For Veterinary and Extension Services:**

- i. Awareness programs should be developed to promote the safe and effective use of moringa and papaya as ethnoveterinary remedies.
- ii. Guidelines for dosage, preparation, and administration need to be standardized to maximize efficacy and minimize variability.

### **6.2.3 For Policy Makers:**

- i. Support should be given to research and extension programs that integrate locally available plant-based remedies into parasite management strategies.
- ii. Investments should be made in sustainable alternatives to reduce dependence on synthetic anthelmintics and slow the spread of resistance.

### **6.2.4 For Future Research:**

- i. Long-term studies should be conducted to assess the sustainability of moringa and papaya efficacy across different seasons and reinfection cycles.
- ii. Dose-optimization trials, including alternative extraction methods (e.g., ethanol-based), are needed to enhance the bioavailability of active compounds.
- iii. Studies on combined therapies (moringa + papaya, or plant-based remedies + reduced-dose Albendazole) should be pursued.
- iv. Economic evaluations comparing natural remedies with synthetic drugs will help clarify cost-effectiveness for smallholder farmers.
- v. Importantly, further research should explore whether the WAAVP-recommended FECRT timeframe (10-14 days) should be extended for plant-based remedies. The delayed efficacy of moringa in this study (threshold reached by Day 30) suggests that current guidelines may underestimate the true potential of slower-acting phytochemicals.

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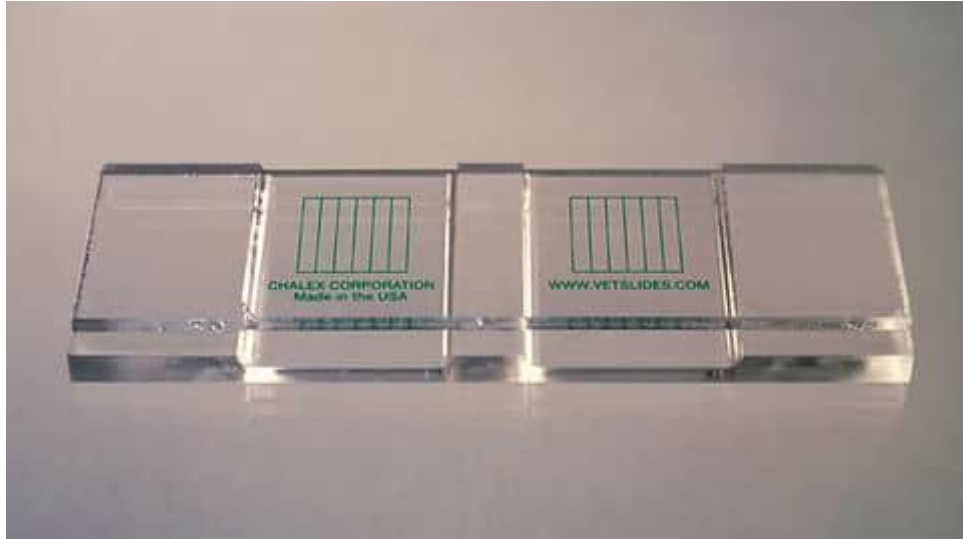
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## APPENDICES

### 1. Equipment and Instrument for the Faecal Count



### 2. McMaster Counting Chamber



### 3. Faecal Cup with Different Faecal Consistency



### 4. Pipette for Filling the McMaster Counting Chamber

## APPENDIX B

### McMaster Technique/Method

#### Procedure of McMaster Techniques

A 2-gram sample of faeces was accurately measured and placed into a clean container. To this, 60 millilitres of a saturated sodium chloride solution was added and thoroughly mixed using a stirring tool to ensure homogeneity. The resulting mixture was then subjected to centrifugation at 1500 revolutions per minute (rpm) for five minutes. Following centrifugation, the tube was carefully removed and placed upright without agitation.

Using a Pasteur pipette, a portion of the supernatant was extracted and gently introduced into both chambers of a McMaster counting slide. The slide was left undisturbed for approximately 3 to 5 minutes to allow the eggs to float and stabilize just below the surface of the chamber.

Microscopic examination of the chambers was conducted at a magnification of 10x. Counting was focused within the engraved grid area of both chambers. The grid lines were brought into sharp focus initially, followed by a slight adjustment downward to visualize the floating parasitic elements. All visible helminth eggs and coccidian oocysts within the counting area were recorded.

The calculation of eggs from chambers is:

$$\text{Egg Per Gram} = \frac{\text{Egg Count} \times \text{Total volume counted}}{\text{Grams of Faeces used}} \quad (\text{Adapted from Tagesu, 2018})$$

## Illustration of McMaster Counting Chambers and Egg Counts

<i>Chamber 1</i>	<i>Chamber 2</i>
x	x
x                      x	x                      x                      x
x	x
x                      x	x                      x                      x                      x
x                      x	x                      x                      x                      x
x                      x	x                      x                      x                      x

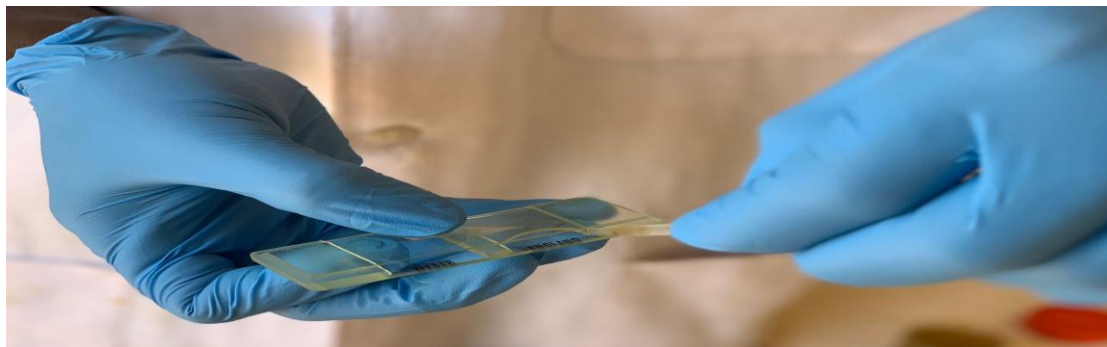
**Example:** Chamber 1(10 Eggs) + Chamber 2 (20 Eggs)

$$\text{Egg Per Gram} = \frac{(10+20) \times 50}{2} = \frac{1,500}{2} = 750$$

**NB:**

**Interpretation:** Egg counts above 1000 EPG are typically indicative of heavy parasitic infections, whereas counts above 500 EPG suggest moderate infection levels. However, it is important to note that a low egg count does not always correlate with low worm burden, as egg output can vary due to several biological and environmental factors (Tagesu, 2018).

### Filling Techniques



Filling the McMaster Counting Chamber

### APPENDIX C

## INTESTINAL HELMINTHS

### i. Intestinal Helminths During Postmortem



Macroscopic appearance of “*H. contortus*” during postmortem examination (Gareh et. al. 2021)

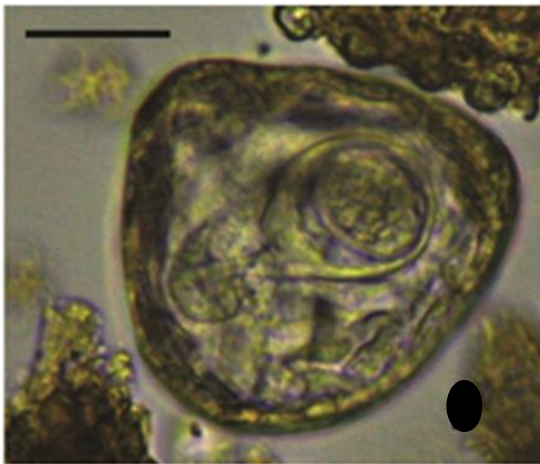


Macroscopic appearance of “*Moniezia* spp” during postmortem examination (OIP.wR8w-jnKLX3qnZMHkEY4FQHafj {474×355})

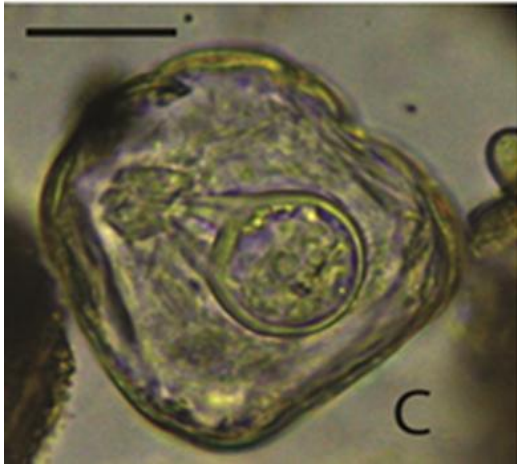
ii. Intestinal Helminths Ova under Light Microscopy



*Heamonchus contortus* ova under a light microscope (Boylu & Önder 2020)



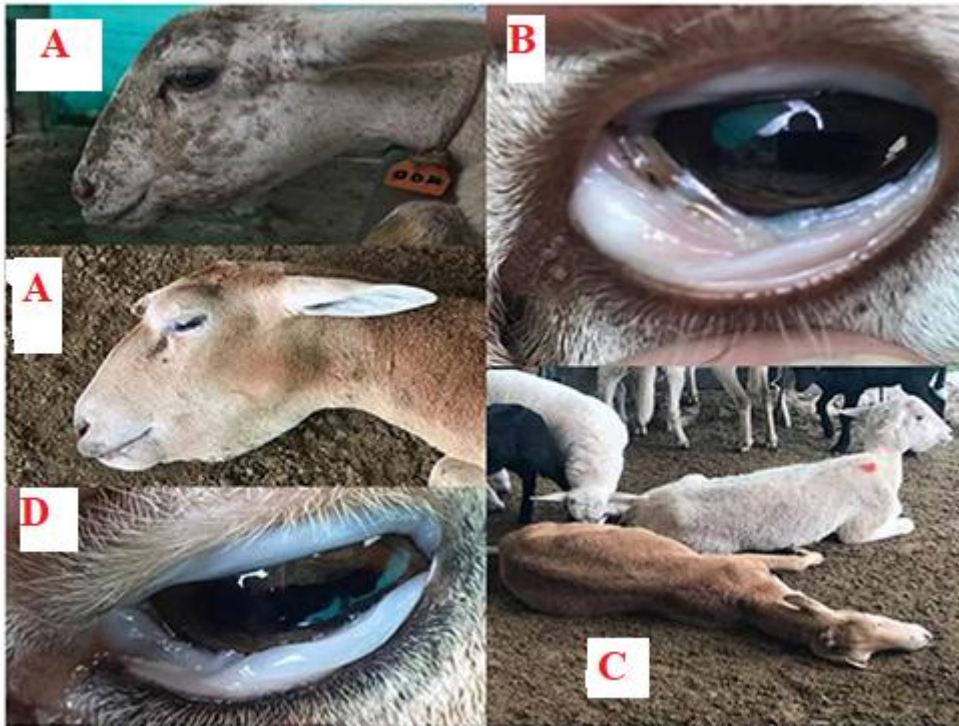
*Moniezia expansa* under a light microscope (Obanda et. al., 2019)



*Moniezia benedini* under a light microscope (Obanda et. al., 2019)



Ova found in sheep according to size from Pinterest



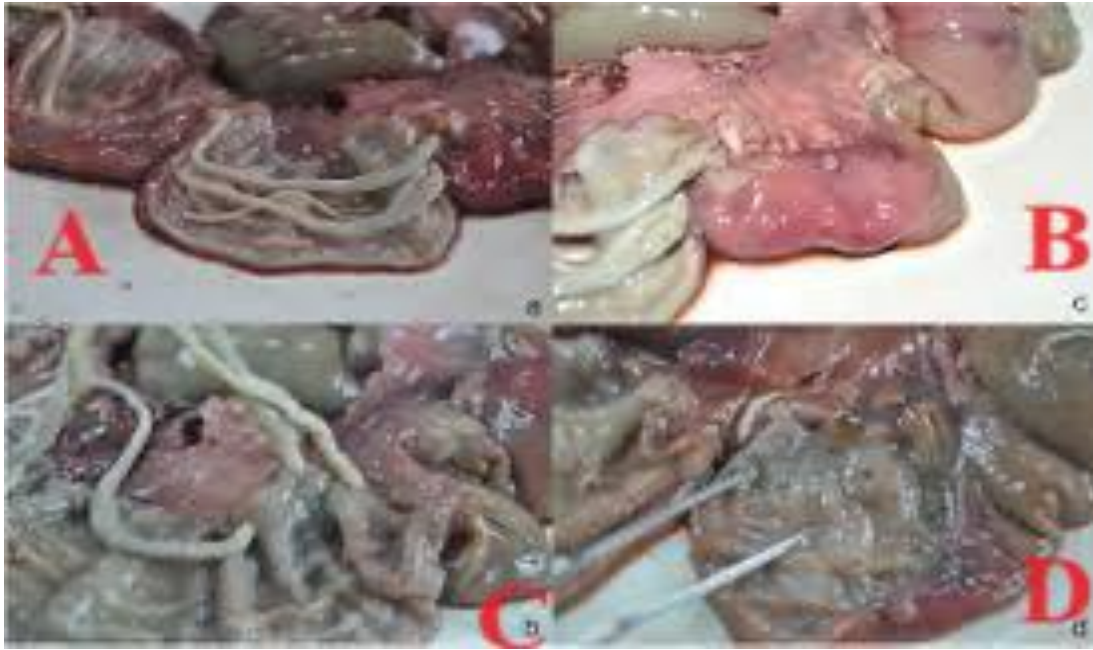
Clinical signs appeared on the examined animals:

- A. bottle jaw
- B. obvious signs of anaemia
- C. weakness
- D. severe anaemia

(Gareh *et al.* 2021)








Intestine of Sheep Suffering from Worm Infestation Before Opening.  
Picture by DIF (2023)



Signs appeared during post-mortem Inspection in the Week after Deworming  
Picture by Author, 2024

- A – Week One
- B – Week Two
- C – Week Three
- D – Week Four

APPENDIX D: Sheep Faecal Scoring Chart at Techiman Disease Investigation Farm		
Type	Shape	Detailed
1		<b>Description:</b> Liquid consistency with no solid pieces <b>Meaning:</b> Inflammation and Diarrhoea
2		<b>Description:</b> Like a smooth, Soft Sausage or Snake <b>Meaning:</b> Normal
3		<b>Description:</b> Sausage shape with Cracks in the surface <b>Meaning:</b> Normal
4		<b>Description:</b> Lumpy and Sausage like <b>Meaning:</b> Slightly Constipated
5		<b>Description:</b> Separated hard lumps <b>Meaning:</b> Very Constipated

*Faecal Consistency of the Sheep, adopted from nagonline.com*

**APPENDIX E**

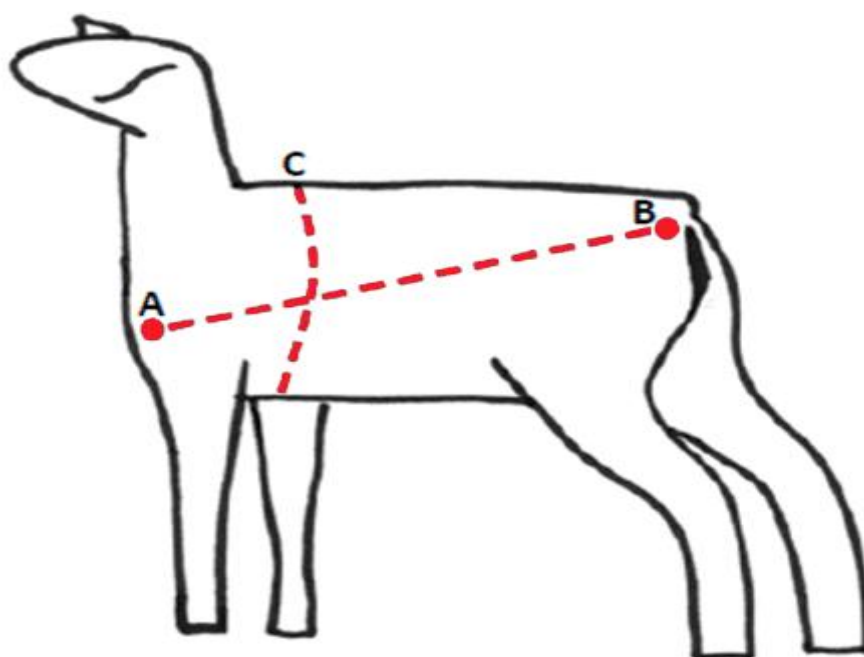
**MORPHOMETRIC MEASUREMENTS**



Measuring the length of the sheep in “cm” Field survey, 2025



Measuring the heart girth of the sheep in “cm” Field survey, 2025



This guide was adopted and adapted from (Practical Farmers,2019 and Gizaw, 1995) to determine the weight of the sheep used in the study, and it is known as **Morphometric Measurements**.

### **Procedure for Estimating the Body Weight of Sheep Using Morphometric Measurements**

i. **Heart Girth Measurement**

Determine the heart girth of the sheep by measuring the circumference of the chest just behind the front legs, at the level of the heart. In woolly sheep, gently press down the fleece to obtain an accurate reading that reflects the actual body size and not the wool, as shown in “C”.

ii. **Body Length Measurement**

Measure the straight-line distance from the point of the shoulder (anterior) to the point of the rump (posterior). This represents the body length, as shown by the line “AB”.

iii. **Body Weight Estimation Formula**

Use the following formula to estimate the body weight (BW) of the animal:  

$$\text{HEART GIRTH} \times \text{HEART GIRTH} \times \text{BODY LENGTH} / 300 = \text{ANIMAL WEIGHT}$$

**For example**, if a sheep has a heart girth equal to 25 cm and a body length equal to 20 cm, the calculation would be  $(25 \times 25 \times 20) / 300 = 41.67$  kg

### **APPENDIX F**

## Faecal Sampling



Faecal Sampling in the morning Field Survey, 2025

**APPENDIX G**

**Research Assistants**



Research Assistants (Field) in **White** and Internship students in **Brown**

Field Survey, 2025



The only lady to support  
Field Survey, 2025



Research Assistants (Field and Laboratory)  
Field Survey, 2025

### Sheep in the Pen



Sheep in the Pen      Field Survey, 2025



Front View of the Bono East Regional Veterinary Laboratory-Techiman  
(*Coordinates: 7.59529, - 1.93331*) Field Survey, 2025



Front View of the Disease Investigation Farm-Techiman (*Coordinates: 7.5941, - 1.93285*) Field Survey, 2025

## **APPENDIX H**

### **AKENTEN APPIAH–MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT**



### **INSTITUTIONAL ETHICAL REVIEW COMMITTEE (AAMUSTED-IERC)**

### **APPLICATION FOR ETHICAL CLEARANCE**

## **ARRANGEMENTS OF PROTOCOL REVIEW**

1. APPLICATION LETTER
  - 1.1 APPLICATION LETTER FROM PRINCIPAL INVESTIGATOR
  - 1.2 SUPERVISOR'S CONSENT LETTER
  - 1.3 COVER LETTER FROM HEAD OF DEPARTMENT
2. BACKGROUND INFORMATION
3. PROPOSAL
4. INFORMED CONSENT FORM
5. CHECKLIST
6. RESEARCH INSTRUMENT
7. CURRICULUM VITAE
  - 7.1 ABRIDGED CV PRINCIPAL INVESTIGATOR
  - 7.2 CURRICULUM VITAE FOR SUPERVISOR

The Chairperson,  
Disease Investigation Farm/Regional Veterinary Laboratory,  
Post Office Box 122,  
Techiman, Bono East.  
4<sup>th</sup> December, 2024

Institutional Ethical Review Committee,  
Akonten Appiah-Menka University of Skills Training and Entrepreneurial  
Development, Kumasi, Asante Region.

Dear Chairperson,

### **APPLICATION FOR ETHICAL CLEARANCE**

I am writing to apply for clearance to do my research as part of a graduate program. As a student committed and eager to pursue a Master of Philosophy in Public Health at AAMUSTED, I am willing to contribute to advanced research in your institution's educational honours.

I want to strengthen these foundations of excellence in research. My coursework has given me a deep understanding of “**Assessing the anthelmintic efficacy of papaya seeds and moringa leaves in sheep at Disease Investigation Farm**”, and I am eager to apply this knowledge to real-world research challenges.

My academic background, experience and analytical skills make me the ideal person to contribute to this research. I believe that my passion and enthusiasm will add tremendous value to the program as I continue my education and professional development.

I am available to discuss potential opportunities to participate in research projects and welcome the opportunity to provide additional information about my qualifications. Thank you for considering my application. I look forward to contributing to advancing knowledge in Antimicrobial and Neglected Tropical Diseases.

Yours faithfully,



Dwaah Prince Kyere,  
**Student ID: 8238000017.**



OUR REF: M/DPHE/ADM/G/03/27

13 December 2024 The Chairman  
Committee on Human Research,

Publication & Ethics AAMUSTED,

Kumasi

Dear Sir,

**LETTER OF RECOMMENDATION: DWAAH PRINCE KYERE**

Mr. Prince Kyere Dwaah (Index number: 8238000017) is an MPhil. Public Health student at the Department of Public Health Education, Faculty of Environment and Health Education at the Mampong Campus of the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED).

Mr. Dwaah, as part of his academic requirements for the award of a Master of Philosophy Degree in Public Health, is to undertake a project dissertation on “Assessing the Antihelmintic Efficacy of Papaya seeds and Moringa leaves in Sheep at the Techiman Investigation Farm”.

This will be a cross-sectional study that seeks to assess the antihelmintic efficacy of papaya seeds and moringa leaves in controlling intestinal nematodes in sheep, focusing on their effectiveness as alternatives to synthetic dewormer. The study site will be the Disease Investigation Farm at Techiman. The outcome of this study is likely to provide insights into a more cost effective and sustainable alternative for managing intestinal helminths in sheep. The data collected will be used solely for academic purposes.

We would be grateful if your outfit would accord him the needed assistance for the successful execution of this proposed study. Your kind approval is required to conduct this study in fulfilment of his academic obligation. Thank you for your kind consideration.

Yours faithfully,

Dr. Nana Yaa Awua-Boateng  
(Academic Supervisor)

**Email:** [dphe@aamusted.edu.gh](mailto:dphe@aamusted.edu.gh)



M/DPHE/ACA/39/01

December 11, 2024

The Chairman  
Institutional Ethical Review Committee  
AAMUSTED  
Kumasi

Dear Sir/Madam,

**INSTITUTIONAL LETTER OF SUPPORT: ASSESSING THE ANTHELMINTIC  
EFFICACY OF PAPAYA SEEDS AND MORINGA LEAVES IN SHEEP AT TECHIMAN  
DISEASE INVESTIGATION FARM**

Mr. Prince Kyere Dwaah (Index number: 8238000017) is our MPhil. Public Health student at the Department of Public Health Education, Faculty of Environment and Health Education, AAMUSTED.

Mr. Dwaah, as part of his academic requirements for the award of Master of Philosophy Degree in Public Health, is to undertake a project thesis on "*Assessing the Anthelmintic Efficacy of Papaya Seeds and Moringa Leaves in Sheep at Techiman Disease Investigation Farm*".

We seek your consent to grant him ethical clearance to collect data from the Techiman Disease Investigation Farm in the Techiman Municipal of the Bono East Region.

The research team is led by our student (Prince Kyere Dwaah) under the supervision of Dr. Nana Yaa Awua-Boateng and Dr. Helena Agyei Lartey, who are experienced researchers with the requisite skills to support the study.

Therefore, the department would be grateful if your outfit could approve the proposed research and its execution. We fully support this proposed study and its execution.

Yours Sincerely,

**REV. DR. DENIS DEKUGMEN YAR**  
Head, Department of Public Health Education



**MINISTRY OF FOOD AND AGRICULTURE  
DISEASE INVESTIGATION FARM AND VETERINARY LABORATORY  
BONO EAST REGION TECHIMAN**

TEL: 03520-91607  
Mobile: 020-8135024  
B/A  
E-mail: aoseitutu@hotmail.com  
Our Ref No: DIF/TCH/RES01  
Your Ref No: .....



P.O. BOX 122  
TECHIMAN-

REPUBLIC OF GHANA

02/12/2024

The Chairperson,  
Institutional Ethical Review Committee,  
Akonten Appiah-Menka University of Skills Training and Entrepreneurial  
Development (AAMUSTED-IERC),  
Kumasi, Asante Region.

Dear Sir/Madam,

**CONSENT FOR RESEARCH ON ANTHELMINTIC EFFICACY OF PAPAYA  
SEEDS AND MORINGA LEAVES IN SHEEP**

I am writing to formally inform you that consent has been granted for the use of the farm animals at the Disease Investigation Farm, Techiman, for a research study to be conducted by Mr. Dwaah Prince Kyere, a Master of Philosophy (M.Phil.) student in Public Health at Akonten Appiah-Menka University of Skill Training and Entrepreneurial Development, Asante Mampong – Ghana.

The research, titled “**Assessing the Anthelmintic Efficacy of Papaya Seeds and Moringa Leaves in Sheep at Techiman Disease Investigation Farm**”, is set to begin in January 2025. Mr. Dwaah, who is also in charge of the Veterinary Laboratory Unit at the Regional Veterinary Laboratory, will be overseeing the project. The study aims to assess the effectiveness of natural anthelmintic agents, specifically papaya seeds and moringa leaves, on sheep health, contributing to the field of veterinary medicine and public health.

I look forward to collaborating and sharing insights from this important study with the AAMUSTED-IERC. Should you require any further details regarding the research or the consent process, please feel free to contact me directly. Thank you for your attention to this matter.

Yours faithfully,

Dr. Anthony Osei – Tutu,  
Farm Manager Disease Investigation Farm,

**A. BACKGROUND INFORMATION**

**Title of Proposal:**

Assessing the Anthelmintic Activity of Papaya Seeds and Moringa Leaves in Sheep at the Disease Investigation Farm.

**Principal Investigator:**

Dwaah Prince Kyere, Master of Philosophy in Public Health, Public Health Education, Post Office Box 122, Techiman, 0540622111 & 0200759509, [pkdwaah@aamusted.edu.gh](mailto:pkdwaah@aamusted.edu.gh)

**AAMUSTED STC NUMBER** (Proposal number to be provided by the AAMUSTEDIRB Office):.....

**STC Approval Date** (If Applicable):.....

For Students: Attach approval letter from Head of Department and

Supervisor For Collaborating Institutions (Attach a letter of Approval)

**Source(s) of Funding:** Not Funded.

**Type of research:**

Parallel Design  $\longrightarrow$  Randomized Control Trail  $\longrightarrow$  Experimental Research.

**INSTITUTION:**

Akenten Appiah-Menka University of Skill Training and Entrepreneurial  
Development, Asante Mampong – Ghana

**PROGRAM:**

Master of Philosophy in Public Health

**CANDIDATE'S NAME:**

Dwaah, Prince Kyere

**CANDIDATE'S ID NUMBER:**

8238000017

**PROPOSED DATE OF COMMENCEMENT OF DATA COLLECTION:**

2<sup>nd</sup> February, 2025

**PROPOSED DATE TO SUBMIT FINAL WORK:**

31<sup>st</sup> July, 2025

**TITLE:**

ASSESSING THE ANTHELMINTIC EFFICACY OF PAPAYA SEEDS  
AND MORINGA LEAVES IN SHEEP AT TECHIMAN DISEASE  
INVESTIGATION FARM

## **EXECUTIVE SUMMARY**

The study is entitled "**Assessing the Anthelmintic Efficacy of Papaya Seeds and Moringa Leaves in Sheep at Techiman Disease Investigation Farm,**" discovers sustainable alternatives to combat growing resistance to conventional dewormers in small ruminant (sheep). Endo intestinal parasites, like as *Haemonchus contortus*, significantly reduce sheep productivity, leading many farmers in Techiman, Ghana, to adopt natural remedies like papaya seeds and moringa leaves.

The research aims to evaluate the efficacy of these remedies in reducing parasitic worm loads, comparing them to standard anthelmintics. Specific objectives include assessing faecal egg count (FEC) reduction, improvements in faecal consistency, and weight gain.

A controlled trial involving

33 sheep will use the McMaster egg-counting technique to measure outcomes. Ethical considerations prioritize humane animal treatment and welfare.

Expected outcomes include significant FEC reduction, improved health markers, and evidence supporting the effectiveness of these plant-based treatments. This study aligns with UN SDGs 2 and 3, promoting sustainable livestock practices and reducing reliance on chemical dewormers.

By providing a cost-effective, eco-friendly alternative for managing parasitic infections, this research holds the potential to improve livestock health, enhance agricultural productivity, and inform veterinary policies in resource-limited settings. Completion is slated for July 2025.

## **INTRODUCTION**

### **Background of the study**

Parasitic diseases, especially gastrointestinal parasites, threaten sheep productivity and

health globally (Jamil *et al.*, 2022; Olounladé *et al.*, 2021). According to the World Health Organization (WHO), anthelmintic resistance is a major concern, affecting drug efficacy and farmers' financial losses. Antimicrobials are a top global health risk, prompting a growing interest in sustainable, cost-effective treatments.

Parasitic illnesses significantly impact sheep productivity in Africa, affecting livelihoods (Chimbwali, 2022) and food security (Adesola *et al.*, 2019). According to Laksemi *et al.*, (2022), numerous parasite organisms damage livestock, cause financial losses, and hinder agricultural production. The Food and Agricultural Organization's data on anthelmintic resistance in African countries complicates sheep husbandry management. Asante-Kwatia *et al.* (2021) highlight the significant gastrointestinal parasites, *Haemonchus contortus* and *Moniezia* spp., that hinder sheep production in Ghana, emphasizing the need for alternative parasite management strategies.

Plant-based natural medicines are gaining popularity due to their efficacy and sustainability (Asunción *et al.*, 2022; El-Ghany, 2020). They have been used for food and medicine for generations. Pareek *et al.* (2023), research on herbal remedies in Ghana, including *Carica papaya*, *Allium sativum*, *Areca catecha*, *Ananas comosus*, *Nicotiana tabacum*, *Cucurbita moschata*, and *O. sativa*, has been limited.

The study investigates the effectiveness of papaya seeds and moringa leaves in treating intestinal nematodes in sheep, with potential benefits for alternative management strategies and improved health.

### **Problem Statement**

The World Health Organization (WHO) has listed antimicrobial resistance as one of the ten threats to global health. Antimicrobial resistance threatens human and animal health and welfare, environment, food and health, economic development, and social security.

Gastrointestinal parasites in sheep farming are long-lasting and widespread problems that greatly affect animal health and productivity, according to a report from the Bono East Regional Veterinary Laboratory in Techiman. In Techiman, infections caused by nematodes such as *Haemonchus contortus*, *Teladorsagia circumcincta*, and *Trichostrongylus spp.* result in notable financial losses due to reduced growth rates, meat output, and higher mortality rates according to a report from the Livestock Division of the Animal Production Division and the Municipal Veterinary Clinic in Techiman.

A report from the Disease Investigation Farm (DIF) revealed a disturbing pattern: sheep treated with standard dewormers for less than a month still had significant levels of helminthiasis. This circumstance signals a rapid return of parasitic infections or the development of resistance to routinely administered anthelmintic drugs. The continued need for deworming, even after recent treatments, highlights the growing problem of anthelmintic resistance. This lowered resistance limits the efficiency of standard anthelmintics, making parasite control more difficult and expensive. Farmers encounter a pattern of repeated and failed treatments, resulting in rising costs and poor animal health. Because of this roughly 45% of the farmers in Techiman have started using natural herbs in treating their small ruminants, and out of the 45, 33 people use moringa leaves and papaya seeds to treat worms. According to their findings, natural herbs such as papaya seed, moringa leaves, and Aidan fruit ("Perekese") are widely used to cure small ruminants suffering from helminths and other ailments.

Given the challenges experienced by the Techiman Disease Investigation Farms and Regional Veterinary Laboratory, there is an urgent need to study alternate strategies for parasite control that are efficient, long-lasting, and cost-effective. Plant-based therapies such as papaya seeds and moringa leaves have been identified as promising alternatives

due to their anthelmintic characteristics. However, there has been limited empirical study on the efficacy and safety of these therapies in sheep, particularly in Ghana.

### **Objectives of the Study**

**General Objective:** To assess the anthelmintic efficacy of papaya seeds and moringa leaves in sheep.

#### **Specific Objectives:**

- i. To determine the anthelmintic efficacy of papaya seeds and moringa leaves in reducing the Faecal Egg Count (FEC) in sheep.
- ii. To compare the efficacy of papaya seeds and moringa leaves with that of conventional anthelmintic dewormers.
  - iii. To assess the faecal consistency after applying the natural remedy
  - iv. To assess weight after the application of the natural remedy.

#### **Significance of the study**

- i. The results of this study will help farmers and veterinary authorities address the potential for sustainable and cost-effective parasite control in livestock.
- ii. This research aims to provide valuable insights into alternative natural remedies, promoting animal welfare, improving livestock health, and potentially reducing reliance on conventional anthelmintic drugs, which may have economic and environmental implications.

### **Justification of the Study**

The justifications for this study will be as follows:  
Increasing the resistance of internal parasites to conventional anthelmintics poses a significant challenge for livestock management. Exploring alternative treatments such as natural remedies is crucial for addressing this issue.

Secondly, the potential cost-effectiveness of utilizing locally available and easily cultivable substances such as papaya seeds and moringa leaves can provide sustainable solutions for farmers, particularly in resource-constrained settings.

Additionally, this research aligns with several United Nations Sustainable Development Goals (SDGs). Below is an explanation of how this research contributes to the specific SDGs:

**SDG 2: Zero Hunger:** This research aims to enhance agricultural productivity and livestock health through natural anthelmintics, supporting sustainable food production systems and reducing reliance on chemical treatments, thereby reducing climate change resilience.

**SDG 3: Good Health and Well-being:** Effective management of parasitic infections in livestock prevents diseases, improves public health, and reduces drug residues while reducing chemical anthelmintics reduces environmental contamination and human exposure.

## **METHODS**

### **Study Site**

Techiman, the capital of the Bono East Region, is situated at a historical trade route crossroads and the Tano River. Covering 647.6 km<sup>2</sup> with a population density of 375.8 km<sup>2</sup>, the municipality is home to three major vegetation zones and focuses on crop and livestock production.

Techiman, Ghana's bustling city, is known as the "Food Basket of Ghana" due to its large traditional market and annual market operations. With a cosmopolitan population from various backgrounds, Techiman is home to 243,335 people, with 90% being rural. The municipality is divided into five zonal councils and 24 administrative

units, including Techiman Zonal Council, Tanoso Zonal Council, Tano Zonal Council, Nsuta Zonal Council, and Nkwaeso Zonal Council. Disease Investigation Farm (DIF), located in Techiman, Bono East, is the only investigation farm in Ghana with a laboratory and an experimental animal farm with over 36 sheep.

### Study Population

All animals that had been in the pen for more than one month.

### Sample Size

**Finite Population Correction (FPC)** will be used to calculate the sample size in this study. The formula for sample size in a finite population is:

$$n = \frac{N \times Z^2 \times p \times (1-p)}{e^2 \times (N-1) + Z^2 \times p \times (1-p)}$$

**n** is the sample size, **N** is the population size (1925), **Z** is the Z-value (1.96 for 95%),

**p** is the estimated proportion (0.5) and **e** is the margin of error (0.05 for 5%).

Steps to Calculate:

**Choose confidence level:** 95% confidence was used, with a Z-score of 1.96.

**Set proportion (p):** the proportion of the population with the characteristic of interest is unknown; use 0.5 (for maximum variability).

**Set margin of error (e):** Often set to 0.05.

$$n = \frac{36 \times 1.96^2 \times 0.5 \times (1-0.5)}{0.05^2 \times (36-1) + 1.96^2 \times 0.5 \times (1-0.5)}$$

$$= \frac{34.5744}{1.0479} \quad \text{_____}$$

$$= 32.994 \approx 33$$

The calculated sample size is approximately **33** animals. The sample size will be 33 animals which will be divided into four experimental groups of about equal size. Groups 1 will have nine while Groups 2, 3 and 4 each had eight animals according to Charan & Kantharia, (2013). from farms will be maintained in a semi-intensive system with a defined schedule. Lambs will be weaned at 70 days, while ewes and rams will be provided with concentrate feed and stalls based on their size and physiological stage.

### **Ethical Considerations**

Ethical clearance will be taken from the Ethics Committee on Human Research Publication and Ethics (CHRPE) of the Akenten Appiah-Menka University of Skill Training and Entrepreneurial Development, Asante Mampong, Ghana.

Before the commencement of the study, formal permission was sought from the Ghana Farm Manager of the Disease Investigation Farm. The ethical clearance contained the ethical considerations will focus on ensuring the welfare of the animals involved (Animal Welfare, Our Concern). The sample size for the study was calculated to ensure the welfare of the animals involved (Animal Welfare, Our Concern). Here are the ethical considerations:

**Animal Welfare:** I ensured that the sheep were treated humanely throughout the study. This includes provision of appropriate nutrition, and veterinary care.

**Pain and Distress:** I minimized the pain and distress experienced by the animals during the study. I monitored animals closely for signs of distress.

**Humane Endpoints:** I established humane endpoints to minimize suffering. If animals exhibited severe symptoms or distress, I took appropriate measures to alleviate suffering or euthanize them if necessary.

**Refinement of Techniques:** I used refined techniques to minimize discomfort and maximize the quality of data obtained. This includes refining procedures

for administering treatments and collecting samples.

**Consideration of Alternatives:** I explored all alternatives to animal testing whenever possible.

### **Preparation for Treatment**

#### **Preparation of the *Carica Papaya* Seeds**

The seeds will be collected freshly from ripe pawpaw fruits and washed with clean water to remove dirt. The seeds will be sundried for four days and air-dried for another two days. It will be later grinded into powder form. The pawpaw seed powders will be weighed (50 g) and blended into a liquefaction in 100 ml of distilled water. The mixture will then be centrifuged at 1500 rpm. The supernatant will be filtered through sterile filter papers into a beaker as the study extract. 1 ml of the filtrate is expected to contain 0.1 g, which is 100 mg/ml.

#### **Preparation of the *Oleifera* Leaves**

Moringa leaves and blooms will be air-dried at room temperature for one week, ground in an electric blender and kept in dry conditions for further proceedings. Aqueous moringa leaves will be prepared by mixing dry powder (50 g) in 150 ml of distilled water. The mixture was then centrifuged at 1500 rpm. The supernatant will be filtered through sterile filter papers into a beaker as the study extract. 1 ml. of the filtrate is expected to contain 0.1 g, which is 100

#### **Proprietary Anthelmintic (Conventional Dewormer)**

The dosage of conventional dewormer for therapeutic use in Ghana is 10 ml/kg body weight. For an animal weighing 1kg, such will receive 25 mg of the active ingredient per day.

## **Animal Grouping and Treatment**

**Group 1** received no medication than the control group.

**Group 2** will be drenched with the *papaya* seeds at 1:10 ml (w/v) of water

/kg body weight **Group 3** will be drenched with the *Oleifera* leaves at 1:10

ml (w/v) of water/kg body weight. **Group 4** will be drenched with

Conventional dewormer. The Conventional dewormer was administered at

a rate of 10 mg/kg body weight in divided doses for a day.

## **Examination**

### **n of Faeces**

### **Collection of**

### **Faecal**

### **Samples**

- i. The fresh faecal samples will be collected directly from the rectum of each animal in the morning before administering treatments.
- ii. Each sample will be kept in a discrete faecal cup.
- iii. Samples will be transported to the laboratory under proper sterile conditions. (Tagesu 2018)

## **McMaster egg counting technique**

McMaster is the quantitative method for determining the number of nematode eggs per gram of faeces to estimate the worm burden in an animal (Tagesu 2018). The advantage of this technique is quick as the eggs are floated free of debris before counting.

## **Statistical Analysis**

The study analyzes egg per gram using Microsoft Excel Vision 2010, T-test, one-way ANOVA, and Tukey's HSD post hoc test. Statistical analyses are performed at a 5%

significance level using IBM SPSS Statistics Version 26, adopted from Ameen et. al 2020.

## EXPECTED OUTCOME

**Reduction in Faecal Egg Count (FEC):** Papaya seeds and moringa leaves are expected to significantly reduce Faecal Egg Count in sheep, indicating their anthelmintic efficacy compared to untreated controls and conventional dewormers.

**Improvement in Faecal Consistency:** The study predicts that sheep treated with papaya seeds and moringa leaves will experience improved faecal consistency, indicating improved gastrointestinal health and reduced parasite burden.

**Weight Gain and Improved Health:** Natural remedies are expected to improve weight gain and overall health in sheep by enhancing nutrient absorption due to reduced parasitic interference.

**Comparison with Conventional Dewormers:** Research suggests papaya seeds and moringa leaves could be a cost-effective and viable alternative to conventional dewormers for reducing helminthic infections in sheep.

**Support for Sustainable and Cost-effective Practices:** The study aims to promote the use of locally available, affordable, and sustainable alternatives to synthetic anthelmintics, thereby enhancing livestock productivity, promoting animal welfare, and reducing chemical dependency.

**Contribution to Research and Policy:** The study aims to contribute to sustainable livestock management research and inform veterinary policies on alternative treatments

for parasitic infections in resource-limited settings by providing empirical data.

## REFERENCE

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- Pareek, A., Pant, M., Gupta, M. M., Kashania, P., Ratan, Y., Jain, V., Pareek, A., & Chaturgoon, A. A. (2023). *Moringa oleifera: An Updated Comprehensive Review of Its Pharmacological Activities, Ethnomedicinal, Phytopharmaceutical Formulation, Clinical, Phytochemical, and Toxicological Aspects*. International Journal of Molecular Sciences, 24(3).

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## GANTT CHART

	2024					2025						
Activity	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July
Write Proposal												
Present Proposal to Faculty												
Seek Ethical Clearance												
Write Up of Chapters 1 to 3												
Faecal Sampling and Faecal Egg Count												
Thesis Presentation												
Write Up Chapter 4												
Data Analysis												
Write Chapter 5 & 6												
Final Thesis Presentation												
Final Corrections												
Submitting of Thesis												

## BUDGET

No.	Item	Unit Cost	Total Cost
1	Ethical Clearance		€ 1,000.00
2	Conventional Dewormer		€ 200.00
3	Preparation of Natural Dewormers		€200.00
4	Deworming	132 sheep x € 20	€ 2,640.00
5	Data Analysis		€ 1,000.00
6	Printing of Final Thesis	(4 copies x € 200.00)	€ 800.00
	<b>Total</b>		<b>€ 5,840.00</b>
7	Miscellaneous (5%)		€ 292.00
	<b>Grand-Total</b>		<b>€ 6,132.00</b>

<b>Non-Chargeable Items</b>
Facility User Fee
Faecal Sampling and Examination (NB: it will be done 4x)

## **INFORMED CONSENT FORM FOR ADULT**

### **PART I: INFORMATION SHEET**

**Title:** Assessing the Anthelmintic Efficacy of Papaya Seeds and Moringa Leaves in Sheep at Techiman Disease Investigation Farm

**Principal Investigator:** Dwaah Prince Kyere

**Address:** Disease Investigation Farm and Regional Veterinary Laboratory, Post Office Box 122, Techiman-Bono East, Ghana

#### **General Information about Research**

This study aims to assess the effectiveness of using natural remedies such as papaya seeds and moringa leaves as anthelmintic treatments in sheep at the Techiman Disease Investigation Farm. Parasitic infections, particularly gastrointestinal parasites, pose a significant challenge to livestock health, leading to economic losses and issues of resistance against conventional dewormers. This research explores whether papaya seeds and moringa leaves can be viable, cost-effective, and sustainable alternatives for managing these infections.

This study's participants are sheep at the Disease Investigation Farm who have been kept in pens for at least a month. The research will involve preparing treatments from papaya seeds and moringa leaves, grouping the animals, administering the treatments, and monitoring changes in parasite load and overall health.

#### **Procedures**

To achieve the objectives, this research will:

1. Divide the sheep into four treatment groups.
  - Group 1 (Control) will receive no medication.
  - Group 2 will receive a papaya seed-based treatment.
  - Group 3 will receive a moringa leaf-based treatment.
  - Group 4 will be treated with a conventional anthelmintic.

2. Collect faecal samples before and after treatment to monitor changes in parasite load through the McMaster egg-counting technique.

3. Measure health indicators such as faecal consistency and weight to assess the overall impact of these treatments.

**Reason for Participant Selection:** Sheep at the Disease Investigation Farm have been chosen due to prior evidence of high parasite loads and observed resistance to standard dewormers, making them an ideal population for testing alternative solutions.

**Types of Questions in Surveys and Interviews:** The study will not involve direct surveys or interviews with human participants. Instead, data will be gathered through laboratory analysis and animal health assessments.

### **Possible Risks and Discomforts**

The study's methods are designed to minimize potential discomfort or damage to the animals, and humane practices will be followed throughout. Minimal risks to the animals involve mild physical stress during faecal sample collection.

### **Possible Benefits**

This research could yield benefits by reducing the reliance on synthetic anthelmintics, potentially lowering costs for farmers and promoting better animal health and productivity. Additionally, using plant-based remedies aligns with sustainable agricultural practices, potentially benefiting broader livestock management practices.

### **Confidentiality**

The collected data will be handled confidentially, with all results reported in aggregate. Individual animals will not be identified in the reporting of results.

### **Compensation**

No financial compensation applies to the animals involved.

### **Additional Cost**

No additional costs will be incurred by the farm or staff during participation in the study.

### **Voluntary Participation and Right to Withdraw**

Participation in the research will be selected by the Farm Manager and the Principal Investigator. Any animal may be withdrawn from the study without penalty if they have concerns about its welfare.

### **Contacts for Additional Information**

For further details about this study, you may contact the research team at Akenten

Appiah- Menka University of Skills Training and Entrepreneurial Development,  
Ghana, The Farm Manager and the Principal Investigator.

**PART II: VOLUNTEER’S AGREEMENT**

The above document describing the benefits, risks and procedures for the research titled “Assessing the Anthelmintic Efficacy of Papaya Seeds and Moringa Leaves in Sheep at Techiman Disease Investigation Farm” has been read and explained to me (The Farm Manager). I have been allowed to have any questions about the research answered to my satisfaction. I agree that our animals are to be used.

**NB:** The farm manager signed up for them because the participants are animals.

**Witness’s/Farm Manager’s Name:** Dr. Anthony Osei – Tutu

**Witness’s/Farm Manager’s Signature:**



**Date:**

20/10/202

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

**Researcher’s Name:** Dwaah Prince Kyere



**Researcher’s Signature:**

**Date:**

20/10/2024

## INSTRUMENTS

1. **Faecal Sampling Equipment:** Faecal Sampling Equipment will include a sample container, a cool man box, gloves, and an ice pack. It will be utilized to collect faecal samples from sheep for faecal examination.
  
2. **Microscope and Faecal Examination Equipment:** A compound microscope equipped with appropriate magnification lenses will be used to examine faecal samples for parasite eggs using a McMaster counting chamber, pipette, salt solution, gloves, and a test tube. This allows for accurate egg identification and counting, facilitating the assessment of treatment efficacy.
  
3. **Measuring Tape:** A digital weighing scale will be used to monitor the sheep's body weight throughout the study period. Changes in body weight can indicate overall health status and may reflect the effectiveness of anthelmintic treatments.
  
4. **Clinical Examination Tools:** Instruments such as stethoscopes, thermometers, and examination gloves will be used to conduct clinical assessments of sheep before and after treatment. This includes monitoring vital signs, checking for signs of illness or distress, and evaluating general physical condition.
  
5. **Data Recording Tools:** Data recording tools such as notebooks, data sheets, and laptops will document faecal egg counts, body weights, clinical observations, and blood test results. This ensures accurate and organized data collection for subsequent analysis.
  
6. **Statistical Software:** Statistical software packages such as the Tukey T-test will be used for data analysis. This includes conducting statistical tests to compare treatment groups, assess efficacy, and identify significant differences or trends.

# **CURRICULUM VITAE**

**Dwaah Prince Kyere**

Post Office Box 122, Techiman, Bono East Region, Ghana, West Africa

+233 540622111 or +233 200759509 or +233 544282115

pkdwaah@ammusted.edu.gh or dwaah.dwaah@biola.edu

**ORCID ID:** 0009 - 0009 - 9515-3213

## **EDUCATIONAL BACKGROUND**

Master of Philosophy in Public Health

**Akenten Appiah-Menka University of Skill Training and Entrepreneurial  
Development, Asante Mampong - Ghana**

2024 - Up to date

Bachelor of Science in Agriculture (**Major:** Animal Science)

**Valley View University, Oyibi - Accra, Ghana**

2021-2023

Certificate in Veterinary Laboratory Techniques

**Animal Health and Production College, Pong Tamale - Ghana**

2012-2015

## **EMPLOYMENT HISTORY**

**Job Title:** Animal Health Officer (Laboratory)

**28/02/2019 - Up to**

**Date**

**Position:** Head of the Laboratory Unit of Disease Investigation Farm and Regional  
Veterinary Laboratory, Techiman–Bono East

### **Duties**

- Supervise laboratory and equipment staff and oversee daily operations and activities.
- Performing over five postmortems weekly when our animals die or if a client brings his/her carcass.

- Scheduling and assisting with routine care, including veterinary and human health appointments, as well as performing emergency care.
- Assessing individual needs of clients and staff through daily communication after postmortem.
- Collect over five hundred tissue samples like faecal, blood, and the rest when there is a new stock for laboratory analysis and also five brain tissue when a suspected rabid animal dies.
- Spearheaded laboratory and farm equipment, such as microscopes, centrifuges, and the rest, with extreme care and precision.
- Taking care of all stock needs, including branding, grooming, feeding, castration, and shearing.
- Ensuring farm safety and bio-security procedures at the laboratory and farm.
- Training over one hundred students on the attachment on how to collect, handle, pack, and transport samples.
- Developed an unmounted educational rabies program to promote well-rounded learning.

### **MAJOR RESEARCH PROJECTS UNDERTAKEN**

Primary Prevention Strategies for Combating Rabies: A Case Study in Techiman, Ghana. **Name of Journal:** Postgraduate Medical Journal **Date of Submission:** 08/08/2024 **Manuscript ID:** pmj-2024-145752

Survey of Sheep and Goat Management Systems at Techiman South Municipality of Bono-East Regions of Ghana. **Date of Submission:** 15/10/2024 **Name of Journal:** UDS International Journal of Development.

Prevalence of Tick-Borne Haemoparasites in Small Ruminants in Techiman (Ghana) and Diagnostic Sensitivity of Giemsa Stain. **Date of Submission:** 20/11/2024 **Name of Journal:** UDS International Journal of Development.

A Cross-Sectional Study of the Awareness and Knowledge of Rabies and Related Activities in Techiman.

**Name of Journal:** Journal of Interventional Epidemiology and Public Health

**Manuscript ID:** JIEPH-D-24-02018

**Date of Submission:**

07/12/2024

### **RESEARCH UNDERTAKEN AND YET TO BE SUBMITTED**

The Risk of Zoonotic Tuberculosis and Its Transmission Dynamics in Techiman, Ghana.

The Systematic Review of the Anthelmintic Efficacy of Papaya Seeds and Moringa Leaves.

Prevalence and Intensity of Gastrointestinal Helminths Infestation in Slaughtered Livestock at Techiman.

Assessing the Knowledge, Attitudes, and Practices of Health Workers in Techiman South Municipal regarding Dog Bite and Rabies Disease Management.

### **RECENT PUBLICATIONS**

Mechanisms of Worm Resistance: Insights from Immunology, Genetics, and Beyond.

**Name of Journal:** International Journal of Livestock Research

**Date of Submission:** 21/02/2024      **Accepted:** 12/03/2024

**Published:** 31/03/2024

The Role of Community-Based Rabies Education in Promoting Preventive Health Behaviours in Techiman: A Case Study on Rabies Sensitization      **Manuscript ID:** jbhe-24-150056

**Name of Journal:** Journal of Health Education Research and Development.

**Date of Submission:** 13/10/2024      **Accepted:** 26/10/2024

**Published:** 31/10/2024

## **MEMBERSHIP OF PROFESSIONAL BODIES**

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- Veterinary Medical Technicians Association of Ghana (VEMTAG)
- Civil and Local Government Staff Association of Ghana (CLOGSAG)
- Global Alliance for Rabies Control (GARC)

## **COMMITTEE MEMBERSHIP**

Techiman Public Health Emergency Management Committee (PHEMC) on Zoonoses

# CURRICULUM VITAE

**NANA YAA AWUA-BOATENG**  
**(Ph.D.)**

## **Curriculum Vitae**

### **Personal Data:**

AWUA-BOATENG, Nana Yaa

Department of Public Health Education, Akenten Appiah-Menka University of  
Skills Training and Entrepreneurial Development (AA-MUSTED)

P. O. Box 40, Mampong-Ashanti, Ghana.

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[nanayaa4lyf@gmail.com](mailto:nanayaa4lyf@gmail.com)/[nyawua-boateng@aamusted.edu.gh](mailto:nyawua-boateng@aamusted.edu.gh)

### **Areas of Expertise or Professional Skills:**

1. Molecular Epidemiology of Infectious Diseases
2. Communicable Diseases
3. Epidemiology
4. Clinical Microbiology
5. Global and International Health
6. Chemistry

### Professional Experience:

Position	Office/Location	Period
Department Examinations Coordinator	Department of Public Health Education, AAMUSTED, Mampong	2022 - date
Academic Counsellor	Levels 100 & 200. Public Health Education, AA-MUSTED, Mampong	2022 - date
Lecturer	Department of Public Health Education, AAMUSTED, Mampong	2021 - date
Assistant Laboratory Manager	THECA/TyVEGHA Projects, Kumasi	2019 – 2021
Programmes Coordinator	Centre for Health Systems Strengthening, Kumasi	2019
PhD student	Kumasi Centre for Collaborative Research in Tropical Medicine (KCCR), Kumasi	2016 - 2020
Biomedical Scientist	AG EOD Working Group, KCCR, Kumasi	2013 - 2015
Laboratory Manageress	Buruli Ulcer Projects, KCCR, Kumasi	2006 - 2013
Ag. Head of Laboratories	Kumasi Centre for Collaborative Research in Tropical Medicine (KCCR), Kumasi	Jan. 2013
Ag. Deputy Head of Laboratories	Kumasi Centre for Collaborative Research in Tropical Medicine (KCCR), Kumasi	Jul. 2010
Snr. Laboratory Technologist	University of Cape Coast Hospital, Cape Coast	2001 - 2004
Chemistry Tutor, Housemistress	Presbyterian Secondary School, Adeiso	2000 - 2001
Mathematics Tutor	Mfantsipim School, Cape Coast	2000
Laboratory Technician	Kwahu Government Hospital, Kwahu-Atibie	1996

### **Educational Background:**

<i>No.</i>	<i>Qualification &amp; Certificate Obtained</i>	<i>Name of Institution Attended</i>	<i>Date</i>
1.	Diploma in Education	AAMUSTED-Mampong, Ghana	2023
2.	Ph.D. Public Health	KNUST, Kumasi, Ghana	2021
3.	M.Phil. Clinical Microbiology	KNUST, Kumasi, Ghana	2009
4.	B.Sc. Chemistry	UCC, Cape Coast	2000
5.	Advanced Level Certificate	Wesley Girls' High School, Cape Coast	1995
6.	Ordinary Level Certificate	Wesley Girls' High School, Cape Coast	1993

### **Publications, Research/Projects Conducted or Undertaken**

#### **Publications:**

1. Gyamfi O, Aboko J, Ankapong E, Marfo JT, **Awua-Boateng NY**, Agyei V, Sarpong K, Dartey E, 2023. Heavy metals in local and imported cosmetics in Ghana and their health risk assessment. Cogent Public Health.
2. **Awua-Boateng, N.Y.**, Mohammed, A., Aglanu, L.M., Acheampong, G., Amuasi, J.H., Bonsu, F.A., Phillips, R.O. and Owusu-Dabo, E., 2019. Is pulmonary tuberculosis in pregnant women a problem in Ghana? Observations and lessons from the national tuberculosis prevalence project.
3. Sylverken AA, Owusu-Dabo E, Yar DD, Salifu SP, **Awua-Boateng NY**, Amuasi JH, Okyere PB, Agyarko-Poku T, 2016. Bacterial etiology of sexually transmitted infections at a STI clinic in Ghana; use of multiplex real time PCR. Ghana Med J, 50(3):142-148
4. Darko SN, Yar DD, Owusu-Dabo E, Awuah AA, Dapaah W, Addofoh N, Salifu SP, **Awua- Boateng NY**, Adomako-Boateng F, 2015. Variations in levels of IL-6 and TNF-alpha in type 2 diabetes mellitus between rural and urban Ashanti Region of Ghana. BMC Endocr Disord, 15:50, PMID: 26391589

5. Samuel Fosu Gyasi, Esi Awuah, John Asiedu Larbi, George Asumeng Koffuor, Alex Yaw Debrah, **Nana Yaa Awua-Boateng** and Owusu-Afriyie Osei, 2013. Susceptibility of Arsenic- Exposed ICR Mice to Buruli Ulcer Development. *Pharmacologia*, 4: 254-264
6. Beissner Marcus; Symanck Dominik; Phillips Richard Odame, Amoako Yaw Ampem, **Awua- Boateng Nana Yaa**; Sarfo Fred Stephen; Jansson Moritz; Huber Kristina Lydia; Herbinger Karl Heinz; Battke Florian; Loescher Thomas; Adjei Ohene; Bretzel Gisela Detection of Viable Mycobacterium ulcerans in Clinical Samples by a Novel Combined 16S rRNA Reverse Transcriptase/IS2404 Real- Time qPCR Assay *PLoS Neglected Tropical Diseases* 2012 6(8): e1756
7. Willemien Nienhuis, Ymkje Stienstra, Mohammed Abass, Wilson Tuah, William Thompson, Peter Awuah, **Nana Yaa Awua-Boateng**, Ohene Adjei, Gisela Bretzel, Jan Schouten, Tjip van der Werf Paradoxical responses after start of antimicrobial treatment in Mycobacterium ulcerans infection *Clin Infect Dis* 54(4):519-26 (2012), PMID 22156855
8. Beissner Marcus; **Awua-Boateng Nana Yaa**; Thompson William; Nienhuis Willemien A; Klutse Erasmus; Agbenorku Pius; Nitschke Joerg; Herbinger Karl- Heinz; Siegmund Vera; Fleischmann Erna; Adjei Ohene; Fleischer Bernhard; van der Werf Tjip S; Loscher Thomas; Bretzel Gisela A genotypic approach for detection, identification, and characterization of drug resistance in Mycobacterium ulcerans in clinical samples and isolates from Ghana. *The American journal of tropical medicine and hygiene* 2010; 83(5):1059-65.
9. Herbinger Karl-Heinz; Beissner Marcus; Huber Kristina; **Awua- Boateng Nana Yaa**; Nitschke Jörg; Thompson William; Klutse Erasmus; Agbenorku Pius; Assiobo Awovi; Piten Ebekalisai; Wiedemann Franz; Fleischmann Erna; Helfrich Kerstin; Adjei Ohene; Löscher Thomas; Bretzel Gisela Efficiency of fine-needle aspiration

compared with other sampling techniques for laboratory diagnosis of Buruli ulcer disease. *Journal of clinical microbiology* 2010;48(10):3732-4.

10. Comparative Study on Different DNA Amplification Techniques (LAMP, Real- Time and conventional PCR) for the Molecular Diagnosis of Buruli Ulcer Disease. Beissner M, Phillips R, Maman I, **Awua-Boateng NY**, Sarfo S, Huber KL, Symank D, Jansson M, Wawrzeczko A, Amekuse K, Nitschke, Wiedemann F, Battke F, Badziklou K, Adjei O, Löscher T, Kere AB, Bretzel G. 102. Annual Meeting of the German Society for Tropical Medicine and International Health. Heidelberg, Germany, March 15-16, 2012.
11. Nienhuis Willemien A; Stienstra Ymkje; Thompson William A; Awuah Peter C; Abass K Mohammed; Tuah Wilson; **Awua-Boateng Nana Yaa**; Ampadu Edwin O; Siegmund Vera; Schouten Jan P; Adjei Ohene; Bretzel Gisela; van der Werf Tjip S Antimicrobial treatment for early, limited Mycobacterium ulcerans infection: a randomised controlled trial. *Lancet* 2010; 375(9715):664-72.
12. Karl-Heinz Herbinge, Ohene Adjei, **Nana-Yaa Awua-Boateng**, Willemien A. Nienhuis, Letitia Kunaa, Vera Siegmund, Joerg Nitschke, William Thompson, Erasmus Klutse, Pius Agbenorku, Alexander Schipf, Simone Reu, Paul Racz, Bernhard Fleischer, Marcus Beissner, Erna Fleischmann, Kerstin Helfrich, Tjip S. van der Werf, Thomas Löscher, Gisela Bretzel. Comparative Study of the Sensitivity of Different Diagnostic Methods for the Laboratory Diagnosis of Buruli Ulcer Disease. *Clinical Infectious Diseases* 2009; 48:1055-1064
13. Herbinge K-H; Brieske D; Nitschke J; Siegmund V; Thompson W; Klutse E; **Awua-Boateng N Y**; Bruhl E; Kunaa L; Schunk M; Adjei O; Löscher T; Bretzel G Excision of pre-ulcerative forms of Buruli ulcer disease: a curative treatment? *Infection* 2009; 37(1): 20-5.

## **Research/Projects Conducted**

- Molecular Characterization and Resistance profile of *Mycobacterium tuberculosis* Complex in previously treated patients in two West African countries, Ougadougou, Burkina Faso – Oral Presentation (2016)
- Childhood tuberculosis: Burden and Risk Factors in Selected Regions of Ghana, Berlin, Young Researchers Symposium – Oral Presentation (Virtual) 2021
- Incidence of Salmonella Bacteraemia and Antibiotic Resistance of Salmonella in Paediatric Patients in Kumasi, Ougadougou, Burkina Faso – Oral Presentation (2010)
- Comparative Study of the Sensitivity of Different Diagnostic Methods for the Laboratory Diagnosis of Buruli Ulcer Disease, Kumasi, Ghana – Poster Presentation (2009)

### **Research/ projects undertaken:**

1. TyVEGHA, School of Public Health, KNUST 2019 - date (PI – Prof Ellis Owusu-Dabo); Role played – Assistant Laboratory Manager
2. SETA Plus, School of Public Health, KNUST 2019 – 2021 (PI – Prof Ellis Owusu-Dabo); Role played – Assistant Laboratory Manager
3. BURULIVAC, KCCR 2009 – 2013, (PI – Prof. Richard Philips) Role played – Laboratory Manager
4. BURULICO, KCCR 2006-2008 (PI – Prof Ohene Adjei) Role played – Laboratory Manager
5. Burden and Risk Factors for Childhood Tuberculosis in Selected Regions of Ghana 2017 – 2019 (PhD project)

## **Professional Development:**

### **Curriculum Development**

#### **Highlights of Activities**

1. Developed Handbook on Principles of Epidemiology and communicable Diseases (B.Sc. Level 200 & 300)
2. Developed Handbook on Introduction to Public Health (B.Sc. Level 100)

3. Development of B.Sc. Occupational Health and Safety programme (Regular) - for National Accreditation Board (NAB) – 2021 (Member of Committee).
4. Development of Master of. Public Health programme (Regular) - for National Accreditation Board (NAB) –2021 (Member of Committee).
5. Development of Master of. Public Health programme (Weekend & Sandwich) - for National Accreditation Board (NAB) –2021 (Member of Committee).
6. Development of B.Sc. Public Health (Disease Control) programme - for National Accreditation Board (NAB) –2023 (Member of Committee).

**Courses taught at Postgraduate and Undergraduate and Thesis**

**Supervised/Assessed Postgraduate Courses Taught**

1. EOH 812: Toxicology and Industrial Hygiene
2. MPB 728: Global Health
3. BIO 826: Parasites and Vector Control
4. BIO 828: Epidemiology of Parasites
5. Postgraduate Research Seminar

**Undergraduate courses taught:**

1. PHS 111: General Biology
2. PHS 121: Introduction to Public Health
3. PHS 234: General Microbiology
4. PHS 242: Principles of Epidemiology
5. EHP 245: Environmental Microbiology
6. PHD 353: Environmental Epidemiology
7. EHP 361: Epidemiology and Communicable Diseases
8. Pre-Internship Seminar
9. Post- Internship Seminar

### **Diploma (Sandwich)**

1. DEH 103: Public Health Planning (Diploma)

### **Post-Diploma (Sandwich)**

1. EHP 361: Epidemiology and Communicable Diseases

### **Supervision of undergraduate students' project works**

(Supervised at least 70 students' project dissertations)

### **Supervision of Thesis of postgraduate student's projects work**

(Currently supervising 7 MPhil students' theses)

### **Student Development:**

#### **Resource person at Seminars:**

- i. Guest Speaker, Gender week, February 2023, AAMUSTED-Mampong
- ii. Guest Speaker, Women's Week, 2023, AAMUSTED-Mampong
- iii. Guest Speaker, EHSAG Week, 2023, AAMUSTED - Mampong
- iv. MC for most Faculty of Environment and Health Education interaction with students

#### **Academic Counseling services:**

Counselling services to students (especially in the Faculty of Environment and Health Education) on the conduct of project work and dissertation writing.

- i. Provide academic counseling services to students with academic challenges and help them to resolve them (AAMUSTED-Mampong).
- ii. Provide advisory services to students per semester on diverse issues with the potential to affect their academic work performance.
- iii. Providing recommendations and reference letter for postgraduate applicants for schools in Ghana and abroad.

### **Mentorship:**

#### **Area(s) of Development**

#### **Teaching, Research and Service:**

- Technical and laboratory skills to enhance teaching and research more effectively in Professional/Career development
- Establishment of collaborations with other researchers in and outside the university

#### **Membership of Professional Association(s):**

<i>No.</i>	<i>Name of Association</i>	<i>Position held</i>	<i>Period</i>
1.	Ghana Science Association (GSA) – AAMUSTED- Mampong	<b>Member</b>	2022 to date
2.	Ghana Biomedical Convention (GBC)	<b>Member</b>	2015 to date
3.	University Teachers Association of Ghana (UTAG)	<b>Member</b>	2021 to date

#### **Institutional Service:**

<i>No</i>	<i>Name of Committee(s) and/or Board(s)</i>	<i>Position / role</i>	<i>Period</i>
.			
1.	Ghana Science Association (AAMUSTED Branch)	<b>Member</b>	2022 to date
2.	Faculty of Science. Board, (AAMUSTED, Rep from FEHE)	<b>Member</b>	2022 to date
3.	Development New Programme, Master of Public Health	<b>Member</b>	2021
4.	Development New Programme, B.Sc. Occupational Health Safety	<b>Member</b>	2021
5.	Development New Programme, B.Sc. Public Health (Disease Control)	<b>Member</b>	2023

## SERVICE TO THE UNIVERSITY/COMMUNITY

### Church Activities

No.	Church Activities/Role	Date
1.	Patron, Church Choir, Presbyterian Church of Ghana, Newtown Congregation	2022 to date
2.	Presbyter, Presbyterian Church of Ghana, Newtown Congregation	2022 to date
3	District Secretary-Women's Fellowship, Presbyterian Church of Ghana, Newtown Congregation	2022 to date

### *MPhil Thesis Assessed (Internal Assessor)*

1. Joshua Armah Doku – Occupational Hazards Among Emergency Medical Technicians of the National Ambulance Service in Ghana; 2021 – *MPhil. Environmental and Occupational Health, Department of Public Health Education, AAMUSTED-Mampong, Ghana*
2. Emmanuel Obeng Bekoe - Human Health Risk Assessment from Exposure to Microbial and Chemical Contaminants in Groundwater Sources Occurring in Tamale Metropolis;; 2023 – *MPhil. Environmental and Occupational Health, Department of Public Health Education, AAMUSTED-Mampong, Ghana*
3. Abdul-Razak Mohammed Raji - Epidemiology of Mange Mites of Small ruminants in the Northern Region of Ghana; 2024 - *MPhil in Biology, Department of Biology Education, AAMUSTED- Mampong, Ghana*
4. Albert Wise Kadey - Assessment of Bacteriological Contamination and Pesticide Residues on Selected Vegetables Produced at the Anloga District in the Volta Region of Ghana; 2024 – *MPhil. Environmental and Occupational Health, Department of Public Health Education, AAMUSTED-Mampong, Ghana*

## **Referees**

**1. Prof. Christian Agyare**

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**2. Prof. Emmanuel Dartey**

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**3. Dr. Denis D. Yar**

*Head of Department, Public Health Education, AAMUSTED, Mampong*

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## **Certification**

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I, the undersigned, certify that to the best of knowledge and belief, these data correctly describe me, my qualifications and my experience.

*W Awua-Boateng*

**Dr. Nana Yaa**

**Awua-Boateng 5**

**May 2024**

## APPENDIX I

### **PROTOCOL FOR INCLUSION/EXCLUSION OF SHEEP IN NATURAL ANTHELMINTIC TREATMENT**

*(Based on Pre-sampling Worm Load using FEC values)*

#### **1. Pre-sampling Procedure**

- i. Collect faecal samples from all sheep prior to treatment (Day 0).
- ii. Determine **Eggs per Gram (EPG)** using the McMaster technique.
- iii. Categorize sheep into worm load classes (light, moderate, heavy) following standard parasitology thresholds, adjusted for my study, before grouping them into 4.

#### **2. Classification of Worm Load**

<b>Parasite Type</b>	<b>Light Infection</b>	<b>Moderate Infection</b>	<b>Heavy Infection</b>
<i>Haemonchus contortus</i> (nematode)	< 200 EPG	201–1000 EPG	> 1000 EPG
<i>Moniezia</i> spp. (cestode)	< 100 EPG	101–500 EPG	> 500 EPG

*(Thresholds adapted from WAAVP, 2023; modified for natural remedy context)*

#### **3. Inclusion Criteria**

Sheep are eligible for natural remedy treatment if:

- i. Sheep are clinically stable (no signs of severe anaemia, emaciation, or diarrhoea).
- ii. No concurrent treatment with conventional anthelmintics in the past 6 weeks.
- iii. Sheep are above 3 months of age and fit for oral drenching.

#### **4. Exclusion Criteria**

Sheep should **not** receive natural remedy treatment if:

- i. Animals showing **severe clinical signs** (e.g., pale mucous membranes, bottle jaw, profuse diarrhoea).
- ii. Pregnant/lactating ewes in late gestation, unless safety has been validated.
- iii. Animals previously unresponsive to natural remedy treatment in earlier trials.

#### **5. Treatment Protocol**

- i. **Papaya seeds:** 1:10 ml aqueous extract/kg body weight (per piloting).
- ii. **Moringa leaves:** 1:10 ml aqueous extract/kg body weight (per piloting).
- iii. Administration: Oral drench, single dose, with repeat dosing after 14 days if FEC remains above the inclusion threshold.
- iv. **Monitoring:** Repeat FEC at Day 5, Day 10 and Day 30 to assess treatment efficacy.

## **6. Post-treatment Follow-up**

- i. If **FEC reduction  $\geq 50\%$** : Continue natural remedy use, as this indicates moderate efficacy.
- ii. If **FEC reduction  $< 50\%$** : Switch to conventional anthelmintics, as the natural remedy alone is insufficient.
- iii. If reinfection occurs, re-classify animals using the above thresholds before re-treatment.