PREVALENCE OF GASTRO-INTESTINAL PARASITES IN SHEEP AND GOATS AND ZOONOTIC HELMINTHES IN ASMARA SLAUGHTERHOUSE IN MAEKEL REGION, ERITREA

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A RESEARCH THESIS SUBMITTED IN PARTIAL FULFILLMENT OF REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE (APPLIED PARASITOLOGY) IN THE SCHOOL OF PURE AND APPLIED SCIENCES OF KENYATTA UNIVERSITY

OCTOBER, 2025

DECLARATION

This thesis is my original work and has not been presented for a degree or other award in any other University or Institution.

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DEDICATION

This thesis is dedicated to my beloved brother Engineer Goitom Araya and my wife Yordanos Berhe, who have stood with me up to the highest level of the work during the research period for their encouragement in financial and psychological support as well as assisting my children too while I was undertaking my studies.

I am also dedicating this work to my father Mr. Araya Haylemaryam and my mother Akberet Tewelde for their moral encouragement in my research work.

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ABBREVIATIONS AND ACRONYMS

CDC	Centre for Disease Control and Prevention
EPG	Eggs Per Gram of feces
FEC	Fecal egg count
GIT	Gastro-intestinal tract
GITP	Gastro intestinal tract parasites
MOA	Ministry of Agriculture
MOH	Ministry of Health
MND	Ministry of National Development
NAPHL	National Animal and Plant Health Laboratory
PGE	Parasitic gastro enteritis
SOP	Standard Operating Procedure
SPP	Species
WHO	World Health Organization

ABSTRACT

Gastrointestinal parasites are the main cause of parasitic infections in livestock especially in small ruminants including sheep and goats. Small ruminants are a major source of livelihoods for small-scale farmers in many parts of the world including Africa. These animals provide direct income from sales, as well as food products like the meat and milk. In Eritrea, small ruminants are a great source of income and food products for many small-scale farmers. However, the productivity in these animals has been greatly affected by infections associated with gastrointestinal parasites. Although some studies have been conducted and reported from the southern part of the country, there have been no reports on disease risk factors. In addition, there have been no studies carried out on disease prevalence and associated risk factors of GI-parasites in Maekel region of Eritrea. The aim of the current study was to determine the prevalence of gastrointestinal (GI) parasites, associated risk factors and the zoonotic helminths from slaughter house in Maekel region, Eritrea. A total of 384 barka sheep and rora goats were sampled to determine the current gastrointestinal parasitic disease prevalence. Fecal samples were obtained from the animals and examined for the presence of parasites microscopically. Data were analyzed using STATA version 12 utilizing one-way analysis of Variance (ANOVA) and T test. Results indicated overall disease prevalence of 91.33% among the sampled animals. Different parasite species caused disease in varying infection rates including *Haemonchus spp* (27.2%), *Eimeria spp,* (19.79%), *Cooperia spps* (15.9%)*, Strongylus spps* (11.9%), *Monezia spp* (7.8%), *Ascaris spps* (5.5%), *Dictyocaulus filarial* (5.2%), *Paramphistomum cervix* (5.2%), *Oesophagostomum colunibiamum* (3.7%), *Chabertia.ovina* (3.7%), *Trichuris globulosa* (3.4%), *Ostertagia circuncincta* (0.5%)*, Bunostomum trigunocephelum* (2.1%) and *Nematodirus* (1.8%). The rainy season was associated with more infections than dry season. Zoonotic helminths of sheep and goats in Asmara slaughterhouse of Maekel region were dominated by *hydatid cysts*, *Strongyloides, Trichuris, Ascaris, Paramphistomum, Dictyocaulus filaria, Haemonchus* egg and *Fasciola spp*. Risk factors included poor housing, mixed housing with other animals, common water supply with other livestock, irregular deworming and poor knowledge of farmers on parasitic helminths. It was observed that significantly more female than male animals were infected with parasites ($P<0.05$). Based on these findings, the study concludes that parasitic infections are highly prevalent in sheep and goats in the study area. In addition, zoonotic parasites were common and the wet season was associated with higher infections than the dry season. Furthermore, risk factors like poor housing and contaminated water sources may be associated with increased infections as the lack of management practices. The study recommends introduction of mass drug administration targeting both humans and animals. In addition, community health education can be used to empower farmers with necessary knowledge and skills for disease prevention and control.

CHAPTER ONE: INTRODUCTION

1.1 Background information

Globally, small ruminants are the most essential animals among small-scale farmers in the livestock production industry. These animals have a big impact on the ecological and economic sectors of agriculture especially for the communities that live in the rural areas. Sufficient production of sheep and goats (small ruminants) supports farmers as a means of generating income most importantly from their products such as milk, meat, manure, skin, medicine, gifts, hair (Hailegebrael *et al*., 2017). Productivity in sheep and goats can be achieved through good husbandry practices including, providing feed of good nutritional value, applying efficient reproduction systems and seeking veterinary health services regularly (Olifan *et al*., 2020).

Gastrointestinal parasites are one of the major problems in small ruminant productivity in the tropical and subtropical regions of the world due to suitable conditions for transmission and development of diseases among the animals (Takalani *et al*., 2020). Gastrointestinal parasites in small ruminants are associated with high economic losses among farmers. These diseases are associated with diverse adverse effects in infected ruminants including reduced reproduction rate, low body weight, low quality animal products and death (Solomon *et al*., 2021). These effects are brought about by the complicated interactions of animals, man and the environment, as these aid the transmission of the parasitic pathogens (Andernice *et al*., 2021). Small ruminants including sheep and goat are an important source of income among small-scale farmers in Eritrea. However, the production of these animals is affected by gastrointestinal parasites, which are commonly associated with disease leading to reduced yield in terms of stock population and quality. It is not clear to what extend these diseases have affected

productivity and income to the farmers. In addition, the parasite species causing infection in the livestock have not been studied and risk factors associated with disease are not documented especially in the Maekel region of Eritrea. Additionally, zoonotic parasites in the small ruminants as well as on the human being life are affected also not studied yet in the Maekel region, Eritrea. Therefore, the current study aimed to determine the prevalence of gastrointestinal parasites and risk factors associated with disease in sheep and goats among small ruminant farmers in the Maekel Region, Eritrea. In addition, detection and distribution of zoonotic helminths in Asmara slaughterhouse of Maekel region, Eritrea was assessed within the past two years (2022-2024).

1.2 Statement of the problem

Gastrointestinal parasites can lead to low productivity in livestock and has been associated with huge economic losses especially among small-scale farmers who rely on small ruminants including sheep and goats for their livelihoods. Small ruminant farmers in the Maekel region of Eritrea are highly dependent on sheep and goats for their economic prowess. However, there has been reportedly low productivity in small ruminants and this could be due to several factors including parasitic infections among other factors. There have been no studies reported on gastrointestinal parasitic infections in sheep and goats in the Maekel region despite research carried out elsewhere in the country which demonstrated that livestock in Eritrea are heavily infested by parasites. In addition, risk factors associated with parasitic infections have also not been documented. There is no available data on the seasonal distribution of parasitic infections as well as zoonotic parasites among sheep and goats in the Maekel region.

1.3 Justification of the study

Gastrointestinal parasitic diseases can greatly cause huge economic losses in small ruminants among small-scale farmers who may lack sufficient resources for effective livestock management (Kétomon *et al*., 2023). Studies aimed at collecting data on the parasite species causing infections as well as the prevalence of disease can help in establishing strategies for disease prevention, treatment and control. Studies on occurrence of disease and the extent of gastrointestinal parasitic infections as well as the pathogenic species in small ruminants in the Maekel region of Eritrea where sheep and goats are the main sources of livelihoods can help in guiding informed decisions on measures for increased productivity. In addition, it is important to undertake studies aimed at establishing the factors associated with gastrointestinal parasitic diseases. The knowledge on disease risk factors would be important in educating and guiding farmers on the best husbandry practices for increased livestock productivity and profitability. Assessing the seasonal variation of disease status among sheep and goats would be an important undertaking that would help in early planning for measures aimed at disease prevention and control. As zoonotic diseases, which are transmitted from the infected animals to health animals and man, they can cause serious problem in population's health, assessing their prevalence can greatly help in strategizing prevention and control measures.

1.4 Research questions

i. What is the prevalence of gastrointestinal parasitic infections in sheep and goats reared by small-scale farmers in the Maekel region, Eritrea?
ii. What is the prevalence of zoonotic helminths within the past two years (2022-2024) in Maekel region, Eritrea?

iii. What are the risk factors associated with gastrointestinal parasitic infections in sheep and goats reared by small-scale farmers in the Maekel region, Eritrea?

1.5 Objectives

1.5.1 General objective

To determines the prevalence of gastrointestinal parasites in sheep and goats and zoonotic helminths from Asmara slaughterhouse in Maekel region, Eritrea in order to improve production.

1.5.2 Specific objectives

i. To determine the prevalence of gastrointestinal parasitic infections in sheep and goats reared by small-scale farmers in the Maekel region, Eritrea.
ii. To determine the prevalence of zoonotic helminths within the past two years (2022-2024) in Maekel region, Eritrea.
iii. To establish the risk factors associated with gastrointestinal -parasitic infections in sheep and goats reared by small-scale farmers in Maekel region, Eritrea.

1.6 Significance of the study

Establishing disease occurrence and prevalence as well as the factors associated with infection will be an important step to effective disease prevention and control. Data on circulating parasitic infections in sheep and goats will give guidance on the proper medication required for disease treatment. Documentation of disease risk factors will be important in guiding on the development of education programs aimed at enlightening the livestock keepers on the best animal management practices. This will lead to improved husbandry practices hence increasing productivity and profitability. Furthermore, establishing the prevalence of zoonotic helminthiasis can guide in formulation of policies on disease control, prevention and effective treatment.

1.7 Limitation of the study

The distribution of female and male sexes of study animals was not uniformly available in the study area with the males being fewer than females in both sheep and goat species. In addition, the other regions were not included in this study due to limited resources.

CHAPTER TWO: LITERATURE REVIEW

2.1 Gastrointestinal parasites in livestock

Gastrointestinal parasites are the most common cause of parasitic infections in sheep and goats globally. Parasitism is one of the major cause's production losses in small ruminants (Mots'elisi *et al.*, 2021. Trematodes (*Paramphistomum* spp, *Fasciola* spp), nematodes (like *Strongyloides* spp, *Haemonchus* spp, Ascaris spp.), cestodes (*Monezia* spp), and Protozoans (*Cryptosporidium*, *Entamoeba* and *Eimeria spp*) are among the most abundant parasites causing disease in these ruminants (Dogo *et al.*, 2017). These parasites are passed out along with faeces of the host and are released into the environment and are transmitted to uninfected animals during grazing on contaminated pasture and water (Ruhoollaha *et al*., 2021). In previous reports, parasitic infections of sheep and goats are indicated as the major problems that cause productivity and economic reduction to the farmers (Zainab, 2022). Prevention of these parasitic infections in sheep and goats using integrated methods like better breeding strategies, best farming practices, advanced biological control measures, scientific biotechnological materials with standard techniques and best chemical control measures can increase productivity in these animals (Shanna, 2020).

2.2 Gastrointestinal parasites of small ruminants in Eritrea

Gastro-intestinal diseases are abundant in poor countries where the food nutrient quantities are inefficient for the animal requirements. Lack of veterinary services and suitable environmental conditions for the development and transmission of GI-parasites increase the prevalence of these infections. The pastoral livestock keepers are faced with reduced productivity and income due to GI infections of their sheep and goats (Eke *et al*., 2019). The use of anthelmintic drugs is one of the best methods of controlling GI

infections in livestock, even though they are costly and are associated with toxicity and parasite resistance (Abayomi *et al*., 2018). In Eritrea, as in other countries with the same climatic conditions, sheep and goats get infected with GI-parasites when freely graze on contaminated pastures. Transmission can also take place when animals drink contaminated water (Yafet *et al.,* 2020**).** Farmers do not have enough knowledge concerning antiparasitic drugs and animal health services because they only seek veterinary services when the infections reach critical stages. In addition, some GI-parasites are zoonotic infecting humans as well (Kassahun *et al.,* 2021).

Although some parasitological studies on sheep and goats were carried out in Eritrea. especially in the southern highland regions, most of these studies have focused only on estimating the distribution of GI parasites and there have been no attempts to establish the disease risk factors, which have great impact on the management system of GI parasites (Mussie, 2017).

2.3 Transmission of intestinal parasites in small ruminants

Small ruminants, despite their numerous interesting advantages and many functions in pastoralist's life, especially the sheep and goats face many challenges. In many developing countries in tropical and subtropical Africa, goats and sheep play an important role in agricultural sectors. However, the parasitic diseases pose great challenges on the growth and development of sheep and goats (Tirth and Namita, 2019).

Many studies have reported that, most of the small ruminants from tropical and sub-tropical areas suffer from the infestation of gastrointestinal parasites. Many parasitological surveys have shown that, *Coccidia*, *Strongyloides* spp, *Moniezia* spp, *Trichuris* spp, *Haemonchus* spp and *Toxacara* spp were the most common GI-parasites

species (Handiso *et al.,* 2019). Other studies carried out in Ethiopia indicated high prevalence of *Trichostrongylus* spp., *Haemonchus* spp., *Strongyloides* spp. and *Eimeria* spp in sheep and goats (Dereje *et al.,* 2022).

In addition to grazing as a mode of transmission, inhalation, and skin penetration are other ways for transmission of parasites. Transmission also occur mostly during rainy seasons due to the development of larval stages and contamination of drinking water (Witchuta *et al*., 2021; Ephrem *et al.*, 2022).

2.4 Zoonotic diseases interaction in relationship to animals, man and environment

The small ruminants (sheep and goats) are associated with numerous zoonotic diseases, especially the helminthiasis. In Sub-Saharan Africa, Latin America and Asia, the zoonotic helminthic diseases are a public health concern (Hussein *et al*., 2017; Derinda *et al.,* 2021). Zoonotic helminths belong to two phyla, namely; Phylum Aschelminthes (Nematode) and Phylum Platyhelminthes, *Toxocara* spp., *Strongyloides* spp., *Trichuris Fasciola* and *Monezia* spp species are the most abundant species of nematodes. These helminths are among the parasites that cause neglected tropical diseases (NTDs) (Elemo and Geresu, 2017, Heba *et al*., 2018; Ikpe *et al*., 2022).

Complex interactions within animals, man and the environment, have been shown to play a significant role in the transmission of zoonotic helminths from animals to humans. Small ruminants especially the sheep and goats are reservoirs of zoonotic helminthic diseases transmissible to man, (Eduard *et al.,* 2019). Transmission process is higher in the areas where small ruminants are living with displaced people, more contaminated environments and water source and abuse of ruminant dungs (Kétomon *et al., 2023)*.

Additionally, GI-parasite studies are very important for knowing the life cycle and transmission between domestic, wild animals and humans (Paula, 2019**)**.

2.5 Prevalence of zoonotic helminths infections in sheep and goats, Maekel region Eritrea

Reports from previous studies have demonstrated that there are important associations among the farmers, animals and the environment in other parts of Eritrea including the Maekel region (Waktole *et al*., 2023). This close interaction between the animals, pastoralists and the ecosystems has been shown to increases the prevalence of zoonosis helminths in these regions**.** This could be an important factor in the process of disease transmission from animals to man (Emelie *et al***.**, 2021**).** Although, *Cryptosporidium, Giardia,* and *Eimeria* infections were reported from sheep and goats, their zoonotic capacity and the public health concern are often not highlighted (Sanjoy *et al.*, 2022**)**. Therefore, this study aimed to assess the prevalence of gastrointestinal parasites isolated from sheep and goats in Asmara slaughterhouse of Maekel region, Eritrea that are responsible for zoonosis in humans.

2.6 Risk factors associated with GI-parasites in small ruminants

Prevalence of GI-parasitic infections has been reported in Africa especially sub-Saharan regions due to different range of agro-ecological conditions (Ibn and Makija, 2022). Factors associated with zoonotic disease transmission include: poor personal hygiene, poor defecation habits and facilities, lack of clean water supply for domestic use and animals, contaminated pastures, poor indoor plumbing, poor drainage systems, poor human waste disposal, lack of proper sewerage system like dung as fertilizer, poor and dirty animal houses (Hafiz *et al.,* 2021*;* Bura *et al.,* 2020). The climatic factors that

determine distribution of GI-parasites include rainfall, moisture, temperature and humidity **(**Kamonge, 2019).

In addition, drug resistance is also a very important risk factor that is associated with the GI-parasites. In third world countries for example, anti-parasitic medications are widely abused especially by small-scale farmers which promote the development of resistance. (Andrew *et al.,* 2019). There is therefore need to implement other control measures alongside antiparasitic drug use (Habtu *et al.,* 2022). The gastrointestinal parasitic infections are reported to cause more severe pathology among the young stock (≤ 12 months) than adults, as the adults have developed greater immunological resistance to these infections (Mots'elisi *et al*., 2021).

2.7 Diagnosis of gastrointestinal parasites in sheep and goats

Diagnosis of parasites in livestock including sheep and goats can be carried out through macroscopic and microscopic examining of feces for live parasite, parasite eggs or segments (Figure 2.1). Other methods for diagnosis include coproculture, bloodwork, and postmortem examination (Janina *et al*., 2021). The most commonly used diagnostic method for detection of gastrointestinal helminthic infection in livestock is the microscopic examination and identification of parasite eggs (ova) in faeces (Cringoli *et al.,* 2021; Nielsen *et al.,* 2021, Osires *et al*., 2021; Wood *et al.,* 1995). In the McMaster technique, the number of eggs from each sample is recorded and converted in to the number of eggs per gram of feces using the two counting chambers (Gustavo *et al*., 2023)**.** Diagnostic techniques of parasitic infections in livestock face challenges including specificity, sensitivity, personnel skills, cost-effectiveness and improper infrastructure affect the measures taken on parasites prevention and control (Mirabeau, 2020).

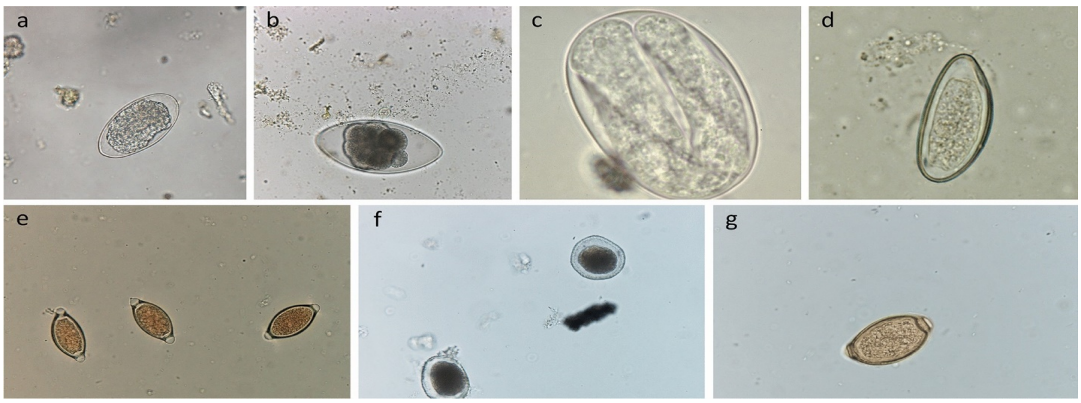

Figure 2.1: Eggs of GI-parasites commonly seen in fecal stool. a) *Strongyle*-type egg, b) *Nematodirus* spp. egg, c) *Strongyloides* spp. egg, d) *Skrjabinema* spp. egg, e) *Trichuris* spp egg, f) *Toxocara* spp. egg, and g) *Capillaria* spp. egg (Gustave *et al*., 2023).

2.8 Prevention and control measures of intestinal parasites

There exist several control methods of parasites which can be stand alone or integrated methods. Some of these integrated methods are good practices and strategies for land farming, animal breeding, biological control, biotechnological techniques and chemical control (Toyin *et al*., 2020). The most commonly used drugs include levamisole, tetrahydro pyrimidines and benzimidazole which have been used both for prevention and treatment. Regular deworming of the animals, knowledge on the climatic, ecological and epidemiological conditions of the habitat are important factors in ensuring effective and timely control of the gastrointestinal parasites (Dave, 2018; Islam *et al*., 2017).

Regular cleaning of the animal houses is also a major factor in control of parasites (Andrew *et al.,* 2019). Contaminated materials, protecting the animals from drinking unsafety water, contaminated food, common grazing areas, awareness to farmers and disposable materials prevent transmission of parasites (Vincent *et al.,* 2019). Rotation on pasture, drying animal's facilities and regular farming with removal of manures are also very important in reducing the transmission of parasites (Public Health England, 2019).

2.9 Future perspectives in the prevention and management of gastrointestinal parasitic diseases in sheep and goats

As discussed above, parasites continue to be a major threat animal health worldwide. The occurrence of these parasites also affects the productivity of the livestock. Even though, there are efforts towards control and prevention of parasitic infections, there are still several challenges faced due to improper approach. The control needs a wholesome one health approach including epidemiological studies including parasite distribution in time and space, ecological aspects which involves the animal's environment, management practices/ husbandry, good diagnostics among other approaches. Therefore, the current study aimed to address some of these issues through studying the addressing the prevalence of these GIT parasites, zoonotic parasites and their associated risk factors in Maekel region of Eritrea with the aim of improving the control of the parasites.

CHAPTER THREE: MATERIALS AND METHODS

3.1 Study area

The study was carried out in the Maekel region of Eritrea (Figure 3.1), which lies at an elevation of 2,325 meters above sea level. The region was chosen as a study site because of the high population of farmers for sheep and goats due to the fertility of lands as compared to most parts of Eritrea. The area is characterized by two rainy seasons per year with an annual average of 483mm and average humidity of 51%. Due to its high altitude (2325above sea level), temperatures are relatively mild.

The long rainy season extends from June until September and the short rainy season occurs from March until May. An average about 60% of the region's annual precipitation is recorded during the months of July and August. In contrast, December to February are typically driest period (Metrology unit's ministry of Agriculture, Eritrea, 2023).

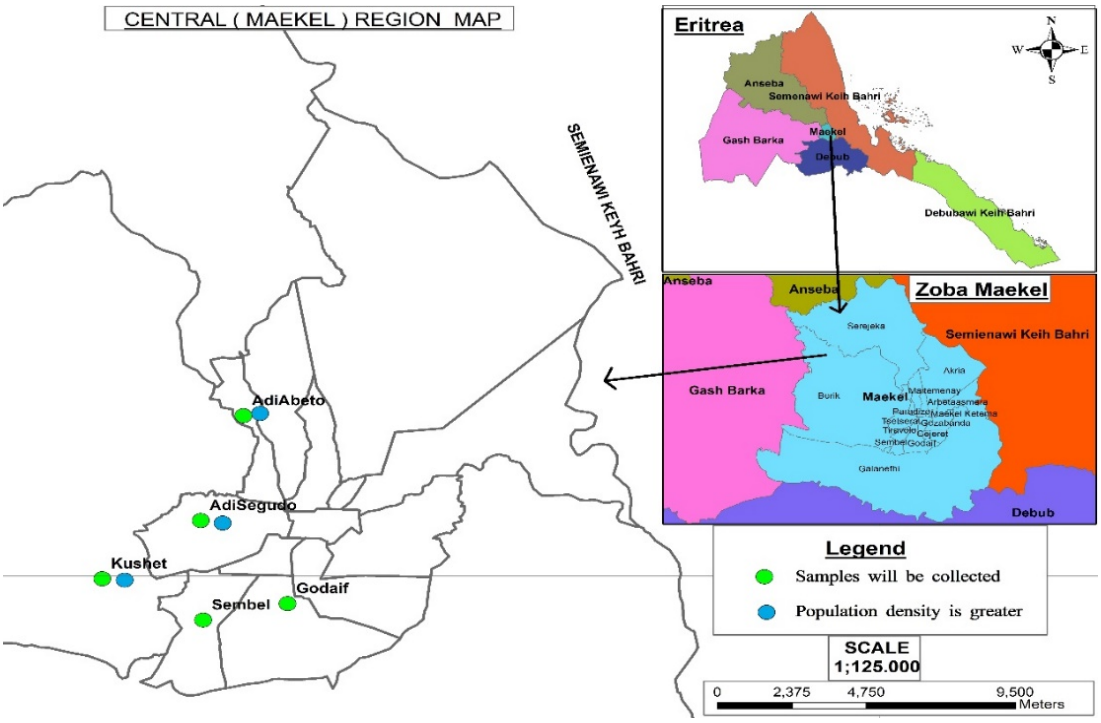

Figure 3.1: Map of Maekel region, Eritrea (Map and information unit of Maekel administration region, state of Eritrea, 2023)

3.2 Study population

The proposed study was conducted among smallholder farmers who keep rora goats breed and barka sheep breed in their farms. The feacal sample was collected from both goats and sheep for detecting GI-parasites. Homesteads were selected randomly for sampling of the animals and within each household small ruminant stock; subjects were selected through simple random procedure.

3.3 Sample size determination

Sample size for the present study was calculated using the Daniel's (1999) formula.

$N - (Z\text{^}2\,P(1-P))/D\text{^}2$, or N=Z^Pq/D^

Where, N= Desired sample size, when the target population is greater than10, 000.

Z= Standard normal deviation (1.96) at 95% confidence

P = 0.5 presumed disease prevalence (since the estimate target population with the characteristic under investigation is not known) and D = error margin required. Since the exact prevalence of GI parasites in sheep and goats in Eritrea is not known, a prevalence of 50% was used as per the requirements of the formula.

Therefore, N= Z^Pq/D^=1.96^ X0.5X0.5X1/0.05^=384

Hence, total population samples of 384 were used from the purposely selected sites without discrimination of sheep and goat's species.

3.4 Study design

The cross-sectional sampling was used and this involved sampling of sheep and goats of both sexes for determination of disease prevalence and parasite species. Forty small ruminant farmers were purposively recruited from four villages (ten farmers per village) and different numbers of animals were sampled from the four villages (Adi Abieto (96

animals), Adi Segudo (97animals), Kushet (94animals) and Godaif-Sembel (97animals) from Maekel region. Hence a total of 384 animals (barka sheep breed and rora goats breed) were used in the study. The forty farmers selected for this study were requested to fill a questionnaire to collect information on animal management practices. Fecal samples were collected from sheep and goats for laboratory analysis of gastrointestinal parasites using microscopy techniques. Retrospective data was also collected from Asmara slaughterhouse to establish the status of zoonotic helminths for the period from January 2022 to May 2024.

3.5 Inclusion criteria

Selected farmers had to have both sheep and goats. Farmers in the selected villages had to consent to questionnaire survey and were willing to allow their sheep and goats to be sampled.

3.6 Sample collection

Random sampling techniques was used for selection of sheep and goat farmers in the four villages of Maekel region and their animals. Fresh fecal samples were collected from the rectum of selected sheep and goats, using a finger fitted with a finger-glove. Collected samples were placed in plastic bottles with suitable waterproof screw cap in order to keep the samples fresh. Sample bottles were labeled correctly with the relevant matching information. These samples were transported in a cool box to parasitology laboratory unit, within National Animal and Plant health laboratory (NAPHL) under ministry of Agriculture in Eritrea, for analysis. Flotation and sedimentation techniques were used for processing the samples for identification of the parasites. Flotation technique was used since it is good for lighter eggs like nematodes (e.g., roundworms, hookworms) and some

cestodes (e.g., *Hymenolepis*), as well as many protozoan cysts. Sedimentation on the other hand is usually preferred method for heavier or operculate eggs, such as those from trematodes (e.g., Schistosoma, *Paragonimus*) and certain cestodes (e.g., *Diphyllobothrium*).

3.7 Flotation technique

Two grams of fecal samples was weighed and placed into container 1 and 15 ml of saturated sodium chloride salt solution was added and mixing done using a stirring stick. The suspension was filtered through cheesecloth into container 2. The solution was put into a test tube and cover with a cover glass. After 15–20 min stand-on-time, cover glass was removed gently and examined under a microscope for detecting the presence of parasite eggs (Hussein, 2017).

3.8 Sedimentation technique

Three grams of fecal samples were placed in a container and mixed with 100 ml of tap water using a stirring stick. Suspension was filtered through a sieve and the filtrate was collected in conical flask and left for 3 to 5 min. Supernatant was discarded, again 100 ml of tap water was added. Procedure was repeated until the sediment looks clear, then placed on glass watch and 1 drop of methylene blue (1%) was added. Specimen was examined under light microscope for detecting trematode eggs.

3.9 Maekel region Eritrea Asmara slaughterhouse data collection

Retrospective data was collected from the Maekel region, Eritrea, Asmara slaughterhouse, based on the past two years (2022-2024) records on zoonotic parasites.

3.10 Assesment of risk factors assocated with GI-parasitic infections

Forty questionnaires were distributed to the selected sheep and goat's owners for collecting data on the farmers' knowledge of livestock GI-parasites and the disease management systems in livestock farming. The questioners' information was collected from forty farmers (purposely, ten farmers from each selected villages). Knowledge of farmers about specific parasites affecting sheep or goats and the specific control methods were collected based on the educational level as elementary (grades 1-5), secondary (grades 9-12) and higher level above grade 12. In addition, data on which anti-parasitic drugs were used locally in sheep and goats was collected including the frequency of use, knowledge of chemical application, availability and accessibility of veterinary services. Observation were also made and reported on other risk factors. In addition, sampling was also done in two seasons to asses seasonal variation of parasites between dry and wet season.

3.11 Data analysis

Data analysis was done using STATA version 12. Descriptive statistics was conducted to determine the distribution of the GI-parasites, as well as using A One-Way Analysis of Variance (One-Way ANOVA), that was used to determine the prevalence rate of GI-parasites between the villages. ANOVA was also used to analyze the rainfall seasonal variation in the four villages. Chi-square test was also used for analysis of association between prevalence GI-parasitic infection and potential risk factors in the selected study area. Again, ANOVA test was also conducted to analyze the distribution of zoonotic helminths of Asmara slaughterhouse at Maekel region Eritrea. Finally, analysis was carried out at 95% confidence interval and a P value ≤ 0.05 was considered statistically significant. The results were presented in text, table, figures, bar graphs and percentiles.

3.12 Ethical approval

The study was approved by the Ministry of Agriculture, state of Eritrea. The research work was also approved by the concerned authorities in Maekel region, Eritrea (Appendix-IV). Informed consent was obtained from the farmers before sampling and administration of the questionnaires. Participants were voluntarily recruited and any information obtained from the participants were kept strictly confidential. During sampling, animals were restrained following standard operating procedures (SOPS) to minimize discomfort and ensure animal welfare.

CHAPTER FOUR: RESULTS

4.1 Prevalence of gastrointestinal parasitic infections among sheep and goats in Maekel region, Eritrea

The study findings revealed that, out of the total 384 sheep and goat's samples tested from the four selected villages, 351 (91.33%) were positive for gastrointestinal parasites while only 34 (8.67) were negative for any type of parasite. Different Parasites were identified to the genus levels and a total of 14 species of parasites were reported based on the microscopic examination and analysis of fecal samples (Figure 4.1). The identified feacal parasites included *Strongyle* eggs, *Strongyloides, Ascaris*, *Haemonchus*, and *Eimeria* (Figure 4.1)

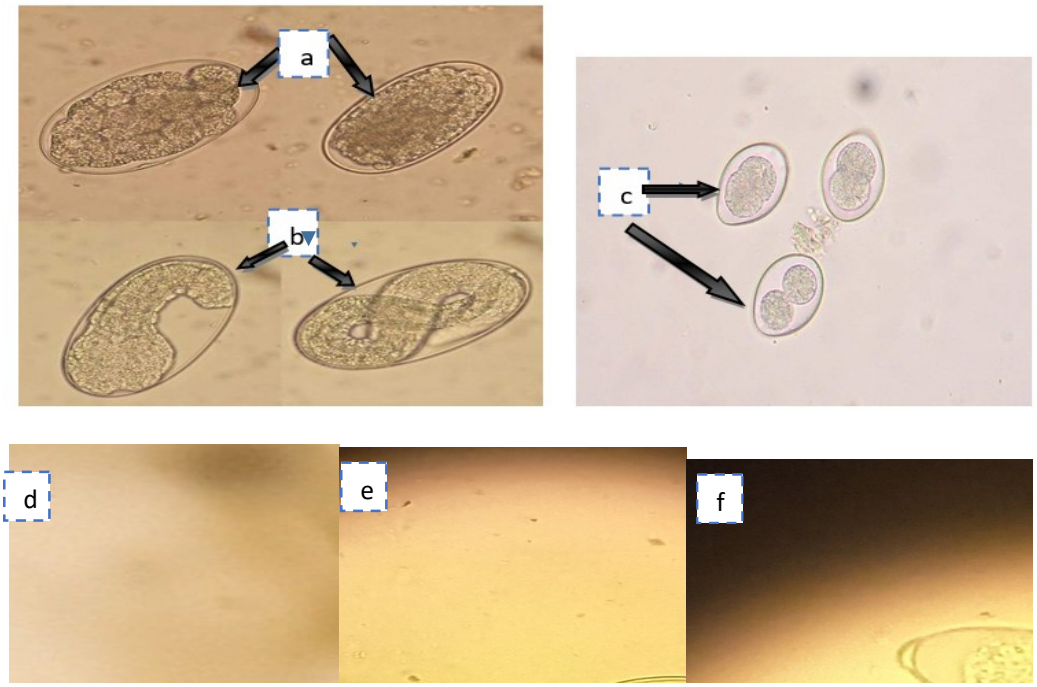

Figure 4.1: Different species of GI-parasites detected from faecal samples a) Strongyl eggs spps b) Strongyloides eggs c) Eimeria d) Ascaris egg (X10) e) *Haemonchus contortus of sheep* (X40), *f*) *Eimmeria spp* (magnification X40).

Furthermore, results indicated that the highest infection rate (94.79 %) was in Adi-abeito, while the lowest prevalence (87.63 %) was recorded in Sembel-Godaif. The most prevalent parasite was *Haemonchus contortus*, with a prevalence of 27.08% animals, as *Ostertagia circumcincta* was the least (0.5 %). Mean parasite numbers between the four villages did not differ significantly as evaluated by ANOVA analysis ($F = 0.4929$; $p = 0.6888$). Analysis of the different species of parasites indicated significant differences ($p = 0.0001$) with *Haemonchus contortus* (26±19.305) being the most abundant while the *Ostertagia circumcincta* (0.5±1.0) was the least common (Table 4.1).

TABLE 4.1. Prevalence of GI-parasites in Maekel region, Eritrea

Region		**Adi-abeito (n=96)**	**Kushet (n=94)**	**Adi-segdo (n=97)**	**Sembel-Godaif (n=97)**	**Prevalent rate**	**P-ratio**	**p-value**
Infection status	**Positive**	91(94.79 %)	87(92.55 %)	88(90.72 %)	85(87.63 %)	351(91.41%)		
	Negative	5(5.21%)	7(7.45%)	9(9.28%)	12(12.37 %)	33(8.59%)	t=40.827	0.0001
GI-Parasite							**Mean**	**SD**
Haemonchus contortus		54 (56.3%)	23 (24.5%)	16 (16.5%)	11 (11.2%)	104 (27.2%)	26	19.305
Eimeria spp		28 (29%)	21 (22.3%)	11 (11.3%)	16 (16.3%)	76 (19.79%)	19	7.27
Cooperia spp		22 (29.7%)	17 (18.1%)	9 (9.3%)	13 (13.3%)	61 (15.9%)	15.25	5.560
Strongylus spp		14 (14.6%)	9 (9.6%)	10 (10.3%)	13 (13.3%)	46 (11.9%)	11.5	2.380
Moniezia benedini		8 (8.3%)	7 (7.5%)	7 (7.2%)	8 (8.2%)	30 (7.8%)	7.5	0.5774
Ascaris spp		4 (4.2%)	8 (8.5%)	6 (6.2%)	3 (3.1%)	21 (5.5%)	5.25	2.217
Trichuris globulosa		3 (3.2%)	0 (0%)	5 (5.2%)	5 (5.1%)	13 (3.4%)	3.25	2.363
Dictyocaylus filarial		5 (5.3%)	2 (2.1%)	8 (8.3%)	5 (5.1%)	20 (5.2%)	5	2.449
Oesophagostomum columbianum		1 (1.1%)	2 (2.1%)	5 (5.2%)	6 (6.1%)	14 (3.7%)	3.5	2.380
Paramphistomum cervix		2 (2.1%)	3 (3.2%)	8 (8.3%)	7 (7.1%)	20 (5.2%)	5	2.944
Bunostomum trigonocephalum		2 (2.1%)	0 (0%)	0 (0%)	6 (6.1%)	8 (2.1%)	2	2.828
Chabertia ovina		2 (2.1%)	0 (0%)	7 (7.2%)	5 (5.1%)	14 (3.7%)	3.5	3.109
Nematodirus spp		0 (0%)	2 (2.1%)	5 (5.2%)	0 (0%)	7 (1.8%)	1.75	2.363
Ostertagia circuncineta		0(0%)	2(2.1%)	0(0%)	0(%)	2(0.5%)	0.5	1.00

4.1.1 Prevalence of GI-parasites in female and male of sheep and goats in Adi-Abieto

Analysis of fecal samples obtained from male and female sheep and goats in the Aid-Abieto Maekel region of Eritrea revealed that more female than male sheep and goats were infected with GI-parasites. ($t = 1.65157$; $p = 0.05011$). Furthermore, all female (100%) animals were infected with the parasites including *Oesophagostomum colombianum, Bunostomum trigonocephalum* and *Dictyocaulus filarial.* The most common (75%) parasite infecting the male animals was *Ascaris spp* (Figure 4.2).

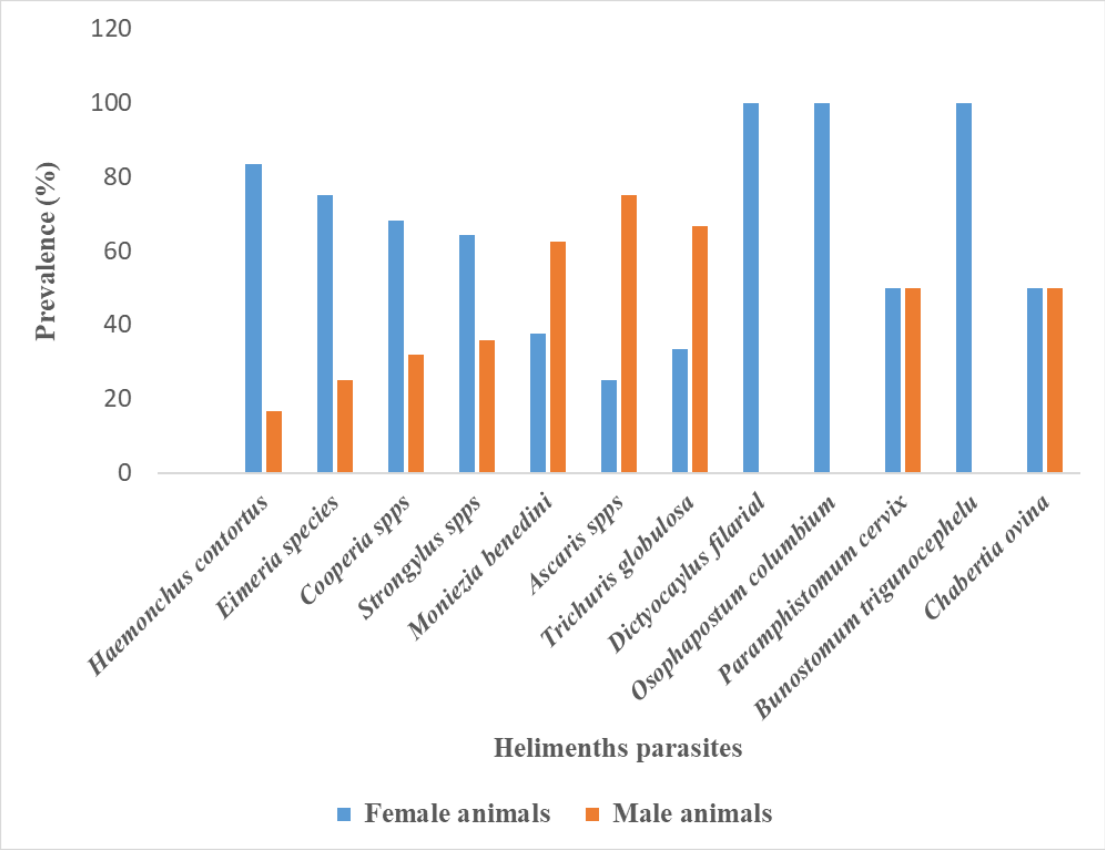

Figure 4.2: Prevalence of GI-parasites in female and male of sheep and goats in Adi-Abieto, Eriterea

4.1.2 Prevalence of GI-parasites in female and male of sheep and goats Kushet

Eleven parasites were associated with disease in sheep and goats in the Kushet region of Maekel, Eritrea (figure 4.3). The most common parasitic infection in female animals were *Osophapostum columbium, Nematodirus spp and Strongylus spp*. Male animals were more infested with *Dictyocaylus filarial* and *Ostertagia circuncineta* with infections found in 50% of the animals. Overall analysis indicated that parasite prevalence was significantly higher in female sheep and goats as compared to the male animals (p = 0.00924) (Figure 4.3).

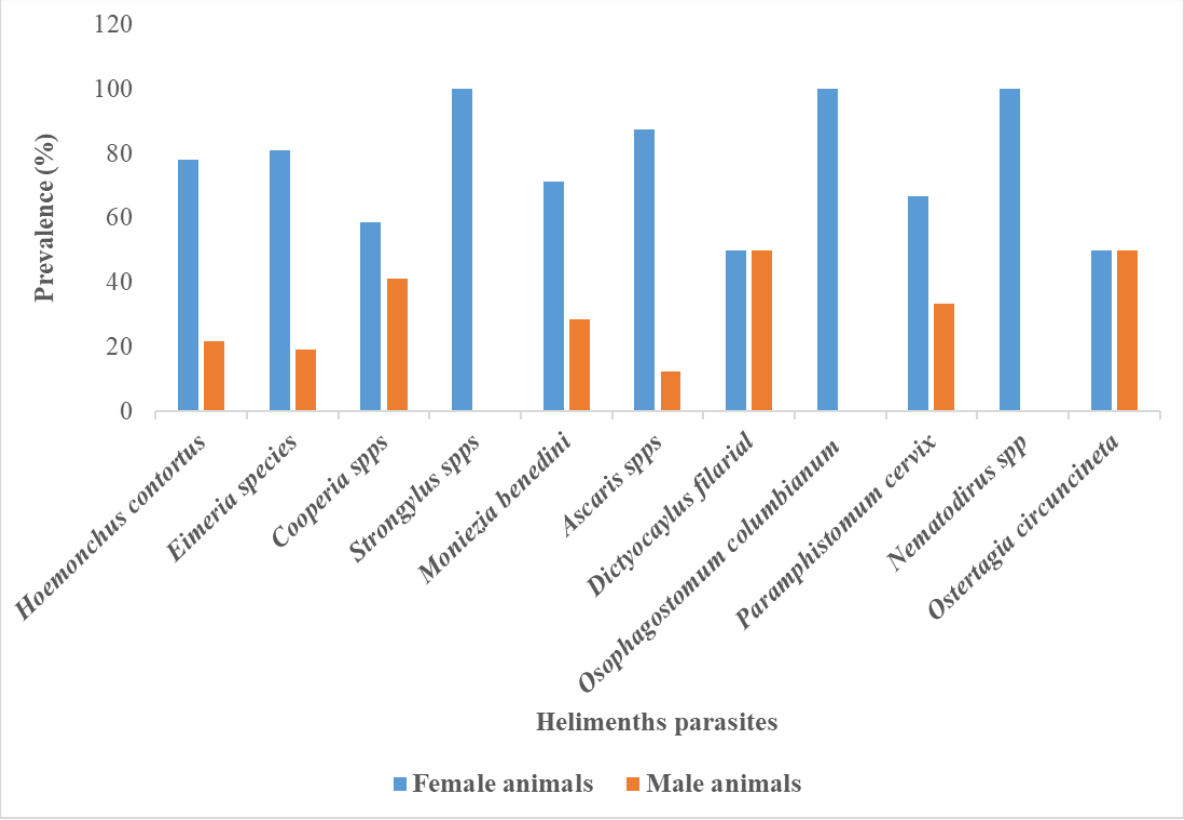

Figure 4.3: Prevalence of GI-parasites in female and male of sheep and goats Kushet

4.1.3 Prevalence of GI-parasites in female and male of sheep and goats in Adi-Segdo

The prevalence of parasitic infections in sheep and goats from the Adi-Segdo region of Eritrea indicated that sheep and goats were infected at varying proportions with the various

parasites. These included *Moniezia benedini, cooperia spp and Paramphistomum cervix* had high prevalence (100%) in females and zero in males (Figure 4.4). Male animals were mainly infected by *Chabertia ovina* (57.14%) which was the parasite with lowest prevalence in females. These data showed that female animals had significantly higher infection then male animals (t = 8.3665; P = 0.0001) (Figure 4.4).

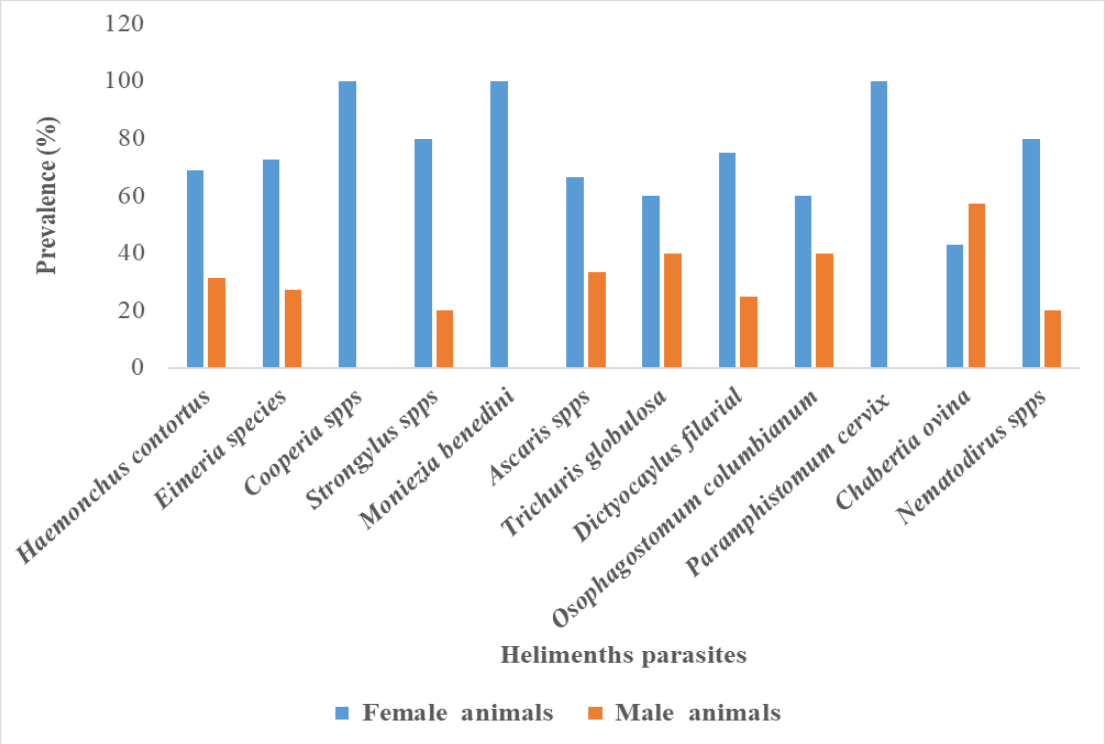

Figure 4.4: Prevalence of GI-parasites in female and male of sheep and goats in Adi-Segdo

4.1.4 Prevalence of GI-parasites in female and male of sheep and goats in Sembel-Godaif

Twelve parasitic species were reported to infect sheep and goats in the Sembel-Godaif region of Maekel. Female animals generally had higher infections rates than the number of males infested by the same parasites. While all male animals were infected by *Dictyocaylus filaria,* there was no single infection of the female animals with this species. The highest infections

of the female animals were by the *Bunostomum trigonocephelum (*83.33 %) parasite. These results concluded that female animals were significantly more infected with parasitic pathogens than male animals in this study region (t = 3.3879; P = 0.00132) (Figure 4.5).

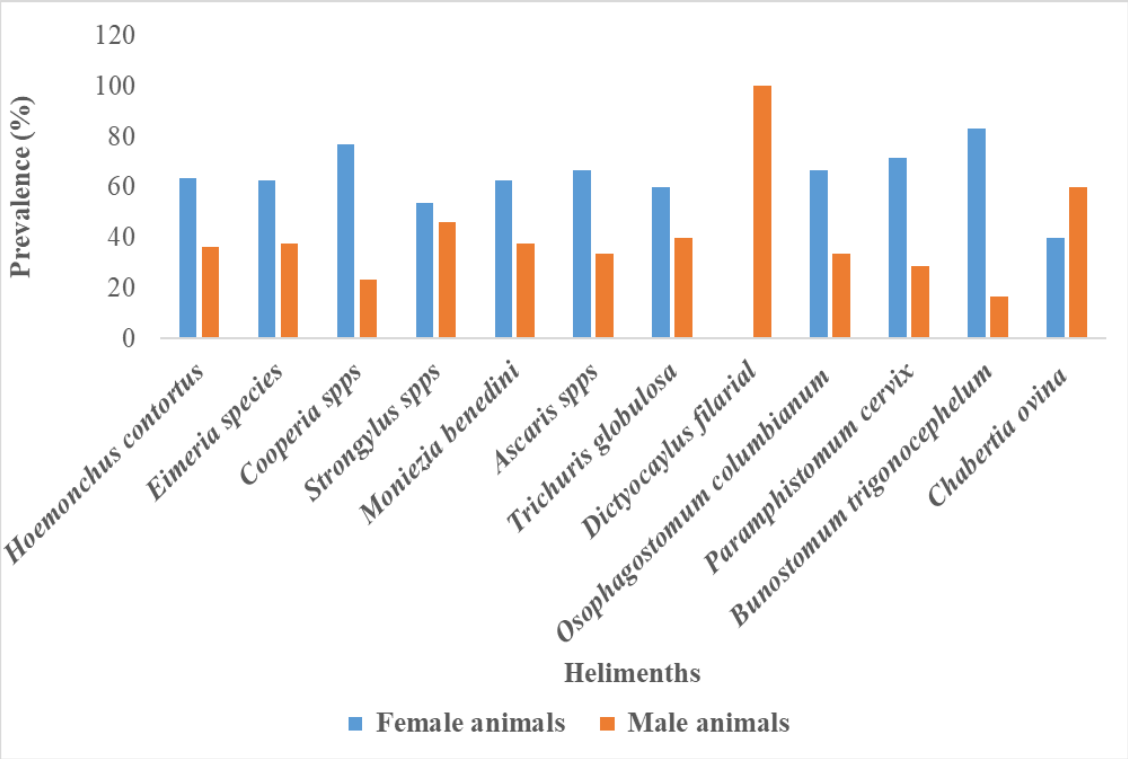

Figure 4.5: Prevalence of GI-parasites in female and male of sheep and goats in Sembel-Godaif

4.2 Zoonotic helminths from Asmara slaughter house of Maekel region, Eritrea from January 2022 to May 2024

During determination of the prevalence of zoonotic helminths for the period from January to May 2024 from records on sheep and goats slaughtered at Asmara slaughterhouse in the Maekel region of Eritrea, examination of the lungs, liver and stomachs, revealed the presence of various parasites. Different types of zoonotic helminths including *Paramphistomum* in stomach; *Strongloids, Ascaris* and *Trichuris* eggs in the small intestinal tract and

Dictyocaulus filarial in the liver were detected and some extended up to the level of hydatid cysts in lungs. Prevalence rates in male animals was 8.38% in 2022, 8.56% in 2023, and 12.96 % in 2024, while in females 11.42 % in 2022, 11.25 % in 2023 and 14.09 % in 2024. There were no significant deviations in prevalence rates based on animal age categories within the animal types (Figure 4.6 and Table 4.2).

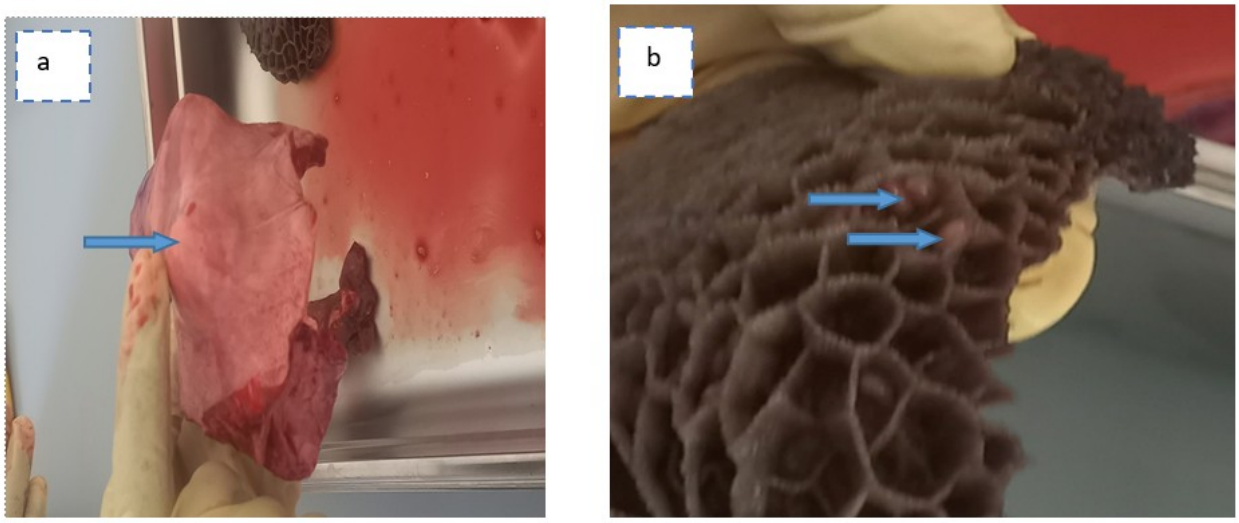

Figure 4.6: Organs of sheep and goats, which are infected with zoonotic helminths a) Hydatid cyst in a lung of sheep (blue arrow), and b) *Paramphistomum* egg in the stomach (reticulum) of sheep

Table 4.2: Zoonotic helminths recorded in Asmara slaughterhouse of Maekel region, Eritrea in 2022, to 2024

Years	**Variables**		**Records**			**Parasites detected**
	Category	Sheep and goats	Total slaughtered	Infected	(%)	
			2,182	205	9.40	*Paramphistomum, Strongloids, Ascaris, Eimeria spp* and reach to hydatid cysts.
2022 (January-December)	Sex	Male	1455	122	8.38	*Strongyloides, Ascaris, Haemonchus* and extend to hydatid cysts.
		Female	727	83	11.42	*Strongyloides, Fasciola spp, Moniezia benedini*
	Age range	1-3 months	209	31	14.83	*Haemonchus, Paramphistomum* up to hydatid cysts.
		4-8 months	745	67	8.99	*Trichuris, Paramphistomum, Dictyocaulus filaria*
		9months-6years	1228	107	8.71	*Strongyloides, Ascaris* and up to hydatid cysts.
2023 (January-December)		Sheep and goats	1,892	179	9.46	*Eimeria spp, Strongyloides, Fasciola spp, Ascaris, Paramphistomum, Haemonchus, Dictyocaulus filarial, Moniezia benedini.*
	Sex	Male	1261	108	8.56	*Strongloids, Ascaris, Fasciola spp,*
		Female	631	71	11.25	*Trichuris, Paramphistomum, Dictyocaulus filarial*
	Age range	1-3 months	229	27	11.79	*Haemonchus, Eimeria spp, Strongyloides* and reach to hydatid cysts.
		4-8 months	528	49	9.28	*Strongyloides, Moniezia benedini*
		9months-6years	1135	103	9.07	*Fasciola spp, Strongyloides, Eimeria spp., Strongyloides* and up to hydatid cysts.
2024 (January-May)		Sheep and goats	743	98	13.19	*Eimeria spp, Strongyloides, Fasciola spp, Ascaris, Paramphistomum, Haemonchus, Dictyocaulus filarial*
	Sex	Male	594	77	12.96	*Strongloids, Ascaris, Haemonchus*
		Female	149	21	14.09	*Eimeria spp, Paramphistomum, Dictyocaulus filarial*
	Age range	1-3 months	57	8	14.04	*Strongyloides, Haemonchus, Trichuris*
		4-8 months	288	26	9.03	*Fasciola spp, Moniezia benedini*
		9months-6years	398	64	16.08	*Ascaris, Strongyloides, Paramphistomum, Eimeria spp, Dictyocaulus filarial*

4.3 Risk factors associated with gastrointestinal parasitic infections in Maekel region, Eritrea

Risk factors associated with parasitic infections as reported by 40 farmers included provision of housing, water sources, mixed housing with other livestock, cleaning frequency, house floor type, farmers literacy levels, parasite screening, deworming frequency and seasonal variation in relation to GI-parasites prevalence.

4.3.1: Provision of housing for sheep and goats in maekel region,Eritrea

The results indicated that, most of the farmers 23/40 (57.5%) provided housing for their animals (Figure 4.7).

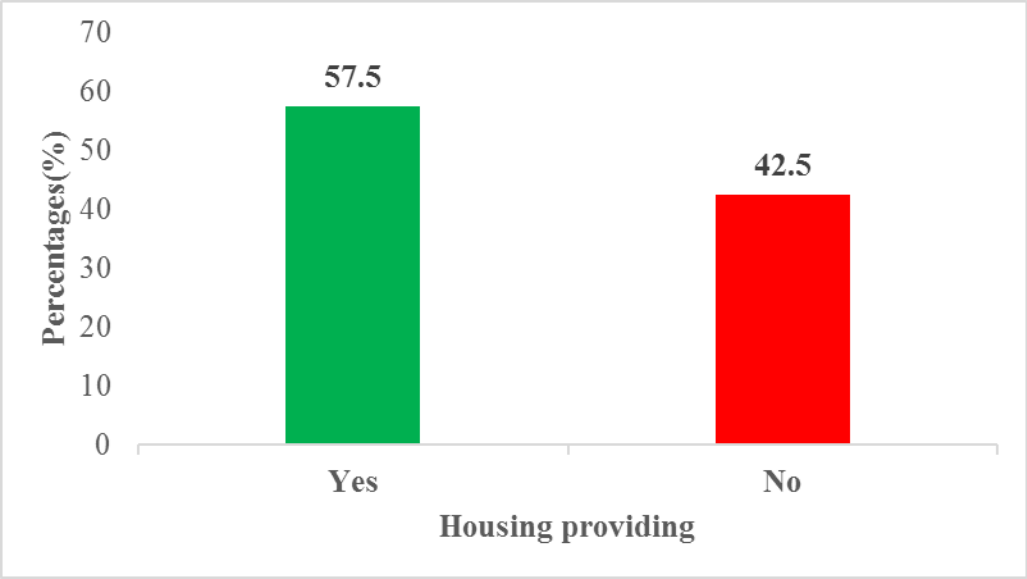

Figure 4.7: Housing provision for sheep and goats in maekel, Eritrea

4.4.2 Water sources in Maekel region, Eritrea

Only 2.5% out of the farmers provided drinking water in a designated area, whereas 27.5% did not avail water in a designated area for their animals. In addition, majority of the farmers (70 %) watered their animals in dams/ponds (Figure 4.8).

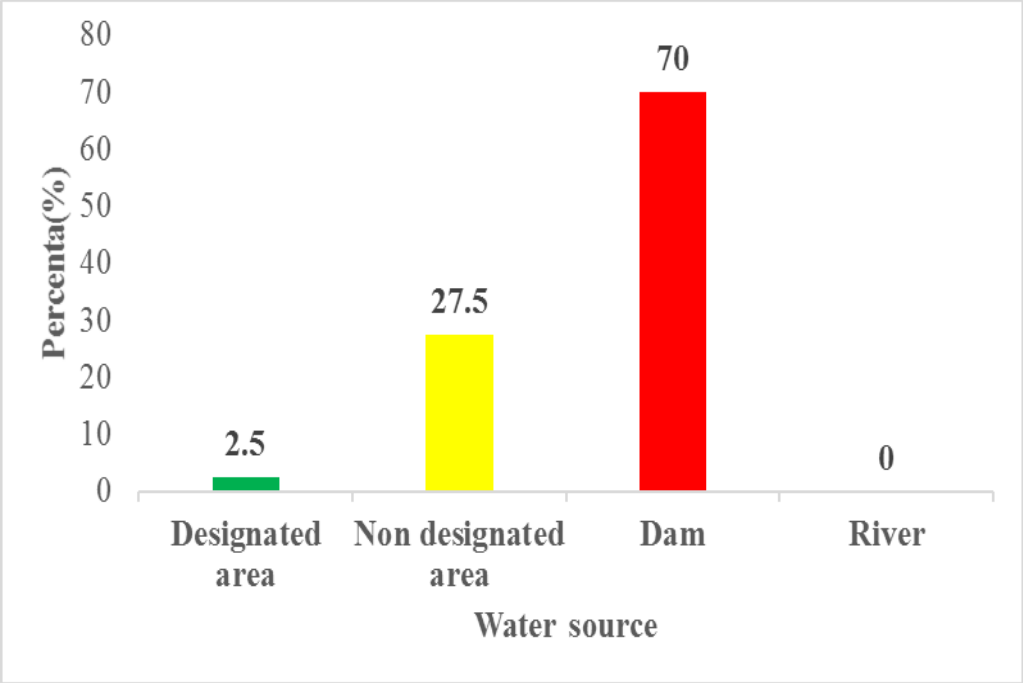

Figure 4.8: Sources of water in Maekel region, Eritrea

4.3.3 Housing of sheep and goats with other animals in maekel region, Eritrea

Majority (67.5%) of the farmers affirmed that, their sheep and goats were not housed with other livestock, while the rest (32.5%) indicated that they had mixed housing of their sheep and goats with other livestock (Figure 4.9).

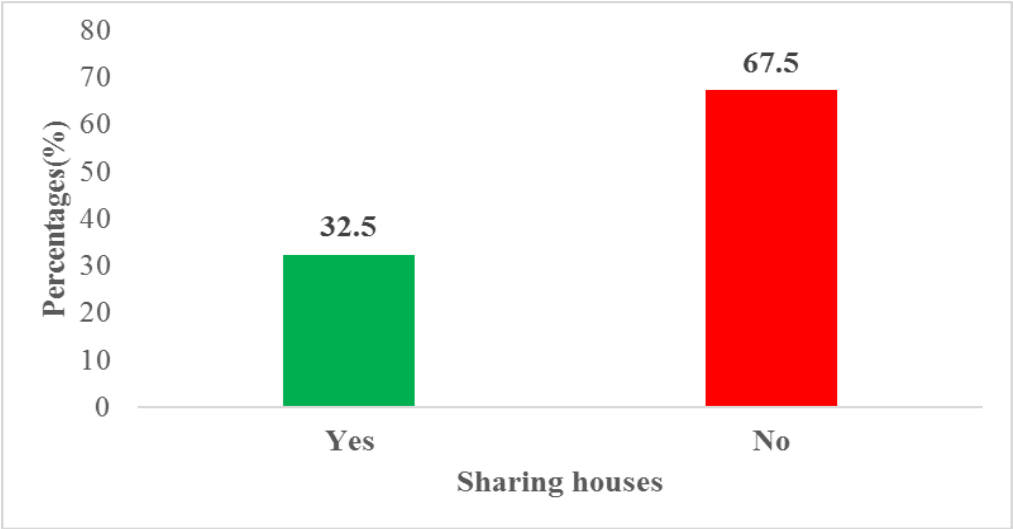

Figure 4.9: Housing of sheep and goats with other livestock in maekel region, Eritrea

4.3.4 Animal house cleaning frequency in maekel region,Eritrea

Only 5.0% of the farmers cleaned their animal houses regularly (the regularity was days or weeks), while 27.5% of the farmers were cleaning their animals houses daily. Majority of the farmers (62.5%) were cleaning their animals houses weekly, 2.5% of the farmers were cleaning the houses monthly while 2.5% confirmed that their animal houses were cleaned annually

(Figure 4.10)

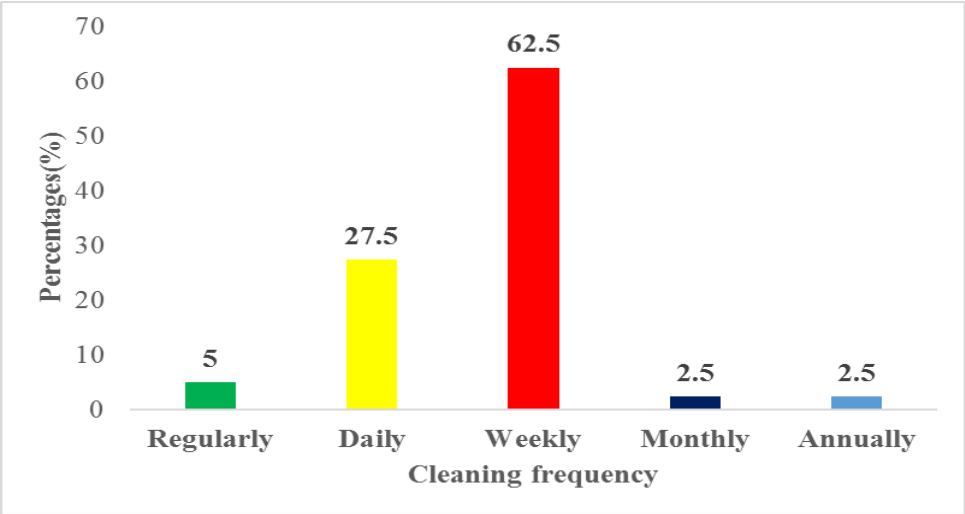

Figure 4.10: Cleaning frequency as a possible risk factor for parasite infections

4.3.5 Floor type for housing of sheep and goats in maekel region Eritrea

Majority of the farmers (97.5%) had earthen floor type of housing for their sheep and goats, while only 2.5% had concrete floor type of housing for their animals (Figure 4.11).

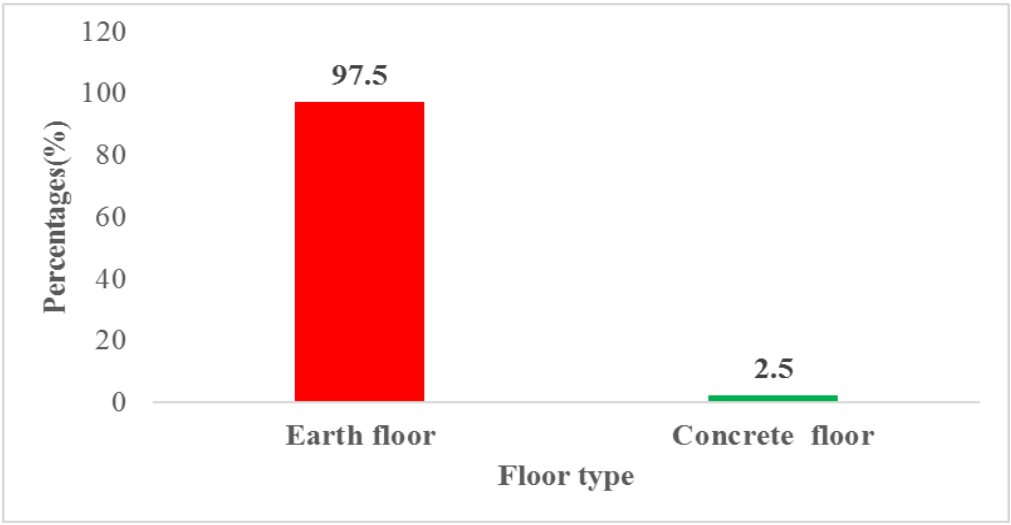

Figure 4.11: Floor type for housing of sheep and goats in Maekel region, Eritrea

4.3.6 Literacy level of the farmers in Maekel, Eritrea

Majority of the farmers (70.0%) had only elementary level (1-5 grades) while only 30% of these farmers had secondary level of education (9-12 grades) and none of the farmers from that area had been educated beyond secondary school level (Figure 4.12).

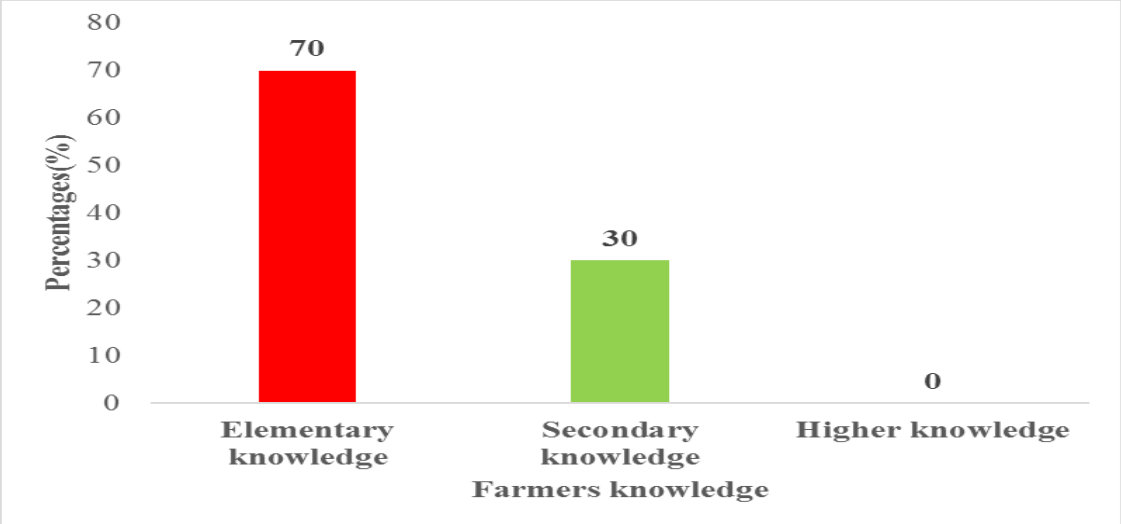

Figure 4.12: Literacy levels for farmers in Maekel region, Eritrea

4.3.7 Screening for gastrointestinal parasites by farmers in Maekel region Eritrea

Most of the farmers (82.5%) did not screen for GI-parasites infection, as only 17.5% out of the farmers frequently screened for GI-parasites among their sheep and goats (Figure 4.13).

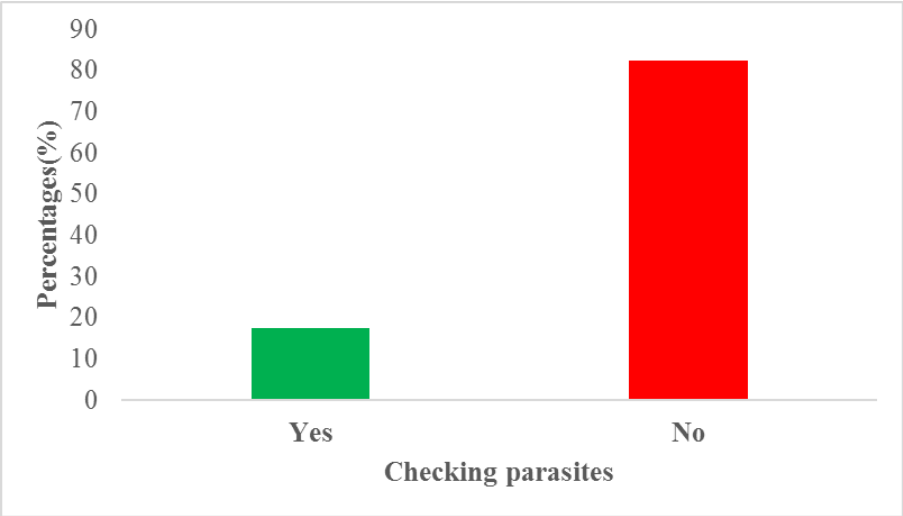

Figure 4.13: Screening for gastrointestinal parasites by farmers in Maekel region, Eritrea

4.3.8 Frequency of deworming for sheep and goats by farmers in Maekel region, Eritrea

Only 5.0% of the farmers dewormed their sheep and goats every three months, while 12.5% of the farmers carried out this practice every six months. Many farmers (42.5%) dewormed their sheep and goats annually while 35.0% attested to deworming their sheep and goats irregularly while 5.0% confirmed not conducting the deworming exercises at all (Figure 4.14).

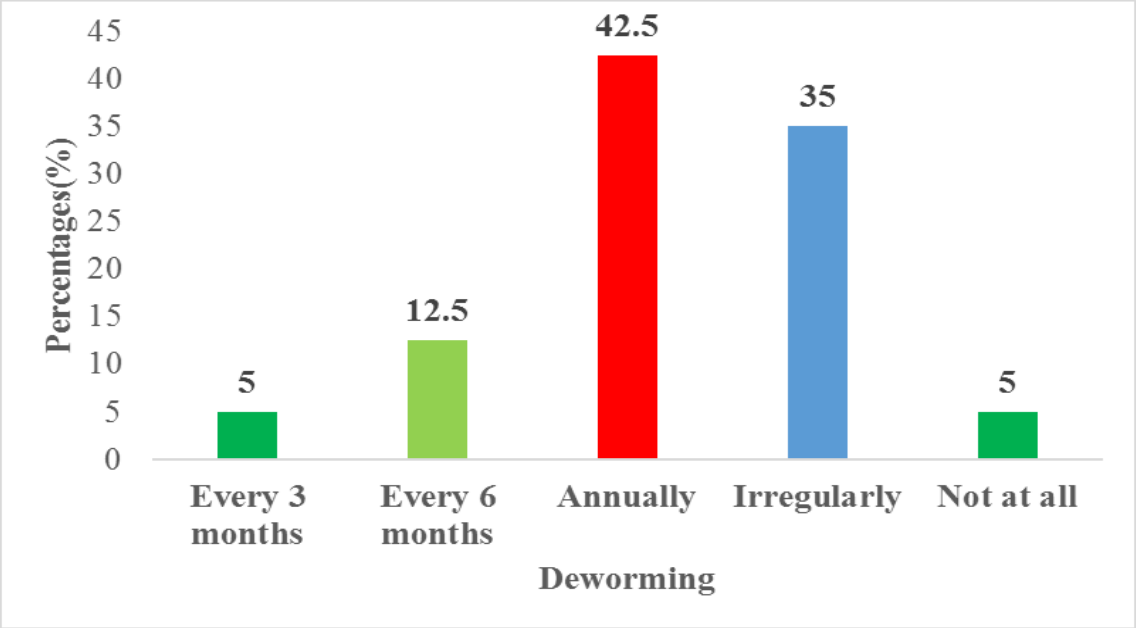

Figure 4.14: Frequency of deworming for sheep and goats by farmers in Maekel region, Eritrea

4.3.9 Seasonal gastrointestinal parasitic disease status in sheep and goats owned by small-scale farmers

Total infestation of gastrointestinal parasite species was higher in the long rain season (June to September), 40.36% (155 out of 384), than in the dry season (December to February) 29.43% (113 out of 384) in Eritrea. It was established that while more females than males were infested with gastrointestinal parasites in the rain (June to September) season, there was no clear distinction in infection proportions across the various age groups (Table 4.3).

Table 4.3: Seasonal variation of gastrointestinal parasite disease status

Dry season (March - May)					season (June-September)			F-Ratio	P-Value
Gender	Ages	GI-parasites detected			GI-parasites detected				
		Samples Tested	Positives	+ves (%)	Sample tested	positives	+ve (%)	-	-
Female	1-11 Months	63	13	20.63	57	31	54.39	1.98	0.1768
	1-4 years	102	27	26.47	102	42	41.18	0.06	0.8163
	5-9 years	116	36	31.03	123	53	43.09	1.61	0.2202
Male	1-11 Months	36	11	30.55	44	13	29.55	3.16	0.0945
	1-4 years	43	19	44.19	35	9	25.71	1.80	0.1963
	5-9 years	24	7	29.17	23	7	30.43	0.00	1.000
Total		384	113	29.43	384	155	40.36		

CHAPTER FIVE: DISCUSSION

5.1 Discussion

5.1.1 Prevalence of gastro-intestinal parasitic infections in sheep and goats in Maekel region, Eritrea

The present study established that prevalence of GI-parasites in the Maekel region of Eritrea was high in goats and sheep with the most dominant species of the parasites being *Haemonchus contortus* (27.2%) while *Ostertagia circuncineta (0.5%)* parasite was associated with the lowest prevalence. According to the results, the prevalence rate of sheep and goats was 91.33 % is higher than that reported by Shimelis *et al.,* 2021, which found that 53.33% and 66.45% of the sample of sheep and goats respectively in the sites of North Gondar zone, Ethiopia. Poor management practices may cause higher rate of infections in Maekel region Eritrea.

The present study indicates that some species of GI-parasites were absent in certain study sites like *Ostertagia circuncineta and Nematodirus* in Adi-Abieto, while *Trichuris globulosa, Bunostomum* and *Chabertia ovina* were absent in Kushet. The present findings were similar to those of Singh *et al.* (2017), who found that prevalence rate of GI-parasites was (85.16%) in goats and (79.24%) in sheep with female animals recording higher infections as compared to the male animals. Similarly, majority of the animals were positive with multiple parasite coinfections as opposed to single parasites monoinfections. The overall sex-specific prevalence in the four studied villages (Adi-Abieto, Kushet, Adi-Segdo and Sembel-Godaif) indicated higher parasitic infections in females than male animals with this trend being the same across the study sites. Under natural situation, males and female sheep and goats have a

higher chance of contamination if they were exposed to the same contaminated communal grazing pasture, but the differences in the variations in the infection rates between the two sexes are not clear. Male sheep and goats' GI-parasites infection rate might be related to their behavioral characteristics (aggressiveness) and hormonal fluctuations during the breeding season (Maquivar *et al,* 2021). Most of the female sheep and goats from Adi-Abieto have higher parasite prevalence rates than males and these results were in contrast to a report by the United Nations Environment Programme (2020**)**, which indicates males had a higher prevalence of GI parasites (77%) than females (55%).

Previous studies have also reported significantly higher GI-parasitic infections in females as compared to male animals (Islam *et al*., 2017; Singh *et al*., 2017). Other studies have indicated that sheep and goats gender had a significant associated with GI-parasitic infections (Rahman *et al*., 2017; Dey *et al*., 2020). It is therefore not clear why female sheep and goats would significantly have more infections when compared to the male animals yet all the animals are grazed in the same fields in addition to their biological behavioral characteristics. The present findings appear to align with reports of previous studies carried out in Ethiopia and Bangladesh where significantly higher number of female sheep and goats were affected by parasitic diseases as compared to the male animals (Getachew *et al*., 2017; Poddar *et al.,* 2017; Elemo and Geresu, 2017).

5.1.2 Seasonal GI-parasitic disease status in sheep and goats owned by small-scale farmers in Maekel region, Eritrea

The present findings demonstrated that, GI-parasitic infections were higher in the rainy season than dry seasons among the studied animals and these compares well with previous study which reported higher prevalence of GI-parasitic infections in sub Saharan Africa regions in the rainy season (Ledger and Mitchell, 2019). A previous study reported that there were various factors that are associated with increased prevalence of livestock diseases in the dry season as compared to the wet season in Kenya (Vincent, 2019). The current results also concur with study by Shimelis, 2021, which reported lower prevalence of gastrointestinal parasites during dry seasons as a result of high temperatures which negatively affect the development of eggs to larval stages. In this study, rainfall, moisture, temperature dynamics and changing of seasonality are main factors that determine and affect free living and intermediate stage infections (Rizwan *et al*., 2017). The infective stages like eggs, larvae and oocysts are shown to develop and progresses in moist and cool environments, which is linked with seasonal effects on gastrointestinal parasitic helminths propagation, environmental adaptations and transmission. A study in Ghana, reported that rainy seasons were favorable for the development of helminthic parasites and farmers were also advised not to send out their animals for grazing especially in early morning so as to decrease their infection (Ibn *et al.*, 2022).

Although there was generally no clear difference in the prevalence of parasitic infections between the various age categories of sheep and goats in the present study, the findings of that young animals were more prone to disease compares to older animal (Shwe *et al*.,

2020), which aligned with reports of a similar research carried out in Southeastern Iran which reported that gastrointestinal parasitic infections were more serious in young animals (≤ 12 months) than adults (Kareem *et al.,* 2023).

5.1.3 Zoonotic helminths from Asmara slaughter house of Maekel region, Eritrea

Based on the categories of gender, the parasites infection rates were dominated by *Strongyloides*, *Ascaris*, *Haemonchus* and *Eimeria* species among the others and caused by the hydatid cysts. Although there was an increase in parasite infection rates for male and female animals in 2024, these changes are comparable across the years and this points to a situation where there have not been any control measures put in place (Takalani *et al.,* 2020, Tejab *et al*., 2018).

The findings in the retrospective study aligns well with the prospective study results where female animals recorded more infections than the male animals. More female than male animals were reported to be more infected by zoonotic parasites (Shimelis *et al*., 2021). This high infection of sheep and goats with zoonotic parasites is worrying because these animals form the most preferred source of meat for the local communities and there is a high possibility of these parasites being transmitted to humans and this could be the reason why these infections are highly prevalent in the study area. Furthermore, transmission of parasites from animals to humans and vice versa would complicate disease control efforts especially in communities where meat may not be well cooked. This calls for community health education as well as mass drug administration in both affected animals and humans.

5.1.4 Risk factors associated with GI-parasitic infections in sheep and goats in the Maekel region, Eritrea

Housing sheep and goats in a good animal structure is vital in preventing exposer to extreme weather elements which would essentially help in disease control. The findings that majority of farmers in the present study had built good houses for their sheep and goats show some understanding in animal management. Furthermore, it is well established that keeping so many different livestock species together would be a risk factor for infections **(**Suchawan *et.al.* 2019). It is established that when different species of animals live together rarely including humans, zoonotic parasite infection rates become high (Solomon *et al.,* 2021).

Providing clean drinking water to livestock is important for disease control and it was concerning that a number of sheep and goat farmers in the present study were providing their livestock with water sourced from dams and other undesignated water sources. Unclean water sources would be a risk factor parasitic transmission (Abayomi *et al*., 2018). Thus, it is likely that, sheep and goats provided with water from these unclean sources could have been highly infected with parasites and this might be the reflection reported in the present disease prevalence. It is important that livestock houses be kept clean in good management system where disease control can be achieved easily. It was concerning that some farmers did not clean their sheep and goats' houses and this could contribute to accumulation of parasites which in turn also contaminate the grazing fields (Waktole *et al.,* 2023). Likewise, livestock houses with earth floors could be harboring more disease pathogens than cemented house floors since it is easy to clean the later than the former. A previous study reported that

systematic management treatments for small ruminants could be very important to reduce the parasitic infection diseases (Golo *et al.,* 2017).

The findings that majority of the farmers were generally illiterate would contrite also to their limited knowledge on parasitic infections and their control hence a major risk for increased infections. Furthermore, upgrading farmer's knowledge on livestock infection management systems can lead to effective disease control (Hafiz *et al*., 2021). Screening for parasites status in livestock can be important to inform on timely disease treatment yet in the current study very few famers did herd screening. Encouraging farmers to regularly inspect their livestock for infections can be an important disease management strategy (Dogo *et al.,* 2017). Irregular deworming is also a risk factor for increased infections as reported in the current study. Reported studies shows that regular deworming was a major control strategy (Roshan *et al*., 2021). However, even though deworming of livestock is important, knowledge of good husbandry practices is very important in parasite control as compared to drug use since deworming is associated with other negative effects such as drug resistance due to drug abuse (Khana *et al*., 2023**).**

5.2 Conclusions

i. The sheep and goats in the current were infected by gastrointestinal parasites at various prevalence levels, the highest being *Hemonchus contortus* (27.2%), followed by *Eimeria* species (19.79%), *Cooperia*species (15.9%)*, Strongylus* spps (11.9%), *Monezia* spp (7.8%), *Ascaris* spps (5.5%), *Trichuris globulosa* (3.4%), *Dictyocaylus filaria* (5.2%), *Osophagostomum colunibiamum* (3.7%), *Paramphistomum cervix*

(5.2%), *Bunostomu .trigunocephelum* (2.1%), *Chabertia ovina* (3.7%), *Nematodirus* (1.8%), and *Ostertagia circuncineta* (0.5%).

ii. Prevalence of GI-parasites was higher in the rainy season (40.36%) than dry season (29.43%).

iii. The prevalence of zoonotic helminths of sheep and goats in Asmara slaughterhouse of Maekel region, Eritrea were dominated by *Strongyloides, Trichuris, Ascaris, Fasciola spp, Paramphistomum, Dictyocaulus filarial,* and *Haemonchus contortus* including manifestation of hydatid cysts.

iv. The risk factors associated with gastrointestinal parasitic infections included poor housing, mixed housing with other animals, dam or common water supply with other livestock, irregular deworming, and poor knowledge of farmers on parasitic helminths.

5.3 Recommendations

i. There is need to improve farmer's awareness, through public health education on sanitation of the animal's house and about the transmission of risk factors for GI-parasites.

ii. There is need for extended distribution of piped water in the Maekel region, Eritrea to improve domestic water supply by providing clean water that could prevent infections.

iii. The study recommends development of consistent deworming programs using anti-parasitic medication for both humans and animals.

5.4 Suggestions for further studies

i. Studies on prevalence and risk factors of GI-parasites of sheep and goats should be undertaken in other regions of Eritrea.

ii. There needs to be investigation studies to establish why female sheep and goats are more susceptible to parasitic infections than male animals.

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APPENDICES

APPENDIX-I: Farmer's sample questionnaire

Dear respondent,

I am a student at Kenyatta University carrying out a research on the prevalence of GI-parasites in goats and sheep within Maekel region of Eritrea. The information collected in this questionnaire was for research purposes and was explicitly be used towards gaining statistics and views of farmers on the prevalence of GI-Parasite in goats and sheep in Maekel region of Eritrea. The participation was voluntary and it was them choose to participate or not.

Thank you in advance.

Instructions

Tick as appropriate by putting an (X) or a tick (√) on the under-line provided or answer

Where required.

QUESTIONNAIRE

1. Farmers practices regarding gastro-intestinal parasites.

[a] Do you provide a house for your sheep and goats?

Yes _____, **No** _____

[b]Watering place for your sheep and goats?

At home (in a designated place): _____

At home (in non-designated place): _____

At the river: _____

Dam: _____

On stagnant water by the road side: _____

[c]What method of farming do you practice?

Paddocking: _____

Tethering: _____

Zero grazing: _____

Free range: _____

[d]What type of floor is the sheep and goat house made up of?

Earth floor type: _____

Concrete floor type: _____

[e]When do you clean the goats and sheep house?

Daily _____

Weekly _____

Monthly _____

2. Farmer's knowledge regarding gastro-intestinal parasites.

[a] what is your education level?

Primary level: _____

Secondary school level: _____

Tertiary education: _____

[b]What is the farmer's knowledge regarding to the gastro-intestinal parasites?

Good knowledge _____

Fair knowledge _____

Not at all _____

[c] Do you check gastro-intestinal parasite infection?

Yes: _____ , **No:** _____

If your answer is yes, how do you check: -……

[d] How often do you deworm your goats?

Every 3 months _____

Every 6 months _____

Annually _____

Irregularly _____

Not at all _____

APPENDIX-II: Standard operating system in laboratory examinations (sops)

a: Standard operating procedure system (sops) in flotation technique

- Fecal sample should be collected directly from the rectum.
- Weight approximate 2gms of faces or measure the feces with a precalibrated teaspoon. If horse 5gms.
- Add 15ml of saturated salt solution (NACL) into container .1.
- Stir the mixture (faces and flotation fluid) very well with a stirring device (tongue blade, fork, and glass road).
- Filter the resulting fecal suspension through a tea strained or a double-layer of cheesecloth into container.2.
- Pour the solution to test tube and place caver glass slowly over it.
- Leave the solution to stand for 15-20min.
- Remove the caver glass, which adhere the eggs from the test tube by lifting it vertically.
- Place the caver glass on microscope slide and examine under microscope using 10 x objectives.

b: Standard operating procedure system (sops) in Sedimentation technique

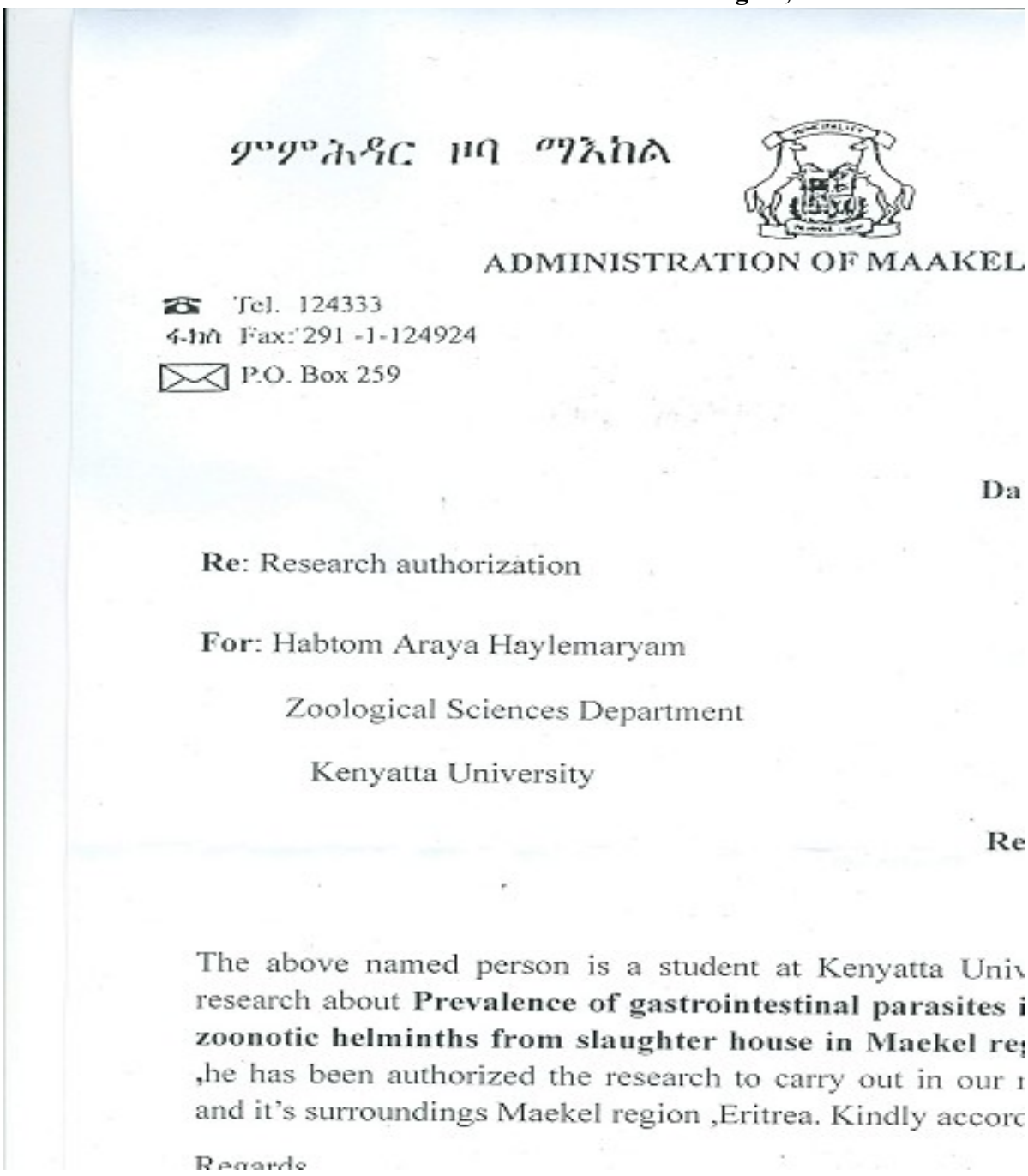
- Weight 3gms of faces into container and add 100ml of tape water.
- Mix it with a stirring device and filter the suspension through a sieve and collect the filtrate in conical flask.
- Leave the filtered to sediment for 3-5min.
- Descant the supernatant and restore it with tape water.

- Repeat the procedure 3-times until sediment looks clear.
- Put the sediment on glass watches and add 1 drop of Methylene blue (1%).
- Observe it with 10 times objective microscope.

c: Standard operating procedure system (sops) in mc-master technique

- Fecal sample should be collected from the rectum of animal.
- Weight 3gm of feces and crush feces using mortal and pestles.
- Add 42ml of flotation fluid then homogenized and filtered the suspension by sieve and collects the filtrate in beaker.
- Fills one or both chambers of Mc-master using Pasteur pipette and allow to stand 5min.
- Examine the filtrate under a microscope 10xmagnification.
- Count the number of eggs inside the two chambers.

APPENDIX-III: Research authorization letter from Maekel region, Eritrea



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ADMINISTRATION OF MAAKEL

☎ Tel. 124333
ፋክስ Fax:'291 -1-124924
P.O. Box 259

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Re: Research authorization

For: Habtom Araya Haylemaryam

Zoological Sciences Department

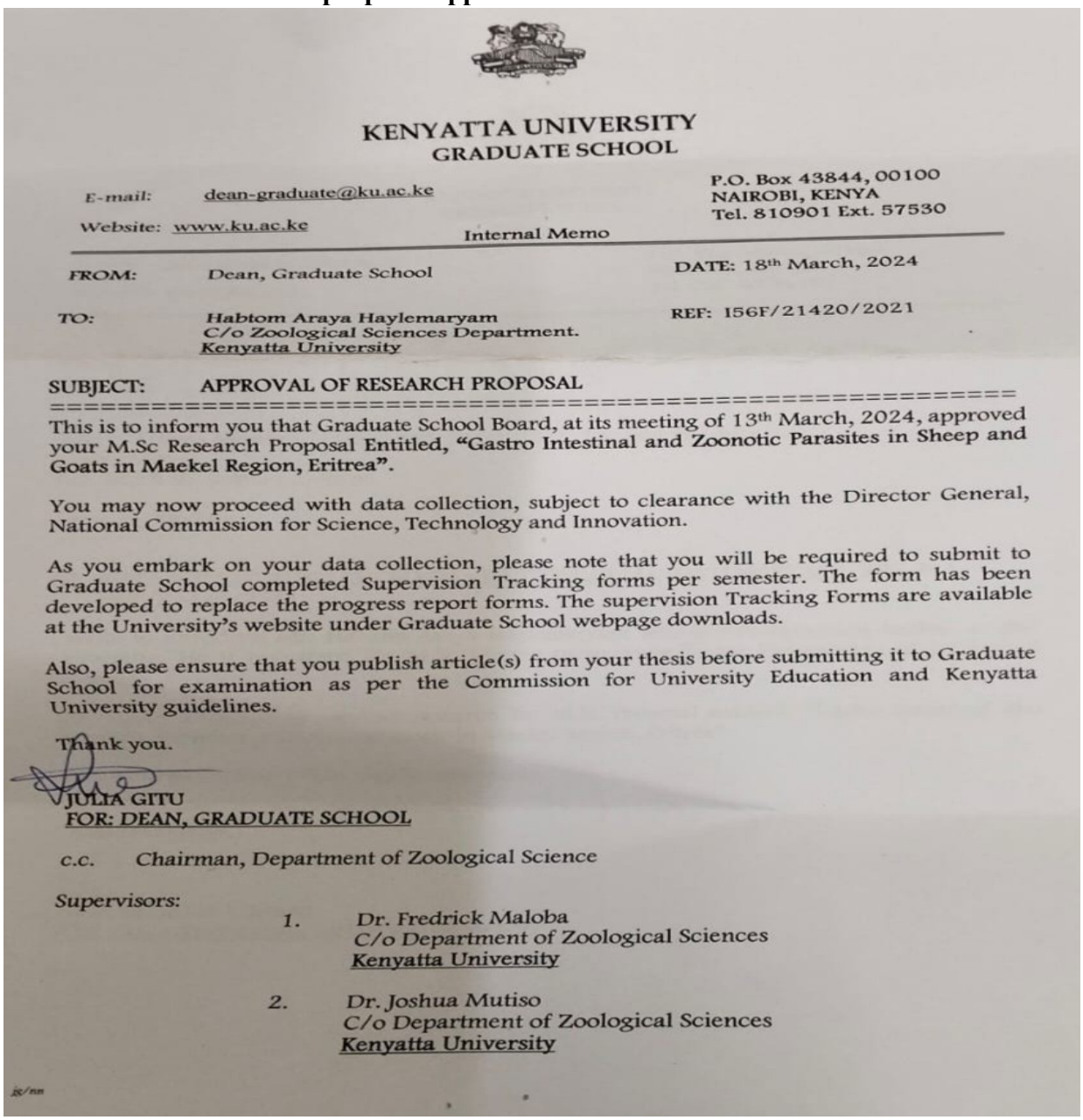
Kenyatta University

Re

The above named person is a student at Kenyatta Univ
research about **Prevalence of gastrointestinal parasites i**
zoonotic helminths from slaughter house in Maekel reg
,he has been authorized the research to carry out in our r
and it's surroundings Maekel region ,Eritrea. Kindly accord

Regards

APPENDIX-IV: Research proposal approval letter



KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 810901 Ext. 57530

Internal Memo

FROM: Dean, Graduate School

DATE: 18th March, 2024

TO: Habtom Araya Haylemaryam
C/o Zoological Sciences Department.
Kenyatta University

REF: 156F/21420/2021

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

This is to inform you that Graduate School Board, at its meeting of 13th March, 2024, approved your M.Sc Research Proposal Entitled, **"Gastro Intestinal and Zoonotic Parasites in Sheep and Goats in Maekel Region, Eritrea".**

You may now proceed with data collection, subject to clearance with the Director General, National Commission for Science, Technology and Innovation.

As you embark on your data collection, please note that you will be required to submit to Graduate School completed Supervision Tracking forms per semester. The form has been developed to replace the progress report forms. The supervision Tracking Forms are available at the University's website under Graduate School webpage downloads.

Also, please ensure that you publish article(s) from your thesis before submitting it to Graduate School for examination as per the Commission for University Education and Kenyatta University guidelines.

Thank you.

JULIA GITU
FOR: DEAN, GRADUATE SCHOOL

c.c. Chairman, Department of Zoological Science

Supervisors:

1. Dr. Fredrick Maloba
C/o Department of Zoological Sciences
Kenyatta University

2. Dr. Joshua Mutiso
C/o Department of Zoological Sciences
Kenyatta University

jg/nn

APPENDIX V: Representative photos from the laboratory and fields during the sampling.