COPROLOGICAL INVESTIGATION FOR GASTROINTESTINAL PARASITIC INFESTATION IN GOATS IN GAZIPUR, BANGLADESH

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CERTIFICATE

*This is to certify that thesis entitled, "**COPROLOGICAL INVESTIGATION FOR GASTROINTESTINAL PARASITIC INFESTATION IN GOATS IN GAZIPUR, BANGLADESH**" submitted the **Faculty of Animal Science and Veterinary Medicine, Sher-e-Bangla Agricultural University, Dhaka**, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **DEPARTMENT OF MEDICINE AND PUBLIC HEALTH**, embodies the result of a piece of bona fide research work carried out by **SELIM FARHAD SHIHAB**, Registration No. **14-06106** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

.....
Dated:
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DECLARATION

I declare that the thesis hereby submitted by me for the MS degree at the Sher-e-Bangla Agricultural University is my own independent work and has not previously been submitted by me at another university/faculty for any degree.

Date: 31.12.2021

SELIM FARHAD SHIHAB

Dedicated
To My
Beloved Parents

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The Author

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LIST OF ABBREVIATIONS AND SYMBOLS

ABBREVIATION	FULL WORD
Approx.	Approximately
BBS	Bangladesh Bureau of Statistics
Dept.	Department
df	Degree of freedom
DLS	Department of Livestock Services
e.g.	for example
et al.	and others
etc.	Etcetera
Fig.	Figure
g	Gram
GDP	Gross Domestic Products
GI	Gastro-intestinal
GIP	Gastro-intestinal Parasite
GIT	Gastro-intestinal Tract

LIST OF ABBREVIATIONS AND SYMBOLS (cont'd)

ABBREVIATION	FULL WORD
hrs	Hours
i.e.	That is
mg	Milligram
min	Minutes
ml/mL	Milliliter
mm	Millimeter
mnths	Months
No.	Number
SAU	Sher-e-Bangla Agricultural University
sp.	Species
spp.	Several Species
™	Trademark
W.H.O.	World Health Organization
yrs	Years
^{0}C	Degree Celsius
%	Percentage
~	Tilde

COPROLOGICAL INVESTIGSTION FOR GASTROINTESTINAL PARASITIC INFESTATION IN GOATS IN GAZIPUR, BANGLADESH

ABSTRACT

Gastrointestinal parasitic (GIP) infestation is one of the major hindrances in goat production in Bangladesh. The aim of the current study was to look at the prevalence of GIP infection in goats in Gazipur district of Bangladesh. A total of 50 fecal samples were taken from various areas of Gazipur District and were subjected to routine coprological investigation (direct smear, flotation and sedimentation) to detect the eggs of gastrointestinal parasites. The result showed an overall prevalence of 54% GIP in goats in the study area. Individual parasites observed in the fecal samples were Strongyles (38%), *Fasciola* sp. (24%), *Strongyloides* spp. (12%) and *Paramphistomum* sp. (10%). Jamnapari goats were more prone to GIP infestation than Black Bengal goats. Female goats (64%) demonstrated higher rate of GIP infestation. Non-dewormed goats were significantly more susceptible to GIP infestation. Further study with broader area and sample size with extensive epidemiological data along with the risk factors will provide a clearer picture of GIP infestation status.

Key Words: Prevalence, Gastrointestinal Parasitic infestation, Goats, fecal examination.

CHAPTER 1

INTRODUCTION

Livestock sector is considered to be a pivotal agricultural sub-sector in Bangladesh. It plays a vital role in the improvement of human health and boosting the national economy of the country. Livestock is an integral part of rural farming system, which contribute to the enhancement of the economy of Bangladesh. Livestock sector, especially ruminants play a key role in meeting the demand of essential animal protein of human body in daily diet (Bangladesh Economic Review, 2022). The population of cattle, buffalo, goat and sheep was 24.7, 1.508, 26.774 and 3.752 million in numbers, respectively (Department of Livestock Services, 2022). Livestock's contribution in GDP of Bangladesh was approximately 1.90%, GDP growth rate of livestock was approximately 3.10% and the share of livestock in agricultural GDP was approximately 16.52%. About 20% of the population of Bangladesh directly depends on livestock for employment whereas about 50% of the population partly depends on livestock sector (Bangladesh Bureau of Statistics, 2022).

Goat comprises a major portion of the total livestock in Bangladesh, which is about 47.19% of total ruminants and 6.19% of the total livestock. Bangladesh stands at 4^{th} in goat production, 2^{nd} in goat milk production and 4^{th} in goat meat production in the world (Anonymous, 2022). It is mostly reared in traditional system mainly for several reasons including meat, wool and skin production (Hossain *et al*., 2004). Rearing goats require a small amount of investment of money. Goats often do not require specific housing arrangements. They graze on barren and roadside grassland and require least number of concentrates, which can be provided by homemade supplied feed (rice polish, vegetable skins etc.). Goats can also be fed jackfruit leaves, mango leaves, jujube barks and leaves, which are available in most rearing areas throughout the country. Goat meat, which is known as "Chevon"; has a higher demand in local market. Besides, goat skin has very high demand in local as well as international markets. These have made the goat rearing enterprise very prominent to the vulnerable group of people and the existing socio-economic condition of the country (Hassan *et al*., 2011). Goats also play important role in employment generation, increasing income, storage of capital and improvement of household nutrition (Devendra, 1992).

Parasitic diseases are considered to be a major concern in the health and food safety of animal origin and cause economic losses in nations where the livestock industry is an anchor of the agricultural products (Wadhawa *et al*., 2011). Gastrointestinal parasitism is a worldwide problem for the livestock sector. (Regassa *et al*., 2006).

Gastrointestinal Parasites (GIP) are significantly important in ruminants but the severity of infection varies in different places as temperature, humidity, rainfall etc. may cast some influence in the magnitude and occurrence of the infection (Singh *et al*., 2017; Naqvi *et al*., 2012). The climate of Bangladesh is tropical with monsoon weather, which is highly favorable to the parasites for their growth, development and reproduction (Zahan *et al*., 2018).

Gastrointestinal parasite infection is one of the major reasons, which causes production losses, weight loss and even death in ruminants and thereby negatively influence their production system. GI parasitism, especially fascioliasis, hemonchosis, tricho-strongylosis impaired the growth and productivity of small ruminants (Speedy, 1992). In spite of posing significant losses, GI parasitism was often disregarded as most of the parasite-infected animals show a little number of observable clinical signs throughout their productive life (Raza *et al*., 2010). In addition, the problem is often uncared for due to its duration and deceptive nature (Sanyal, 1998). Without any doubt, the topographical and climatic conditions of Bangladesh is rather suitable for the subsistence of various parasites (Hossain *et al*., 2004). Moreover, GI parasites and their different intermediate hosts were more prevalent because of the shorter winter season and the prolonged summer followed by the monsoon season in Bangladesh (Haq and Sheikh, 1968).

Goats are commonly affected by several GI parasitic infections, which are often considered to be a vital reason that halt the growth and production and sometimes cause serious damage to health of the animals (Murthy and Rao, 2014; Radostits *et al*., 1994). GIP results in financial losses because infected animals are less productive, have lower neonatal weights and have stunted growth (Soulsby, 1982). In acute cases of GI parasitic infections, animal may die without showing any observable clinical signs whereas in chronic cases, several symptoms including inappetite, incoordination, diarrhea, weight loss, bottle jaw and anemia are prominent which may result death of the animals (Radostits *et al*., 1994; Soulsby, 1982). Further, GI

parasitic infections takes a heavy toll in the production cost by adding an extra expenditure for the prevention and control measures (Silvestre *et al*., 2000). There are several risk factors that are involved in the occurrence of GI parasitic infections including breed, age and sex, body condition score of the animals, flock size, housing system and rearing system, deworming status of the animal, distribution of parasite species, parasitic load, the topography of the area etc. (Dey *et al*., 2020; Alim *et al*., 2012; Tariq *et al*., 2010). Also, there is an issue of the development of anthelmintic resistance, which is becoming a major problem and needs to be considered (Pawar *et al*., 2019).

Numerous epidemiological studies on small ruminant GI parasites have been conducted in various parts of Bangladesh (Poddar *et al*., 2017; Sangma *et al*., 2012; Hassan *et al*., 2011; Islam and Taimur, 2008; Mohanta *et al*., 2007). For ruminant growth and production, *Toxocara*, *Strongyles* and *Trichuris* are the most concerning gastrointestinal nematodes (Dey *et al*., 2020). The three most significant trematodiases in various nations, including Bangladesh, are fascioliasis, paramphistomiasis, and schistosomiasis (Squire *et al*., 2019; Yasin *et al*., 2018; Choubisa and Jaroli, 2013). *Fasciola gigantica*, according to earlier studies, is thought to be the cause of fascioliasis in Bangladesh, where prevalence estimates ranged from 10 to 50 percent. (Yasin *et al*., 2018; Rahman *et al*., 2017). Another parasite that is most frequently observed to affect livestock of this country (20–60%) is *Paramphistomum* (Yasin *et al*., 2018; Ghosh *et al*., 2013). In Bangladesh, prevalence of *Schistosome* in animals ranges from 23 to 40 percent (Yasin *et al*., 2018; Sardar *et al*., 2006). The major causes of cestodiasis in livestock, particularly in young sheep and goats, is *Moniezia* (Rahman *et al*., 2017).

Among the various types of problems encountered, parasite infection is thought to be the major cause of hindering the goat production (Nooruddin *et al*., 1987; Dewan *et al*., 1979). High occurrence of different parasites was reported in goats (Mahbub, 1996; Howlader *et al*., 1991; Samad *et al*., 1979; Bhuyan, 1970). Jugessur *et al*. (1998) conducted a survey and reported that 35.3% of the infected goats had above 300 eggs in feces. Similar to other diseases, parasitic infestation or concurrent infections lead to financial losses due to mortality, poor growth, loss of body weight gain, poor skin quality due to ectoparasites in particular, and decreased milk and meat output (Ahmed *et al*., 1994; Nooruddin *et al*., 1987; Dewan *et al*., 1979).

Small ruminants (sheep and goat) constitute the major portion of livestock in Bangladesh; about 80% rural people are involved with livestock farming (Siddiki *et al*., 2009). Small ruminants' production has recently got higher priority in Bangladesh, especially goats, which encouraged the rural women to consider livestock keeping as commercial enterprise thus helping in women empowerment. Despite routine vaccination against major infectious diseases, goats are still suffering from poor body condition state due to parasitism. Under both rural and farm conditions, it was shown that 25% of kids and 43% of adults died from gastrointestinal parasitism in goats (Rahman *et al*., 1975).

Gazipur district is located in the central part of Bangladesh, adjacent to the capital Dhaka. It has an area of 1806.27 square km with a population above 5.2 million (Bangladesh Bureau of Statistics, 2022). It has a high number of livestock population, a large portion of which consists of goats and it represents most part of the country regarding climatic condition (Khatun *et al.,* 2021). In addition, this district has a rich source of goats, mostly reared by rural women in traditional method. Therefore, a study of GIP infestation in goats of this area was a demand of time.

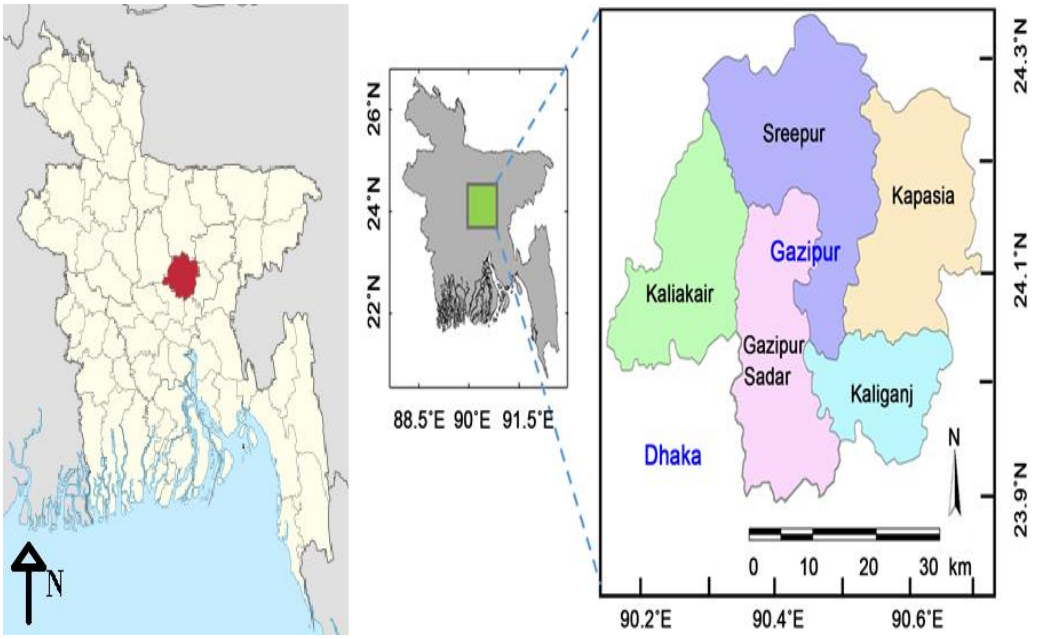

Figure 1. Gazipur District in Bangladesh Map (Shapla *et al.*, 2015).

Considering the above information, the current study was designed while considering the following objectives:

I. To detect gastrointestinal parasitic eggs in fecal sample of goats.
II. To demonstrate the occurrence of GIP in goats in study area.
III. To determine the correlation of GIP with associated factors.

CHAPTER 2

REVIEW OF LITERATURE

Occurrence of gastrointestinal parasites in goat by identifying GIP eggs through coprological investigation of goat feces from various areas of Gazipur district was performed using the information gained from the review of following related studies.

Dey *et al*. (2022), The possible risk factors for trematodes infections in small ruminants were determined in seven topographic zones of Bangladesh in the current study. The study revealed 965 out of a total of 2440 samples were found to be positive for one or more trematode species, with a prevalence of 39.5%. *Paramphistomum* sp., *Fasciola* sp. and *Schistosoma* spp. were the three major trematodes identified with a prevalence of 34.1%, 7.5% and 2.7% respectively.

Omar *et al*. (2021), In this study, Black Bengal goats were kept in natural grazing conditions to test the GI parasites' individual susceptibility to infection with *Haemonchus contortus*. The fecal parasitic eggs from a total of 897 Black Bengal goats were examined which revealed 47.1% prevalence of *Haemonchus contortus*, highest among the GI nematodes.

Sarker *et al*. (2021), The aim of the study was to find out the prevalence of GIP infestation in cattle and goat in Boalia, Rajshahi from December 2020 to April 2021. Overall prevalence of GIP in goat was 43.75%. The prevalence of *Fasciola* sp. and *Paramphistomum* sp. were found 21.29% and 18.06% respectively whereas the prevalence of *Ascaris* sp. and *Trichuris* sp. were observed 25.16% and 3.22% respectively in case of goats.

Chaurasiya *et al*. (2021), This study aimed to determine the prevalence of gastrointestinal parasites in goats in Rewa, India, using standard flotation and sedimentation techniques. Examination of fecal samples from 504 goats for eggs of several gastrointestinal parasites revealed an overall 79.96% prevalence of GI parasite. Prevalence of strongyles, *Trichuris* spp., *Moniezia* spp., *Strongyloides* sp. and *Fasciola* sp. was 55.95%, 15.28%, 11.51%, 3.57% and 2.38% respectively.

Hossain *et al*. (2021), Upon examination of 751 fecal samples of goats in hilly region of Mymensingh, Bangladesh during January to December, 2018; the number of GIP

infection were found 384 which denoted a prevalence of 51.1%. The prevalence of GIP in goat were higher than cattle (48.9%) and sheep (46.4%). Among the twelve recorder GIP, the predominant parasites were *Fasciola* (12.1%), *Paramphistomum* (10.0%) and *Strongyloides* (3.7%).

Thakur and Deep (2020), The goats (n = 207) of various age groups and sexes that were brought to the Veterinary Polyclinic Lalhri from various areas of the Una district of Himachal Pradesh between January 2018 and March 2020 provided the faeces samples that were tested for the current study. In the current study, overall GIPs were found to be prevalent at 78.26%.

Dey *et al*. (2020), The primary goal of this study was to determine the prevalence and risk factors of gastrointestinal nematodes in goats in Bangladesh. A total 1998 samples of goat feces were collected from seven areas of the country and fecal examination was conducted following standard flotation technique. Among the samples, 1241 (62.1%) were infected with nematode eggs which majorly consisted of strongyles (51.9%), *Strongyloides* sp. (19.0%) and *Trichuris* spp. (2.9%). Coproculture also revealed *Haemonchus* spp., *Oesophagostomum* spp., *Trichostrongylus* spp. and *Bunostomum* spp. in different areas.

Bhowmik *et al*. (2020), Prevalence of GIP infections in small ruminants in Sandwip Island, Chattogram, Bangladesh is reported in this study. From the study area, 110 fecal sample from goats were taken for coproscopy i.e., direct smear, flotation and sedimentation. The prevalence of gastrointestinal parasitic eggs was found 61.82%. The occurrence of nematodes and trematodes was found higher compared to cestodes.

Win *et al*. (2020), In Natmauk Township, Myanmar, fecal samples from 100 goats were collected. Methods of fecal flotation and sedimentation were used to look for parasite infections. The occurrence of GIP in goats was relatively high (96%). The parasites that identified from the samples were Trichostrongyle, *Trichuris* spp. and *Moniezia expansa.*

Hassan *et al*. (2019), An overall 89.33% prevalence was observer by investigation of fecal samples from goat in Giza, Egypt. The parasites identified in the study were *Moniezia* spp., strongyles, *Trichuris ovis, Strongyloides papillosus* and *Fasciola* spp. with an incidence of 18.22%, 12.88%, 5.33%, 3.55% and 0.89% respectively.

Verma *et al.* (2018), This study was conducted in August 2015 to April 2016 with a total of 1419 fecal samples from goat to identify GIP infestation in Mathura, India. The study showed an overall prevalence of 86.11%, which included infestation by strongyles, *Moniezia* spp. and *Strongyloides* spp. with an incidence of 28.40%, 18.74% and 0.70% respectively.

Amran *et al*. (2018), This study was conducted by collecting fecal samples from goats of Dhaka, Mymensingh and Chittagong to determine the prevalence of GIP infections. The occurrence of GIP infection in Dhaka, Mymensingh and Chittagong were 63.88%, 62.13% and 59.43% respectively. Prevalence of trematode was higher in Mymensingh (40%) compared to Dhaka (6%) and Chittagong (2%). On the other hand, prevalence of nematode was highest in Dhaka (66%), among which highest occurrence of *Haemonchus* sp. was recorded (39.81%). All the three study areas shower a low number of cestode infection.

Moudgil *et al*. (2017), The goal of the study was to assess gastrointestinal parasite diseases in a herd of Gaddi (goat) breed reared under semi-intensive conditions in Himachal Pradesh, India. The herd (n = 20) was split into two groups, clinically ill and sub clinically infected. The coprological examination of both groups showed the presence of eggs of *Moniezia expansa* and larvae of *Haemonchus* species.

Sohail *et al*. (2017), To ascertain the prevalence of gastrointestinal parasites in Peshawar, Pakistan; this investigation was carried out. A total of 100 fecal samples from potentially suspected Beetal goats were collected and processed for qualitative and quantitative evaluation. The prevalence of the parasites recorded was 34%, 25%, 5% and 1% for *Haemonchus contortus, Strongyloids papillosus, Trichostrongylus* sp. and *Trichuris* sp. respectively.

Islam *et al*. (2017), This study revealed the prevalence of 77.0% GI parasite in the fecal samples collected from goats (n = 268/348) in Mymensingh, Bangladesh. The species that were identified in the samples were *Strongyloides* sp., *Oesophagostomum* sp., *Trichostrongylus* sp., *Trichuris* sp., *Haemonchus* sp., *Paramphistomum* sp. and *Fasciola* spp.

Rahman *et al*. (2017), To determine the prevalence of gastrointestinal parasites in small ruminants from various locations of Madhupur, Tangail, an epidemiological study was carried out. Total 426 goats and sheep were studied, and fecal samples were

taken from them. The prevalence of gastrointestinal parasite infection was reported to be 63.4 % overall. The prevalence of nematodes, cestodes and trematodes were found to be 52.11%, 2.11% and 36.62% respectively.

Singh *et al*. (2017), In the western region of Punjab, this study sought to determine the prevalence of gastrointestinal parasitism in small ruminants. A total of 168 goat fecal samples out of the 212 that were investigated tested positive for endoparasitism, with a frequency of 79.24%.

Singh *et al*. (2015), The goal of the current study was to gather epidemiological information on the GI parasitism of goats in Madhya Pradesh, India. In this study, a total of 960 samples were collected and investigated among which 907 samples came out to be positive for GI parasitism with a prevalence of 94.48%. The major parasites found in the study were strongyles, *Strongyloides* sp., *Trichuris* sp., *Moniezie* sp., *Schistosomes* sp. and *Fasciola* sp., which showed a prevalence of 69.27%, 9.17%, 3.85%, 3.02%, 2.29% and 1.77% respectively.

Hossain *et al*. (2015), This study was aimed to determine the occurrence of GIP of small ruminants in Sullah, Sunamganj, Bangladesh in between February to July, 2014. Coprological investigation from the fecal samples of 200 goats revealed 45.0% prevalence of GIP infection. Specific prevalence was found to be 46.67% for *Fasciola gigantica*, 50% for *Paramphistomum cervi*, 35.56% for *Haemonchus contortus*, 35.56% for *Moniezia* sp., 13.33% for *Trichuris* sp. and 11.11% for *Strongyloides* sp.

Rahman *et al*. (2014), During January to December 2010, the prevalence of parasitic infections in Pirgonj, in the district of Rangpur, was investigated in this study. Fecal samples from goats (n=140) in the study area were examined using direct smear, sedimentation and flotation techniques to identify GI parasites. The findings showed that endoparasitic infections were present at a prevalence of 60.71%.

Rabbi *et al.* (2013), Fecal samples from goats (n = 1110) from various regions of Jaypurhat, Tangail, Mymensingh and Netrokona were examined for endoparasites. Prevalence of parasitic ova was observed 76.5%, which consisted of nine hilminthes namely *Fasciola gigantica*, *Paramphistomum* sp., *Schistosoma indicum*, strongyles, *Strongyloides* sp., *Toxocara* spp., *Trichuris* sp., *Capillaria* sp. and *Moniezia* sp. with a prevalence of 14.8%, 28.5%, 3.2%, 35%, 17.4%, 1.5%, 4.6%, 1.2% and 3.7% respectively.

Hossain *et al*. (2011), This study was conducted in Sylhet region to measure the prevalence of fascioliasis in goats. A total of 318 liver samples were collected from the goats of the study area and examined for the presence of *Fasciola* spp. Among the samples, 66 contained *Fasciola gigantica* and the overall prevalence were found 20.75%.

Hassan *et al*. (2011), From February to May of 2006, researchers measured the incidence of ecto and endopatasites in semi-scavenging Black Bengal goats in Pahartali Thana, Chittagong district, Bangladesh. Goats were found to have a 63.41 % (N=317) total prevalence of gastrointestinal helminths. *Strongyloides* spp. (51.74 %) was more common whereas *Moniezia* sp. and *Capillaria* sp. (n=201) were less common in these positive samples.

Kabir *et al*. (2010), This study was conducted during mid-October to mid-December 2008 to comparative prevalence of diseases in cattle and goats at UVH, Ulipur, Kurigram. Among 115 goats tested for clinical disease, a total of 12 goats were positive for fascioliasis which demonstrated a prevalence of 10.44%.

Pathak and Pal (2008), This study revealed that the prevalence of Gastrointestinal parasites in goats (n=88) in Durg, Chhattisgarh was 85.22% during November 1999 to October 2000. Specific prevalence was 80.68% for *Paramphistomum* spp., 45.45% for *Cotylophoron* spp., 17.04% for *Moniezia* spp., 3.40% for *Avitellina* spp., 26.13% for *Haemonchus* sp., 5.68% for *Trichostrongylus* spp., 3.40% for *Cooperia* spp., 30.68% for *Oesophagostomum* spp., 5.68% for *Bunostomum* sp. and 27.27% for *Trichuris* sp.

Islam and Taimur (2008), The purpose of this study was to determine the prevalence of infection with GI parasites in small ruminants in different parts of Bangladesh. A total of 224 Bengal goats were taken under study for a duration of one year and the investigation revealed 74.55% prevalence of GIP infection. The prevalence of *Fasciola gigantica* was observed 14.28%. On the other hand, the prevalence of tapeworm infestation was found 16.52%. The study also revealed that the most occurring nematode was *Trichostrongylus* sp. followed by *Haemonchus* sp.

Mondal *et al*. (2000), The purpose of the study was to detect the prevalence of gastrointestinal helminths in goats which grazed on pasture lands of Mymensingh district. This study revealed the occurrence of *Haemonchus contortus*,

Trichostrongylus sp., *Oesophagostomum* spp., *Bunostomum* spp., *Trichuris* spp. and *Moniezia* sp. in natural grazing goats in grasslands of Kanthal, Trishal, Mymensingh, Bangladesh.

Kamal *et al.* (1993), The study was conducted in Naikhongchhari in Bandarban district of Bangladesh to determine the prevalence of nematodes in goats. A total of 871 fecal sample was collected and examined for parasitic load using stoll's dilution technique and modified McMaster technique. The study revealed an overall infection rate of 78.41%. Among various species of nematodes found, the most prevalent one was *Haemonchus* sp., followed by *Oesophagostomum* sp. and *Bunostomum* sp.

CHAPTER 3

MATERIALS AND METHODS

The current study was conducted at the laboratory of the Department of Medicine and Public Health, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207.

3.1 Materials

3.1.1 Study Area

The present study was conducted during the period of January 2021 to June 2021. Fecal samples (n = 50) were collected from goats of Kaliganj, Sadar, Kaliakair, Kapasia and Sreepur upazila of Gazipur district. After collection, the samples were brought to the Laboratory of Department of Medicine and Public Health, Sher-e-Bangla Agricultural University for coprological investigation.

3.1.2 Sample Size

A total of 50 fecal samples from goats were collected from different households from Kaliganj, Kaliakair, Kapasia, Sadar and Sreepur upazila of Gazipur District. Fresh fecal samples were collected from apparently healthy goats. Simple random sampling technique without giving any prior importance to the demographics was done for sample collection. All the study goats were reared semi-intensively with a shelter provided for only the nighttime and adverse weather conditions (Chowdhury *et al.*, 2002).

Table 1. Number of Fecal Samples Collected from Different Areas of Gazipur District

SL No.	Study Species	Upazila	No. of Samples
1	Black Bengal Goat (*Capra hircus*)	Kaliakair	10
2		Kaliganj	10
3		Kapasia	10
4		Sreepur	10
5		Gazipur Sadar	10
Total			50

3.1.3 Chemicals and Solutions

3.1.3.1 Formalin Solution (10% Formaldehyde)

Hundred (100) mL of stock formaldehyde solution (40%) was added with 300 mL of distilled water to prepare 400 mL 10% formalin solution. The solution was stored at 4^0C for future use.

3.1.3.2 Formal Saline Solution (10%)

Eight and half gram (8.5) of sodium chloride was added in 900 mL of distilled water and mixed well. Then 100 mL of 40% formaldehyde was mixed with the solution to prepare 10% formal saline solution. The solution was then stored at 4^0C until further use.

3.1.3.3 Methylene Blue Solution (1%)

Half (0.5) gram methylene blue was weighed and put on a piece of clean paper. The stain was dissolved in 30 mL of water. Then, 70 mL water was added and mixed well to make the final stain solution. The stain was transferred to a clean brown bottle, labeled and stored in a dark place at room temperature for future use (Jorgensen *et al.*, 2015).

3.1.3.4 Other Chemicals and Reagents

The chemicals and reagents that were used for this study are 70% ethyl alcohol, 95% ethanol, distilled water, disinfectants and other common laboratory chemicals and reagents.

3.1.4 Glassware and Other Appliances

Conical flasks (100,500 and 1000 mL), microscopic slides and cover slips, test tubes, test tube rack, plastic containers, beakers, measuring cylinder, stirring rod, mortar and pestle, test tube rack, pipettes, balance, teaspoon, compound microscope, strainer, dropper, sterilizing instruments, refrigerator, hand gloves, forceps, tray, spatula, metal tong etc.

3.2 Methods

3.2.1 Brief Walkthrough to the Experimental Design

The experiment was carried out in two stages. The first stage involved the collection of fecal sample from households of different areas of Gazipur district, preservation of the sample and transportation to the laboratory. On the second step, coprological investigation was carried out using direct smear method, simple flotation method and simple sedimentation techniques to identify the eggs of gastrointestinal parasites.

The following flow chart represents the design of the experiment

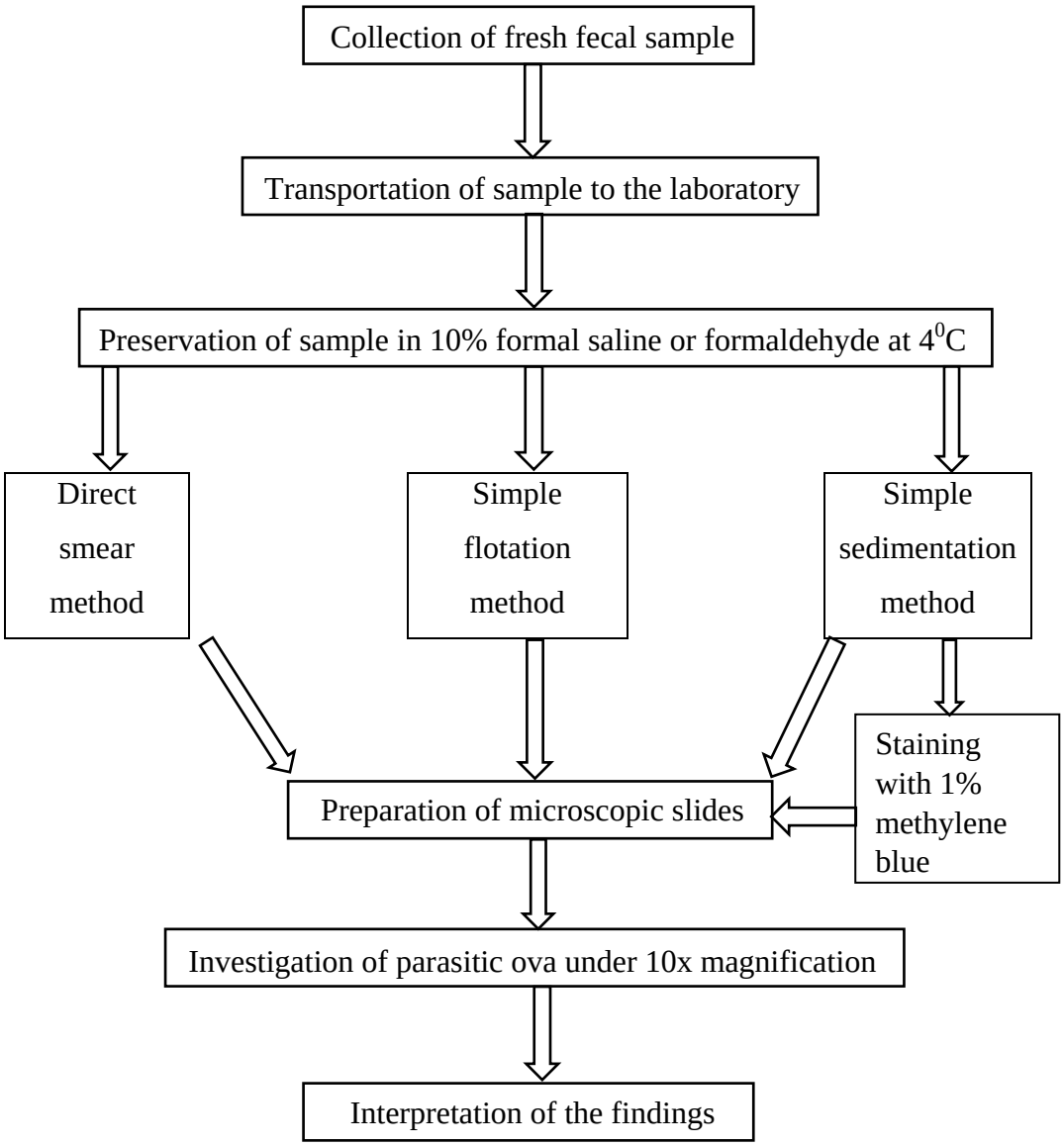

Figure 2: Schematic Presentation of the Experiment

3.2.2 Ethics Statement

Approval from an ethical committee was not required as the present study was conducted on fecal samples of goats. Freshly voided fecal samples were collected from the goats for microscopic investigation after getting verbal approval and permission from their owners. No harm was done to the goats during the collection of samples.

3.2.3 Sample Collection and Preservation

For sample collection and preservation, standard protocols were followed (Hendrix and Robinson, 2006). About 5-10 g (3-5 pellets) of freshly voided feces was collected from each goat. The collected sample was kept in a plastic container with 10% formalin solution (10% formal saline) and preserved at 4^0C temperature until further analyses. The required demographic data (e.g. owner's name and address, age, sex, deworming history etc.) were collected from the owner during sample collection through pre-structured form (Appendix II).

3.2.4 Preparation of Different Solutions

3.2.4.1 Salt-sugar Solution

Four hundred (400) grams of salt (sodium chloride) was added in 1000 mL of water to make saturated salt solution. Then 500 grams of table sugar was added into the solution and stirred well until dissolved. The specific gravity of the prepared solution is 1.28 (Cringoli *et al.*, 2010).

3.2.4.2 Saturated Salt Solution

Five hundred (500) grams of table salt (NaCl) was added to 1000 mL of tap water and mixed well until excess salt settles on the bottom of the flask. The specific gravity of the solution is 1.18-1.20 (Cringoli *et al.*, 2010).

3.2.4.3 Saturated Sugar Solution

Table sugar was added to 1000 mL of tap water gradually and mixed well to the point that no more sugar is dissolved in the water. The solution was kept in room temperature.

3.2.4.4 Normal Saline Solution (0.9%)

Nine (9) grams of sodium chloride was added to 1000 mL of warm tap water and mixed well with a stirring rod. The solution was stored in room temperature until use.

3.2.5 Methods of Fecal examination

3.2.5.1 Direct Smear Method

A very small amount of feces was kept in a glass slide and 2-3 drops of saline solution was poured on the feces. The mixture was well spread over the slide to prepare a smear. Then it was covered with a cover slip and place under microscope. The parasitic oocyst were observed under 4x and 10x magnification respectively (World Health Organization, 1991).

3.2.5.2 Simple Flotation Method

Simple flotation method involves using a flotation fluid with a specific gravity of 1.2 or more. This method was performed by taking about 1 gram of feces and mixing with flotation fluid such as saturated salt, saturated sugar and salt-sugar solution. Then the mixture was filtered into a test tube so that it can form a meniscus up to the top. A glass slide or a cover slip was placed over the meniscus and left for 10-15 minutes at room temperature. Then the slide was examined under microscope (Hendrix and Robinson, 2012). Although flotation method is complex and time consuming, it generates better result than direct smear (Zajac and Conboy, 2012).

3.2.5.3 Simple Sedimentation Method

About 3 g of feces was taken in a cylinder and 40-50 mL of tap water was poured into it. Then the mixture was stirred thoroughly and the suspension was filtered through a strainer into another cylinder. The filtered material was taken in a test tube and kept still for about 5 minutes so that sediment could form. The supernatant fluid was removed with care using a pipette. Then tap water was mixed again with the sediment, mixed well and allowed to sediment for 5 minutes. The supernatant was again discarded carefully and for some samples the sediment was stained with a drop of 1% methylene blue for better illustration under microscope. A small drop of the sediment was placed in a microscope slide and a cover slip was placed over it. Finally, the slide

was observed under 4x and 10x magnification (Gupta and Singla, 2012). The parasitic eggs that have higher specific gravity than water (e.g. *Fasciola* sp.) can be detected by this method (Tagesu, 2018).

3.2.6 Microscopic Examination

Compound microscope of the laboratory of Dept. of Medicine and Public Health, Sher-e-Bangla Agricultural University, Dhaka was used to detect parasitic ova. After preparation, the slides were placed in the microscope and observed at 4x magnification followed by 10x magnification.

3.2.7 Identification of Parasitic Eggs

Eggs, ova and oocysts of the parasites were detected and identified by following their features and morphological characteristics (Soulsby, 1982; Chatterjee, 1980).

3.2.8 Statistical Analysis

The collected information was tabulated and processed using Microsoft Excel-2016^{TM}. Chi-square tests for independence were performed where $n \geq 5$ and Fisher's exact tests were performed where $n < 5$; using the Microsoft Excel to determine the significant variation. P-values were calculated using online calculator (Social Science Statistics, 2022). The level of significance was considered when $P \leq 0.05$ i.e. when the P-value was found to be less than or equal to 0.05, the correlation was considered to be statistically significant.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Results

4.1.1 Overall Prevalence of GIP

In the study, two genera of trematode and two genera of nematodes were identified from fecal samples. The overall prevalence of GI parasite infestation was observed 54%. The overall prevalence of nematodes were 42% whereas overall infection rate caused by trematodes were lower (30%) (Figure 3). Among species-specific GI parasites, infection with Strongyle type parasites was higher compared to *Fasciola* sp., *Paramphistomum* sp. and *Strongyloides* spp. (Table 2).

Table 2. Prevalence of Parasites in Fecal Samples

Parasite	Number of positive samples	Prevalenvce (%) (N = 50)
Fasciola sp.	12	24%
Paramphistomum sp.	5	10%
Strongyloides spp.	6	12%
Strongyle type	19	38%
Overall	**27**	**54%**

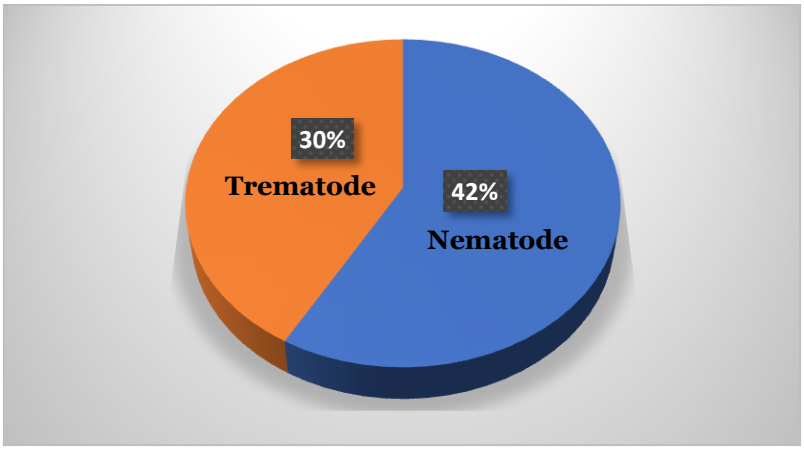

Figure 3. Prevalence of Different Types of Parasites

Identified eggs are depicted in Plate 1.

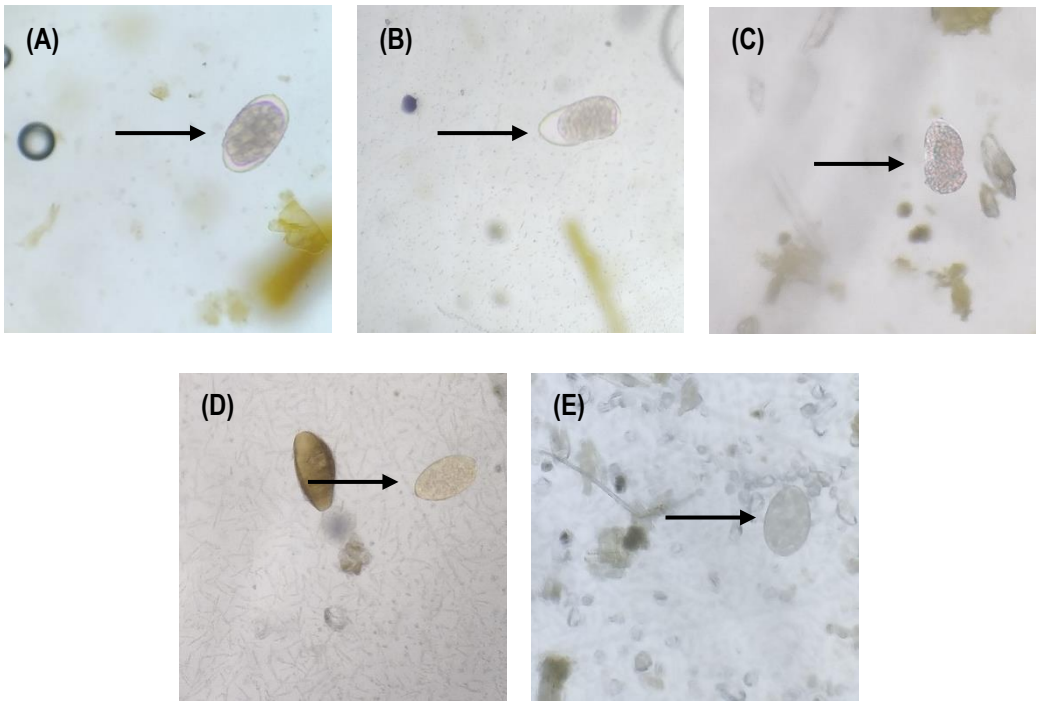

Plate 1. Gastrointestinal Parasitic Eggs Identified from Goat Feces (10x): (A, B) Strongyles; (C) *Strongyloides* sp.; (D) *Fasciola* sp.; (E) *Paramphistomum* sp.

Among the 27 positive samples, 13 (48.15%) were positive for mono infection while 14 (51.85%) were positive for mixed infection (Table 3). Among the parasites observed concurrent infestation with Strongyles., *Strongyloides* spp., *Fasciola* sp. and *Paramphistomum* sp. were very low (Table 3).

Table 3. Concurrent Parasitic Eggs in Fecal Sample

Concurrent Parasites	**Positive samples**	**Rate (%) (P=27)**
Mono infection	**13**	**48.15**
Strongyles and *Strongyloides* spp.	3	11.11
Strongyles and *Fasciola* sp.	4	14.81

Table 3 (cont'd)

Fasciola sp. and *Strongyloides* spp.	1	3.70
Fasciola sp. and *Paramphistomum* sp.	2	7.41
Paramphistomum sp. and Strongyles.	3	11.11
Strongyles, *Strongyloides* spp and *Fasciola* sp.	1	3.70
Mixed infection	**14**	**51.85**

4.1.2 Prevalence Based on Area

Most GI parasitic infestations were found in goats of Sreepur Upazila. Goats of Gazipur sadar showed least amount of parasite infestation (Figure 4).

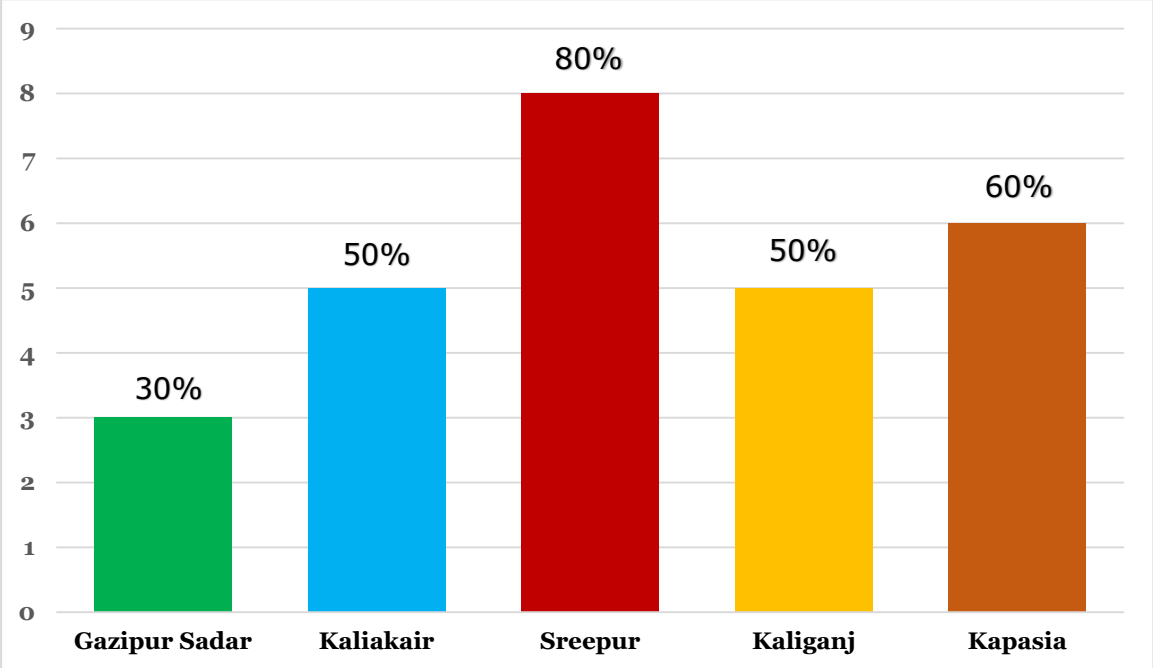

Figure 4. Number of Positive Samples in Upazilas of Gazipur (10 Samples from Each)

4.1.3 Prevalence Based on Breed

Black Bengal goats (52.27%) showed lower GIP infestations compared to Jamnapari goats (66.67%), though it was not statistically significant (P=0.674) (Table 4).

Table 4. Prevalence in Relation to Breed

Breed	Black Bengal % (N = 44)	Jamnapari % (N = 6)	P-value
Total	52.27	66.67	0.674

Note: N= Number of samples; Level of significance P≤0.05

4.1.4 Prevalence Based on Sex

In the current study, the overall prevalence of GIP infestation was found higher in females compared to males but no statistical significance was observed based on sex (female, 64 vs male, 44, %, P=0.156) (Table 5).

Table 5. Prevalence in Relation to Sex

Sex	Male % (N = 25)	Female % (N = 25)	P-value
Total	44	64	0.156

Note: N= Number of samples; Level of significance P≤0.05

4.1.5 Prevalence Based on Deworming Status

In the present study, the overall prevalence of GIP infestation on the basis of deworming status demonstrated that dewormed goats showed a significantly lower chance in the incidence of GI parasites when compared to non-dewormed goats (dewormed, 26.98 vs non-dewormed, 83.33, %, P=0.00006) (Table 6).

Table 6. Prevalence in Relation to Deworming Status

Deworming status	Dewormed % (N = 26)	Non-dewormed % (N = 24)	P-value
Total	26.92	83.33	0.00006*

Note: N= Number of samples; * significant at 5%; Level of significance P≤0.05

4.2 Discussions

Gastrointestinal (GI) parasitic infestation is one of the major impediments to goat production that may lead to severe health issue and even cause death (Kagira and Kanyari, 2001). GIP is one of the major obstacle in in goat rearing in agriculture-based developing countries like Bangladesh (Kaur *et al*., 2009). Besides, some of the GIPs' has a potential zoonotic significance (Wegayehu *et al*., 2013). The present study demonstrated that the overall prevalence of GI parasitic infestation in goats of Gazipur district was found 54%, which indicate a little over half of the goats were infected. A similar type of prevalence was reported in Mymensingh district (51.1%) (Hossain *et al.*, 2021). However, the overall prevalence found in the current study was higher than the previous findings that reported 45% prevalence of GIT parasitic infection in goats in Sullah upazila of Sunamganj district in Bangladesh (Hossain *et al.*, 2015) and 43.75% prevalence in Boalia, Rajshahi, Bangladesh (Sarker *et al.*, 2021). On the other hand, higher overall prevalence of 60-77% was reported in earlier studies in Sandwip island, Chattogram, Mymensingh sadar, Tangail, Pirganj and other parts of Bangladesh (Bhowmik *et al*., 2020; Islam *et al*., 2017; Rahman *et al*., 2017; Rahman *et al*., 2014; Islam and Taimur, 2008). In the neighboring country India, the prevalence of GIP infection was reported higher than the current study at 78-80% in Rewa, Una of Himachal Pradesh, Punjab, Mathura (Chaurasiya *et* al., 2021; Thakur and Deep, 2020; Singh *et al*., 2017). Studies from the other countries also showed a much higher prevalence of 96% and 89.33% in Egypt and Myanmar respectively (Win *et al*., 2020; Hassan *et al*., 2019). The reason for such difference in the prevalence is possibly due to seasonal difference, rearing and management system, soil topography and genetic makeup of the animal (Zvinorova *et al*., 2016). For example high humidity, heavy rainfall and topical atmosphere aids in faster

development of parasitic eggs (Hunter, 2003). The present study was conducted in the central part of Bangladesh in fall season; therefore, it is quite possible that the prevalence of GIP would be lower.

In this study, the rate of nematode infestation was found 42%, higher than the rate of trematode infestation that was 30%. This result was similar to earlier findings reported by Islam *et al*. (2017) and Islam and Taimur (2008). Among the samples consisting parasitic eggs, the rate mono parasitic infestation in this study was observed 48.15%, lower than mixed parasitic infestation rate that was 51.85%. The result was in line with the findings reported in India by Chaurasiya *et al*. (2021) and Thakur and Deep (2020). In case of individual prevalence, it was observed in the current study that Strongyle spp. showed a prevalence of 38%. This finding was in line with the observations from prior studies (Hossain *et* al., 2021; Rabbi *et al*., 2011). However, a lower prevalence of 14-19% for strongyle type parasites were reported in India (Thakur and Deep, 2020; Singh *et al.*, 2017). This variation is possible due to geographic locations, climatic difference and management system of goats (Hassan *et al.*, 2011). Prevalence of *Strongyloides* spp. was found 12% in this study, which was similar to the findings of prior studies (Bhowmik *et al.*, 2020; Hossain *et al.*, 2015; Rabbi *et al.*, 2011). Although this result contradicted with the findings that revealed the prevalence of *Strongyloides* spp.to be 4-7% in the prior studies, which was lower (Hossain *et al*., 2021; Rahman *et al.*, 2017; Rahman *et al*., 2014). Differences in the prevalence of such parasite might be due to sample size, deworming status, difference in area and seasonal condition required for the growth of the parasite (Zvinorova *et al.*, 2016). In case of trematode infestation, the prevalence of *Paramphistomum* sp. was observed 10% in the present study. This observation was in line with earlier findings reported (Hossain *et al*., 2021; Bhowmik *et al*., 2020; Rahman *et al*., 2014). Nevertheless, Hossain *et al.* (2015) and Rabbi *et al.* (2011) reported a higher prevalence of *Paramphistomum* sp. that was 50% and 28.5% respectively in their studies. The prevalence of *Fasciola* sp. in the present study was observed 24%, which was almost identical to previous findings of Sarker *et al*. (2021) and Bhowmik *et al*. (2020). However, Hossain *et al*. (2015) reported that the prevalence of *Fasciola* sp. was 46.67%, which was higher than the current observations; whereas, lower prevalence of such parasite between 4-15% was also reported in previous studies (Hossain *et al*., 2021; Rahman *et al*., 2014; Rabbi *et al*., 2011; Islam and Taimur,

2008). Such variations in trematode infestation was probably due to differences in atmosphere for growth and development, feeding system, deworming and availability of intermediate hosts for those parasites (Bhowmik *et al.*, 2020).

In the present study, the frequency of GIP infestation was highest in Sreepur upazila (80%), followed by Kapasia upazila (60%). Both Kaliakair and Kaliganj upazila showed similar frequency (50%) and Gazipur sadar (30%) demonstrated lowest incidence of GIP infestation. Variation of GIP infestation in different upazila might be due to husbandry practices and rearing system (Amran *et al.*, 2018).

Black Bengal goats in this study demonstrated a lower susceptibility to GI parasitic infestation compared to Jamnapari goats (BB, 52.27% vs J, 66.67%). This result corresponded with the findings of some earlier studies in which the authors observed similar trend (Sarker *et al.*, 2021; Amran *et al.*, 2018). Genetic makeup may have contributed to lower incidence of GIP infestation in Black Bengal goat (Sarker *et al.*, 2021).

The overall prevalence was found higher in female goats (64%) in comparison to male goats (44%). This observation was in line with some earlier studies which reported that female goats are more susceptible to GI parasites than male goats (Hossain *et al.*, 2021; Omar *et al.*, 2021; Sarker *et al.*, 2021; Dey *et al.*, 2020; Amran *et al.*, 2018; Rahman *et al.*, 2017). However, some earlier studies also demonstrated opposite trend in sex-specific GIP infections (Bhowmik *et al.*, 2020; Hossain *et al.*, 2015). This variation was probably due to sample size, management system, grazing practice and housing system (Bhowmik *et al.*, 2020). Furthermore, Islam *et al.* (2017) and Singh *et al.* (2017) demonstrated significant association between sex and GIP infection in their study. Higher susceptibility of female goats observed in the present study may be due to physiological and hormonal differences, lower resistance during pregnancy, parturition and lactation (Squire *et al.*, 2019). This may also be due to the fact that female goats of our country are slaughtered at older age, physiological changes during lactation, inadequate nutrition for production and prolonged exposure of the animals to the disease (Hossain *et al.*, 2010). Additionally, periparturient rise of GIPs', heavy feeding behavior of does also contribute to higher infestation (Hossain *et al.*, 2021).

Another important finding of the current study was that dewormed goats were less susceptible to GI parasites and showed significantly lower incidence of infestation. This observation was similar to the findings of prior reports where authors recorded lower level of parasitic infestation in dewormed goats compared to non-dewormed ones (Dey *et al.*, 2022; Bhowmik *et al.*, 2020; Ratanapob *et al.*, 2012). However, Dey *et al.* (2020) and Amran *et al.* (2018) did not find any significant correlation between deworming status of the animal and GIP infestation. This was probably because of variation in deworming frequency, type of anthelmintic used, anthelmintic dose and route of administration (Kantzoura *et al.*, 2012).

4.3 Limitations

In this study, prevalence of the parasitic infestation was conducted through coprological investigation of fecal sample while serology or molecular tests would have provided more precise prevalence of infestation (Hossain *et al.*, 2021). Moreover, the number of samples taken for the study was relatively low. Therefore, the findings do not represent the prevalence of GIP infestation of the entire population goats of the study area. The reason for such low number of samples was due to the restrictions regarding COVID-19 and limitation of time. Higher number of samples covering a wider area would generate a more accurate condition of the GIP infestation. Broader epidemiological data with more associated risk factors such as season, rainfall, land type, grazing status, feeding status, biosecurity status, education level of farmer etc. would have provided a better picture of the GIP status in the study area.

CHAPTER 5

SUMMARY AND CONCLUSION

The present study was conducted from January 2021 to June 2021 to study fecal samples of goats to look at the occurrence of gastrointestinal parasitic (GIP) infestation in goats of Gazipur district, Bangladesh. For this purpose, 50 fecal samples were collected from goats of various areas of Gazipur district and went through coprological investigation to determine the presence of parasitic eggs.

It was observed in the current study that the prevalence of GIP infestation in the study area was 54%. Individual parasitic infestation identified from the sample were strongyle type, Fasciola sp., Strongyloides spp. and Paramphistomum sp. and their prevalence was 38%, 24%, 12% and 10% respectively. Incidence of GIPs were found highest in Sreepur upazila (80%) and lowest in Gazipur sadar (30%).

Among the positive samples, incidence of single parasitic infestation (48.15%) and mixed parasitic infestation (51.85%) was almost equal. Jamnapari goats, female goats and non-dewormed goats were more prone to GIP infestations.

Based on the outcomes of this study, it can be concluded that:

- A little over half of the study population were positive for GIP infestation.
- The occurrence of nematode (42%) infestation was higher than trematode (30%) infestation.
- Strongyle type (38%) parasites were most prevalent in the goats of the study area, whereas *Paramphistomum* sp. (10%) infection was lowest.
- Jamnapari goats were more prone to GIP infestation than Black Bengal goats (66.67% vs 52.27%)
- Does were more likely to be affected more by GIP infestation than bucks (64% vs 44%).
- Non-dewormed goats were significantly more susceptible to GIPs than dewormed ones (83.33% vs 26.92%).

The present study was a qualitative study. Findings of the study gave an idea about the GIP infestation scenario of the study area during the study period. It did not give a final verdict on the overall status of GIP infestation all over the district. Further research on the following topics may be conducted in relation to the current study:

- Prevalence of GIP infestation by serological and molecular characterization.
- Quantitative analyses of GIP infestation to determine the parasitic load.
- Epidemiological study of GIP infestation with associated risk factors.
- In vivo study of pathogenic effects of GIPs.
- Management practices and their relation to GIP infestation.
- Specific anthelmintic used for deworming and its effect on GIP infestation.

CHAPTER 6

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Appendix I

COMPOSITION OF DIFFERENT SOLUTIONS

1. Formalin solution (10% formaldehyde)

Stock Formalin solution (40%)	100 ml
Distilled water	300 ml

2. Formal saline solution (10%)

Sodium chloride (NaCl)	8.5 gm
Stock Formalin solution (40%)	100 ml
Distilled water	900 ml

3. Methylene blue (1%)

Methylene blue	0.5 gm
Distilled water	100 ml

4. Salt-sugar solution

Table salt (sodium chloride)	400 gm
Table sugar	500 gm
Water	1000 ml

5. Saturated salt solution

Table salt (sodium chloride)	500 gm
Water	1000 ml

6. Saturated sugar solution

Table sugar	2040 gm
Water	1000 ml

7. Normal saline (0.9%)

Sodium chloride	9 gm
Water	1000 ml

APPENDIX II

SAMPLE COLLECTION FORM

Department of Medicine and Public Health
Faculty of Animal Science and Veterinary Medicine
Sher-e-Bangla Agricultural University, Dhaka-1207.

For research purpose only

Owner's Consent

The collected sample and information will be used for research purpose only. All the information regarding the identity of the owner will remain confidential. The findings from the research may be published in journals without revealing any sensitive information.

Do you wish to provide sample from your animal and necessary information required to conduct the research? ☐ **YES** ☐ **NO**

Sample Collection Form **Sample NO.-**

Owner's Information					
Name	:				
Address	:				
Number of Goats	:		**Experience of goat rearing**	:	

Animal's Information					
Age (Approx)	:		**Parity (F)**	:	
Sex	:		**Castration status (M)**	:	
Body wt. (Approx)	:		**Pregnancy status (F)**	:	
Deworming status	:		**Previous deworming**	:	
Vaccination status	:		**Disease history**	:	
Feeding status	:		**Medication status**	:	
Flooring type	:		**Owner's complaint (if)**	:	

Fecal Sample's Information							
Sample type	:	Freshly voided	**Consistency**	:	Solid	**Color**	:
Sample size	:	Pellets	**Presence of foreign matter**	:			

Collection Date **Enumerator**

APPENDIX III

DETAILS OF FECAL SAMPLES COLLECTED

Sample No.	Location	Breed	Sex	Deworming status
1	Gazipur sadar	Black Bengal	Male	Dewormed
2	Gazipur sadar	Black Bengal	Female	Non-dewormed
3	Gazipur sadar	Black Bengal	Male	Dewormed
4	Gazipur sadar	Black Bengal	Male	Non-dewormed
5	Gazipur sadar	Jamnapari	Female	Dewormed
6	Gazipur sadar	Black Bengal	Male	Dewormed
7	Gazipur sadar	Black Bengal	Female	Dewormed
8	Gazipur sadar	Black Bengal	Female	Non-dewormed
9	Gazipur sadar	Black Bengal	Female	Dewormed
10	Gazipur sadar	Black Bengal	Male	Non-dewormed
11	Kaliakair	Black Bengal	Female	Dewormed
12	Kaliakair	Black Bengal	Female	Non-dewormed
13	Kaliakair	Black Bengal	Male	Dewormed
14	Kaliakair	Jamnapari	Male	Dewormed
15	Kaliakair	Black Bengal	Female	Dewormed
16	Kaliakair	Black Bengal	Male	Dewormed
17	Kaliakair	Black Bengal	Female	Non-dewormed
18	Kaliakair	Black Bengal	Male	Dewormed
19	Kaliakair	Black Bengal	Female	Non-dewormed
20	Kaliakair	Black Bengal	Male	Dewormed
21	Kaliganj	Black Bengal	Female	Non-dewormed
22	Kaliganj	Black Bengal	Female	Non-dewormed
23	Kaliganj	Black Bengal	Female	Non-dewormed
24	Kaliganj	Black Bengal	Male	Dewormed
25	Kaliganj	Black Bengal	Male	Dewormed

Table (cont'd)

26	Kaliganj	Jamnapari	Female	Non-dewormed
27	Kaliganj	Black Bengal	Female	Dewormed
28	Kaliganj	Black Bengal	Male	Dewormed
29	Kaliganj	Jamnapari	Male	Non-dewormed
30	Kaliganj	Black Bengal	Male	Dewormed
31	Sreepur	Black Bengal	Male	Dewormed
32	Sreepur	Black Bengal	Female	Non-dewormed
33	Sreepur	Black Bengal	Female	Dewormed
34	Sreepur	Jamnapari	Male	Non-dewormed
35	Sreepur	Black Bengal	Male	Dewormed
36	Sreepur	Black Bengal	Female	Dewormed
37	Sreepur	Black Bengal	Male	Non-dewormed
38	Sreepur	Black Bengal	Female	Dewormed
39	Sreepur	Black Bengal	Female	Non-dewormed
40	Sreepur	Black Bengal	Male	Non-dewormed
41	Kapasia	Black Bengal	Male	Dewormed
42	Kapasia	Jamnapari	Female	Non-dewormed
43	Kapasia	Black Bengal	Female	Non-dewormed
44	Kapasia	Black Bengal	Male	Non-dewormed
45	Kapasia	Black Bengal	Female	Dewormed
46	Kapasia	Black Bengal	Male	Non-dewormed
47	Kapasia	Black Bengal	Female	Non-dewormed
48	Kapasia	Black Bengal	Male	Dewormed
49	Kapasia	Black Bengal	Female	Non-dewormed
50	Kapasia	Black Bengal	Male	Non-dewormed
Total	**Black Bengal – 44**	**Male – 25**	**Dewormed – 26**	
	Jamnapari – 6	**Female – 25**	**Non-dewormed – 24**	

APPENDIX IV

METHODS OF FECAL EXAMINATION

1. **Direct Smear Method**

Procedure:

- ✓ The direct smear was performed by mixing a very small amount of feces with drops of water or saline solution.
- ✓ The mixture was placed on a slide, overlaid with a cover glass and examined the entire smear under a low power microscope.

2. **Simple Flotation Method**

Instruments and reagents required:

- Plastic containers or two beakers
- Saturated sugar solution or saturated salt solution
- Strainer
- Measuring cylinder
- Stirring rod
- Mortar and pestle
- Test tube
- Test tube rack
- Pipettes

Procedure:

- ✓ About one gram of feces was taken and grinded and mixed with 42 ml of saturated salt or sugar solution.
- ✓ Then it was filtered through strainer in to a test tube or cylinder until it form meniscus (up to top of tube).

- ✓ A clean glass slide or coverslip was placed on the mouth of test tube or cylinder and was left undisturbed for 10- 15 minute and then the coverslip/slide was removed and examined under10x of microscope.

3. Simple Sedimentation Method

Instruments and reagents required:

- Plastic containers or two beakers
- Tap water
- Strainer
- Measuring cylinder
- Stirring rod
- Mortar and pestle
- Test tube
- Test tube rack
- Pipettes

Procedure:

- ✓ About 5 gm of feces was taken and grinded well in a cylinder.
- ✓ About 40-50 ml of water was poured into it and mixed thoroughly.
- ✓ Then it was filtered through a strainer and allowed to sediment for 5-10 mins..
- ✓ The supernatant was removed and water was again poured into it and kept for sediment formation.
- ✓ The process was repeated 3-5 times until a clear mixture was gained.
- ✓ The sediment was stained with a drop of 1% methylene blue and a drop of sediment was place on a slide and observed under 10x magnification.

APPENDIX V

GIP INFESTATION STATUS OF THE COLLECTED SAMPLES

S	L	Br	Strongyles type	*Strongyloides* spp.	*Fasciola* sp.	*Paramphistomum* sp.
1	Gs	BB				
2	Gs	BB				
3	Gs	BB				
4	Gs	BB				
5	Gs	J	P			
6	Gs	BB				
7	Gs	BB				
8	Gs	BB	P			
9	Gs	BB				
10	Gs	BB	P		P	
11	Kr	BB				
12	Kr	BB	P			
13	Kr	BB				
14	Kr	J				
15	Kr	BB	P			P
16	Kr	BB	P			
17	Kr	BB	P			
18	Kr	BB	P			
19	Kr	BB				
20	Kr	BB				
21	Kl	BB	P			
22	Kl	BB	P			P
23	Kl	BB	P			P
24	Kl	BB				
25	Kl	BB				
26	Kl	J	P	P		
27	Kl	BB				

Table (cont'd)

28	Kl	BB				
29	Kl	J	P	P	P	
30	Kl	BB				
31	Sr	BB				
32	Sr	BB	P	P		
33	Sr	BB				
34	Sr	J			P	
35	Sr	BB			P	
36	Sr	BB		P		
37	Sr	BB		P	P	
38	Sr	BB			P	
39	Sr	BB	P		P	
40	Sr	BB	P		P	
41	Kp	BB				
42	Kp	J				
43	Kp	BB	P		P	
44	Kp	BB			P	P
45	Kp	BB				
46	Kp	BB			P	P
47	Kp	BB	P			
48	Kp	BB				
49	Kp	BB	P	P		
50	Kp	BB			P	
		Total	**19**	**6**	**12**	**5**

Legends: S = Sample No.; L = Location; Br = Breed of goat; Gs = Gazipur sadar; Kr = Kaliakair; Kl = Kaliganj, Sr = Sreepur; Kp = Kapasia; BB = Black Bengal; J = Jamnapari; P = Positive for parasitic egg.

APPENDIX VI

CHI-SQUARED RIGHT TAIL PROBABILITY ($\geq\chi^2$)

	Significance level (α)							
Degrees of freedom *(df)*	.975	.95	.9	.1	.05	.025	.01	.005
1	0.001	0.004	0.016	2.706	3.841	5.024	6.635	7.879
2	0.051	0.103	0.211	4.605	5.991	7.378	9.210	10.597
3	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12.838
4	0.484	0.711	1.064	7.779	9.488	11.143	13.277	14.860
5	0.831	1.145	1.610	9.236	11.070	12.833	15.086	16.750
6	1.237	1.635	2.204	10.645	12.592	14.449	16.812	18.548
7	1.690	2.167	2.833	12.017	14.067	16.013	18.475	20.278
8	2.180	2.733	3.490	13.362	15.507	17.535	20.090	21.955
9	2.700	3.325	4.168	14.684	16.919	19.023	21.666	23.589
10	3.247	3.940	4.865	15.987	18.307	20.483	23.209	25.188
11	3.816	4.575	5.578	17.275	19.675	21.920	24.725	26.757
12	4.404	5.226	6.304	18.549	21.026	23.337	26.217	28.300
13	5.009	5.892	7.042	19.812	22.362	24.736	27.688	29.819
14	5.629	6.571	7.790	21.064	23.685	26.119	29.141	31.319
15	6.262	7.261	8.547	22.307	24.996	27.488	30.578	32.801
16	6.908	7.962	9.312	23.542	26.296	28.845	32.000	34.267
17	7.564	8.672	10.085	24.769	27.587	30.191	33.409	35.718
18	8.231	9.390	10.865	25.989	28.869	31.526	34.805	37.156
19	8.907	10.117	11.651	27.204	30.144	32.852	36.191	38.582
20	9.591	10.851	12.443	28.412	31.410	34.170	37.566	39.997
21	10.283	11.591	13.240	29.615	32.671	35.479	38.932	41.401
22	10.982	12.338	14.041	30.813	33.924	36.781	40.289	42.796
23	11.689	13.091	14.848	32.007	35.172	38.076	41.638	44.181
24	12.401	13.848	15.659	33.196	36.415	39.364	42.980	45.559
25	13.120	14.611	16.473	34.382	37.652	40.646	44.314	46.928
26	13.844	15.379	17.292	35.563	38.885	41.923	45.642	48.290
27	14.573	16.151	18.114	36.741	40.113	43.195	46.963	49.645
28	15.308	16.928	18.939	37.916	41.337	44.461	48.278	50.993
29	16.047	17.708	19.768	39.087	42.557	45.722	49.588	52.336
30	16.791	18.493	20.599	40.256	43.773	46.979	50.892	53.672
40	24.433	26.509	29.051	51.805	55.758	59.342	63.691	66.766
50	32.357	34.764	37.689	63.167	67.505	71.420	76.154	79.490
60	40.482	43.188	46.459	74.397	79.082	83.298	88.379	91.952
70	48.758	51.739	55.329	85.527	90.531	95.023	100.425	104.215
80	57.153	60.391	64.278	96.578	101.879	106.629	112.329	116.321
100	65.647	69.126	73.291	107.565	113.145	118.136	124.116	128.299

[**Source:** Bartoszynski and Niewiadomska-Bugaj (2008)]