PREVALENCE OF GASTRO-INTESTINAL PARASITES OF GOATS (*Capra hircus* Linnaeus, 1758) IN SURYABINAYAK MUNICIPALITY, BHAKTAPUR, NEPAL

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Submitted to

Central Department of Zoology

Institute of Science and Technology

Tribhuvan University

Kirtipur, Kathmandu,

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July, 2022

DECLARATION

I hereby declare that the work presented in this thesis has been done by myself, and has not been submitted elsewhere for the award of any degree. All sources of information have been specifically acknowledged by reference to the author(s) or institution(s).

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LISTS OF ABBREVIATIONS

CI	Confidence Interval
MoAD	Ministry of Agriculture and Livestock Development
NaCl	Sodium Chloride
NAST	Nepal Academy of Science and Technology
km^2	Square Kilometer
$K_2Cr_2O_7$	Potassium dichromate
rpm	Revolutions per minute
µm	Micrometer
spp.	Species

ABSTRACT

Goats (*Capra hircus*) are small ruminants belonging to the Bovidae family which play an important role in the livelihood of farmers but are frequently encountered with various gastro-intestinal parasitic diseases. These gastro-intestinal parasitic infections in goats are one of the causes of low productivity, morbidity, and mortality. This study was conducted to determine the prevalence, intensity of infection, and farm management system. To determine the prevalence of gastro-intestinal parasites in goats, 300 fecal samples were collected from goats of Suryabinayak Municipality, Bhaktapur, Nepal. Samples were collected from July to August 2021 by purposive sampling technique and subjected to direct smear, sedimentation, and flotation techniques for coprological examination. The study revealed that 86% of samples were positive for gastro-intestional parasites with 15 genera including six genera of protozoan, and nine genera of helminths. Among protozoan parasites, 58.33% *Eimeria* spp., 50.33% *Entamoeba* sp., 1.33% *Cryptosporidium* spp., 0.67% *Balantidium* sp., 0.67% *Endolimax* sp., and 0.33% *Giardia* sp. were reported whereas in case of helminth parasites, 47.33% Strongyles, 10% *Strongyloides* sp., 5% *Moniezia* sp., 3.67% *Fasciola* sp., 2.67% Ascarids, 2% *Trichuris* sp., 1.33% *Capillaria* sp., 0.33% Oxyurids, and 0.33% *Paramphistomum* sp. were encountered. Age-wise prevalence of helminth parasites was apparently higher in adult goats (75%) than that of young ones. The infection was also non-significantly higher in female goats (56.70%) in comparison to males (48.11%). No significant difference was seen in the sex and age of goats for the prevalence of gastro-intestinal protozoan parasites. Single infection was recorded 31.01%, double was 35.27%, and multiple was 33.72%. From the questionnaire survey, some common risk factors were recorded during the study period, which were goat rearing training, management practices, and treatment processes. These factors contribute to the increment of gastro-intestinal infections in goats. Hence, training on goat rearing along with proper management of goat farm, awareness on gastro-intestinal parasitic diseases and their control can help the owners increase in the productivity.

1. INTRODUCTION

1.1 Background

Nepal's agricultural sector is the largest contributor, engaging 65.7% of its population (MoAD, 2014). Livestock rearing also contributes to agriculture (ADS, 2012), mostly goats. The goats are members of the animal family Bovidae and the subfamily Caprinae. Poor farmers of the hills prefer sheep and goat husbandry, which require a small investment and have no social, religious, or cultural taboos or caste restrictions (Ghimire, 1992). Goats are considered the first farm animals to be domesticated (Zeuner, 1963; Devendra, 1998; Das *et al.*, 2017). They are an important source of dairy, meat, and manure. The skin of goats is used to make various products like gloves, boots, and other products that require soft hide (Rizal, 2010).

Goats of Nepal have adapted to a wide range of environmental conditions. It has the exclusive ability to adjust and maintain itself in a harsh environment. So, it is a predominantly important animal in the current agriculture farming system of Nepal (Devendra and Burns, 1970). In 2017/18, the population of goats was 11,647,319 and increased to 12,283,752 in 2018/2019, which indicates that goat farming is an integral part of the lives of the people within the country (MoAD, 2020). In Nepal, four indigenous goat breeds have been identified. They are Chyangra, Sinhal, Khari, and Terai (Bhattarai *et al.*, 2019). There are also some foreign breeds of goats found in our country. Some of them are Boer, Barbari, Saanen, Beetal, Sirohi, and Jamunapari.

Goats are herbivorous animals that are affected by many diseases. Gastro-intestinal parasites cause various parasitic diseases in goats that weaken their health, leading to less production (Gall, 1981; Sanyal, 1996). These infections are also responsible for causing heavy losses due to reduced production, as they can reduce skeletal growth, live-weight gain, and milk yield (Emiru *et al.*, 2013), followed by morbidity and mortality in animals (Lutu, 1984), especially in developing countries like Nepal. Gastro-intestinal diseases are the most varied and common occurrence. It has been detected that gastro-intestinal parasitic infections are the reason for 30% of the deaths of adult ruminants in both rural and farm conditions (Moreno-Gonzalo *et al.*, 2012; Khajuria *et al.*, 2013). In Nepal, parasitic disease remains a major problem for livestock across all production areas. It is a major cause that is hampering productivity, unthriftiness, and the occasional death of

small ruminants (Sood, 1981; Biu *et al.*, 2021). About 24% of goat deaths were reported to be due to internal parasites (Lohani and Rasaili, 1995). The most common gastro-intestinal parasites causing parasitic infection in goats are *Trichostrongylus* spp, *Heamonchus* spp, *Dicrocoelium* sp., *Oesophagostumum* spp, *Fasciola* spp, *Bunostomum* spp, *Trichuris* spp, *Capillaria* spp. *Eimeria* spp, etc. (Tripathi and Subedi, 2015). According to Perry (2002), Strongyle nematodes rank first on the global index of gastro-intestinal parasites . It is found in the abomasum of sheep and goats, and causes blood loss, resulting in a decrease in erythrocytes, lymphocytes, hemoglobin, packed cell volume, body weight, and wool growth (Hayat *et al.*, 1996). Poor animal production and management, as well as infectious and parasitic diseases, had reduced small ruminant productivity (Hailelul, 2002). Also, there are no satisfactory veterinary care services, resulting in enhanced growth and transmission of helminths (Adhikari *et al.*, 2017).

A parasite is an organism that lives in another organism, called the host, and often harms it. It depends on its host for survival. So, it rarely kills its host but instead spreads diseases, of which some can be fatal. The parasite itself is not a disease, but it can activate diseases. There are two main categories based on habitat: Ecto-parasites and endo-parasites. Gastro-intestinal parasites are endo-parasites inhabiting the gastro-intestinal tract of the host. For examples, *Entamoeba, Giardia,* tapeworm, and roundworm. It consists of protozoan and helminth parasites.

Protozoan parasites are microscopic, unicellular organisms that have adapted to invade and live in the cells and tissues of other organisms. It has a very complex internal structure and performs various metabolic activities. Some examples of protozoan parasites of goats are *Eimeria* sp., *Entamoeba* sp. These parasites damage the intestinal tract of animals, leading to malabsorption of food, causing diarrhea, poor growth, pot-bellied appearance, loss of appetite, and eventually death. Helminth generally means "worm." The helminths are elongated, flat, or round-bodied invertebrates. Helminths develop through eggs, larval (juvenile), and adult stages. Different types of worms are transmitted in the form of larvae or eggs. The problem particularly occurs in the rainy season (ITDG, 1996). The nutritional conditions of animals are adversely disturbed by the gastro-intestinal parasites (Irfan, 1984). Gastro-intestinal helminth infection directly affects production due to a drop in efficiency due to pathologic effects followed by the death of animals and indirectly by economic losses due to increased cost of control

strategies (Soulby, 1982). Annually, a large sum of money is spent worldwide to fight helminth parasites in livestock (Jabbar *et al.*, 2006). Helminth parasites include three classes: Trematode, Cestodes, and Nematodes.

Trematodes are leaf-shaped parasites with an oral sucker around the mouth and a ventral sucker or acetabulum to stick to host tissues. They require an intermediate host i.e. snails in their life cycle with vertebrates being the definitive host. They inhabit the bile ducts or small intestine and may also affect the lungs. Metacercaria stage is the infective stage of the trematodes. Fascioliasis is a well-known parasitic disease of herbivores infected by grazing in metacercaria-contaminated pasture and water (Payne, 1990). Infection can range from asymptomatic to fatal. The economic loss due to fascioliasis in Nepal was estimated to be Rs.14.2 crore (Lohani and Rasaili, 1995). Some of the trematodes species that have been reported in domestic ruminants are *Fasciola* sp., *Paramphistomum* sp., *Dicrocoelium* sp., etc.

Cestodes are commonly called tapeworms with flat and elongated bodies divided into a scolex or head, neck, and proglottids. Tapeworms have indirect life cycles that require the passage through at least one intermediate host (insects, mites, other mammals). Cestodes are acquired in the gut by eating contaminated food or water and are found to be largely affecting the ruminants. Some of the examples of cestode parasites are *Taenia* spp., *Moniezia* spp,. etc. *Moniezia* spp. in ruminants causes infections by ingesting foliage contaminated with the mites carrying the infective stage of the parasites. The heavy infection causes poor growth and diarrhea in lambs.

Nematodes are commonly called roundworms due to their cylindrical body. Their lifecycle is simple and direct consisting of an egg stage, larval stage, and adult stage without an intermediate host. The most significant and widespread nematodes of goats are *Haemonchus* sp., *Ostertagia* sp., *Trichostrongylus* sp., *Capillaria* sp., *Nematodirus* sp., *Strongyloides* sp., *Bunostomum* sp., and *Trichuris* sp. The third stage larva is the infective one that infects goats while grazing. These nematodes in the small intestine may cause severe damage to the intestinal mucous membrane. *Toxocara* sp. and *Dictyocaulus* sp. (filarial nematodes) has a worldwide distribution and the prevalence is higher in cattle and buffaloes (Karki, 2005). Infection with gastro-intestinal is considered as one of the

important helminth groups that cause direct damage to livestock (Zanzani *et al.*, 2014) triggering productivity loss (Shrestha, 1996).

1.2 Objectives

The present study was done to fulfill the following objectives:

A. General Objective

- To determine the prevalence of gastro-intestinal parasites of goats in Suryabinayak Municipality, Bhaktapur, Nepal.

B. Specific Objectives

- To identify the gastro-intestinal parasitic species of goats.
- To determine the prevalence of gastro-intestinal parasites with respect to age, and sex.
- To study the intensity of parasites in goats.

1.3 Rationale of the study

Nepal is a developing country that depends on agriculture and animal husbandry as an income source but the farming technique is unsound and there is insufficient information to the people about the parasitic pathogenicity of livestock. Goat farming is also in a poor and unhygienic manner and hence is heavily infected with different parasites. The infection of parasites in goats can cause significant economic loss leading to poor health and reduced growth (Nwosu *et al.*, 2007). The present study intended to determine the prevalence and intensity of gastro-intestinal parasites. This study attempts to conduct a detailed study about gastro-intestinal parasites from the fecal sample of the goats taken from the study area. It will give information related to the gastro-intestinal parasites of goats. This study will lead to the improvement in control measures of parasitic burden thereby boosting productivity. This study will help to fulfill the knowledge gap and will form a foundation for future researchers and investigators working on goats.

2. LITERATURE REVIEW

Gastro-intestinal parasites are cosmopolitan in distribution infecting human, domestic and wild animals. They play a major role in host population regulation (Scott and Dobson, 1989; Hudson *et al.*, 2002), productivity, and performance of animals (Mohamed, 1994). They mainly cause blood loss, tissue damage, spontaneous deviation, congenital malformations, and even death (Gillespie, 2006). Goats (*Capra* sp.) are important domestic and herbivorous animals and are widely distributed all over the world. It is kept for its milk and meat and noted for its lively behavior. Among the most ruminants, goats harbored the highest diversity of GI parasites (Tan *et al.*, 2017). They are infected by different parasitic diseases which are spread to the surrounding animals (Boomker *et al.*, 1989; Hutchinson, 2009).

Generally, goats are a susceptible host to various gastro-intestinal parasites all over the world. *Eimeria* sp., *Cryptosporidium* sp., *Entamoeba* sp., *Giardia* sp., etc. are the common protozoan parasites that infect ruminants and are highly contagious that spread through herds rapidly. Regarding *Eimeria* spp., many researches had been conducted in the past to study its prevalence and reported several species with higher prevalence among kids (Alyousif *et al.*, 1992; Koudela and Boková, 1998; Balicka-Ramisz, 1999). Further, the study among the West African Dwarf kids of Ghana discovered the appearance of *Eimeria* oocysts early about 20 days of birth (Agyei *et al.*, 2004). In the same study, they identified 10 species of *Eimeria* with a higher prevalence of *Eimeria arloingi* followed by *Eimeria ninakohlyakimovae, Eimeria alijevi, Eimeria caprina, Eimeria jolchijevi, Eimeria apsheronica, Eimeria pallid, Eimeria caprovina, Eimeria hirci and Eimeria christenseni*. This outcome was agreed upon by the study conducted in Brazil (Cavalcante *et al.*, 2012). They examined fecal samples of dairy goats and revealed the presence of multiple species of *Eimeria* with 91.2% total prevalence where *Eimeria ninakohlyakimovae* was higher among kids and *Eimeria alijevi* among adults.

In most Asian countries, *Eimeria* spp. seemed to be more frequently occur protozoan parasites than others. In Iran, 89.27% prevalence was identified among Raeini goats including five species of *Eimeria*: *E. arloingi, E. parva, E. ninakohlyakimovae, E. christenseni, E. faorei,* and one *Eimeria spp.* (Radfar *et al.*, 2011). While in the neighbouring country Iraq, only 2.8% of prevalence of *Eimeria* oocysts was observed

from the local breed (Jamal Nasrullah *et al.*, 2014). Similar prevalence of *Eimeria* spp. was also discovered in Thailand (Junsiri *et al.*, 2021). Similarly, the results of small ruminants from Bangladesh also support these prevalence (Islam *et al.*, 2017; Bhowmik *et al.*, 2020). Several studies conducted among the small ruminants of India also showed *Eimeria* spp. as the most frequently occurred parasites (Singh *et al.*, 2017; Satish *et al.*, 2018; Vohra *et al.*, 2018). Recently, Ghimire *et al.* (2021) found 92.4% prevalence of *Eimeria* from the fecal sample of goats in Nepal by floatation technique and discovered 15 different morphologic forms of *Eimeria* with a higher prevalence of *E. ninakohlyakimovae* and lower of *E. caprovina.* Yet another coccidian parasite *Cryptosporidium* spp. is also reported from goats. Caprine cryptosporidiosis has been reported in several countries on different continents like South America (Bomfim *et al.*, 2005), and Spain (Castro-Hermida *et al.*, 2007; Díaz *et al.*, 2010). Lately, cryptosporidiosis has also been reported in goats of India (Maurya *et al.*, 2013) and China (Feng and Xiao, 2017). Cryptosporidiosis is found in average hygienic place and shed with wood slats raised from the ground (Bomfim *et al.*, 2005). Same study also showed the infection of flagellate parasite *Giardia* that promotes diarrhoea in goats.

Utaaker *et al.* (2017) also reported the occurrence of *Cryptosporidium* spp. and *Giardia duodenalis* in goats being reared in different settings in urban and peri-urban areas in northern India. Other parasites that are responsible for diarrhea are *Entamoeba* and *Endolimax*. In Iraq, Mohammed (2017) reported 20% prevalence of *Entamoeba* spp. by using PCR technique and phylogenetic tree analysis.

Gupta *et al.* (2013) reported 97% overall prevalence among the goats from Jabalpur, India with the maximum rate of Strongyles followed by coccidia, *Trichuris,* amphistome, *Strongyloides*, *Fasciola*, *Moniezia,* and *Toxocara*. In contrast to this, the study conducted in the same place in the different year identified a similar prevalence among the goat kids with coccidian as predominant parasites (Pooja *et al.*, 2016). Similar prevalence was also shown by the study led among the goats of Madhya Pradesh, India with a higher incidence of parasitism in kids than in adult goats (Singh *et al.*, 2014). The study in the same place by Shakya *et al.* (2017) reported the incidence of strongyle, *Strongyloides papillosus, Trichuris* spp., and mixed infection with higher nematode infection rate among goats aged >1 year and among females on the basis of sex. On the other hand, Bhattacharjee *et al.* (2021) recorded 56.31% with higher prevalence among Beetal breed

followed by Sirohi and Assam Hill Goat by parasites like *Haemonchus contortus*, *Oesophagostomum* sp., *Strongyloides papillosus*, *Trichostrongylus* sp., *Bunostomum* sp., *Cooperia* sp., *Trichuris* sp., *Fasciola* sp, *Amphistomes*, *Moniezia expansa* and *Moniezia benedeni* and oocysts of coccidian. Wani (2021) tested 338 fecal samples of goats and sheep by using direct qualitative microscopic examination, and centrifugation on small ruminants around Gwalior (Madhya Pradesh) India, and identified the incidence of *Haemonchus*, *Coccidia*, *Trichuris*, *Nematodirus*, and *Fasciola*.

In the neighbouring country, Pakistan, Nabi *et al.* (2014) revealed 40.67% overall prevalence of nematode parasites with the highest prevalence of *Nematodirus spathigerthe* and young animals more infected than adults whereas males were more susceptible to infection in comparison to females. In contrast to this, *Haemonchus contortus* was reported maximum among Beetal goats from the same country followed by *Strongyloides papillosus, Trichostrongylous, Dictyocaulus viviparpus, Eimeria*, and *Trichuris* where the mixed infection was 30% and young one were more prone to infection (Sohail *et al.*, 2017).

Hassan *et al.* (2011) found 63.41% prevalence of parasites in Black Bengal goats in Chittagong, Bangladesh with *Strongyloides* spp. being more prevalent whereas *Moniezia* sp. and *Capillaria* sp. are the least prevalent. Along with this, they also found the age risk factor where older goats (>24 months) were more infested by endo-parasites than younger ones (< 24 months). Furthermore, a study led among the same breed of goat in the same country revealed *Eimeria* sp. as highly prevalent protozoan parasites and *Haemonchus contortus* as highly prevalent helminth parasites (Omar *et al.*, 2021). Also, female goats and goats aged >12 were found to have heavy infections. In addition, Maity *et al.* (2018) diagnosed heavy mixed infection of nematode (*Trichuris* sp.) and cestode (*Moniezia* sp.) in a four months old female Black Bengal kid during post-mortem examination. On the other hand, Dey *et al.* (2020) discovered 62.1% of the overall prevalence of gastro-intestinal nematodes among the goats of Bangladesh sheltered by strongyles, *Strongyloides* sp. and *Trichuris* spp. with higher infection among female goats and goats aged >6 to 18 months. In the same study, light infection was observed most followed by moderate and heavy.

Jittapalapong *et al.* (2012) used sedimentation methods and observed 76.4% with a higher prevalence of strongyle parasites; maximum parasite prevalence among goats aged under <1 year and high infection in male goats of Thailand. They also noticed 79.7% of mixed infections. In contrast to this, the study conducted in the same country detected mixed infection of only 29.73% and maximum infection among female goats (Azrul *et al.*, 2017). Similarly, Fauziah *et al.* (2021) identify an overall incidence of 42.31% including the eggs of *Bunostomum* sp., *Strongyloides* sp., *Haemmonchus* sp., *Trichostrongylus* sp., *Toxocara* sp., *Trichuris* sp. and mixed infections among the goats of Indonesia.

In the case of European countries, Di Cerbo *et al.* (2010) examined the gastro-intestinal infection in goat farms in Lombardy, Northern Italy by using floatation techniques and detected 96% prevalence with different taxa like *Moniezia benedeni*, *Strongyloides* spp., Strongylida, *Nematodirus* spp., *Skrjabinema* spp., *Trichuris* spp., *Capillaria* spp., *Marshallagia* spp. and *Eimeria* spp. and co-infection of multiple parasites even up to 6 taxa simultaneously. Further, Babják *et al.* (2017) recorded a slightly higher prevalence (95.90%) from the dairy goats of Slovakia with strongyle eggs being the highest followed by *Strongyloides papillosus, Trichuris* spp., *Nematodirus* spp., and *Moniezia* spp. They also undergo coprocultures to identify genera of nematodes and identified third-stage larvae of *Trichostrongylus* spp., *Teladorsagia/Ostertagia* spp., *Oesophagostomum* spp./*Chabertia ovina,* and *Haemonchus contortus*.

Dechassa *et al.* (2012) used both sedimentation and floatation processes and identified 100% prevalence of internal parasites infecting Boer goats in Ethiopia with a higher prevalence of *Eimeria* spp. followed by strongyle-type species, *Skrjabinema* spp., *Moniezia* spp., and *Strongyloides* spp. In the same study, the overall prevalence of adult goats and male goats were found to be higher. They also discovered that *Eimeria* spp. was not affected by risk factors such as breed, age, sex, and body condition score. This result is similar to that of Hassan *et al.* (2019) who detected a higher prevalence of coccidian parasites along with mixed infection. Likewise, in Nigeria, Olanike *et al.* (2015) underwent direct microscopic examination and sodium chloride floatation technique and found the overall prevalence of 75.75% with a higher prevalence among Red Sokoto breed in comparison to West African Dwarf by *Strongyloides papillosus, Moniezia* spp, coccidia spp, and *Strongyle* spp. In Somalia, Abdi-Soojeede (2018) detected a total prevalence of 72.1% with *Haemonchus, Eimeria, Strongyloides, Trichostrongyloides,*

Trichuris, and Nematodirus where female goats were found to have higher infections. Further, Matsepe *et al.* (2021) discovered 94.7% gastro-intestinal parasitic prevalence among the Angora goats of Lesotho by using floatation techniques with higher infection of nematodes followed by coccidian and cestodes where immature goats were more significantly prone to gastro-intestinal parasites.

Several studies have been carried out in Nepal regarding the gastro-intestinal parasites of goats however very few research works had been carried out regarding the knowledge and practices of goat rearing. Among them, the study conducted among the goats of Khasibazar of Kalanki, Kathmandu showed a parasitic prevalence of 81.53% (Parajuli, 2007). Few years later in 2019, a study conducted in the same place revealed the prevalence of gastro-intestinal parasites up to 87.25% (Ghimire and Bhattarai, 2019). They reported *Eimeria* (80.75%) as the highest one followed by *Strongyle, Trichuris, Strongyloides, Moniezia, Entamoeba, Fasciola, Balantidium, Cryptosporidium, Capillaria, Trichomonas, Ascaris, Cyclospora, Blastocystis, Giardia,* and *Paramphistomum.* Similarly, the study conducted on the goat of a similar goat market in Bagbazar in Kathmandu also revealed the intestinal helminth parasitic prevalence of 79.70% with the highest prevalence by nematode followed by trematode and cestodes (Pathak, 2011). On the other hand, Purja and Maharjan (2017) reported 100% prevalence with 13 genera of gastro-intestinal parasites like sporozoan, *Fasciola* sp., *Paramphistomum* sp., *Taenia* sp., *Moniezia* sp., *Toxocara* sp., *Bunostomum* sp., *Oxyuris* sp., *Trichuris* sp., *Strongyloides* sp., *Trichostrongyloides* sp., *Nematodirus* sp. He also detected a higher rate (91.81%) of multiple infections among goats. Adhikari *et al.* (2017) studied the prevalence of *Haemonchus contortus* in the goats of western Chitwan of Nepal by sedimentation and floatation whereas egg per gram was calculated by the Mac Master Counting Technique of positive samples. They found a total parasite prevalence of 13.89% and also revealed the maximum *H. contortus* prevalence among the goats of age grouped under one year. Further parasitological studies were conducted among the goats of five different sites in Sunsari District, Nepal for the prevalence of fascioliasis and revealed 35% prevalence (Sah and Sah, 2019). They also found adult goats with a maximum prevalence of fascioliasis than the young ones. Also, In Kapilbastu, Nepal, a study was conducted among the feces of goats with the aim to identify gastro-intestinal parasites and the impact of seasonal changes on their prevalence and revealed the

infection of gastro-intestinal parasites like *Toxocara, Oesophagnum, Strongyloides, Trichuris, Fasciola, and Taenia* (Das *et al.*, 2019).

Bashir (2009) studied the seasonal prevalence of the intestinal helminth parasite of goats (*Capra* sp) and found that 46% of samples collected during winter were positive and 90.3% were positive among the samples collected in summer. Similarly, Rizal (2010) also studied the seasonal prevalence of helminth parasites in goats of Arghakhanchi and determine 68% overall prevalence including trematode, cestode, and nematode infection. Further, Karki *et al.* (2012) carried out a study on the seasonal prevalence of helminth parasites in goats from Khasibazar, Kalanki, Kathmandu and detected a higher prevalence of *Dictyocaulus* followed by *Oesophagostomum* during the summer season. On the other hand, the study conducted in Kapilvastu, Nepal revealed an overall prevalence of 67.92% among the goats predominated by *Toxocara* sp. (Tripathi, 2015). Similar to this, the study conducted in Tilotamma, Rupandehi, Nepal also depicted a similar prevalence of gastro-intestinal parasites with 67.05% mixed infection (Husain, 2017). Also, the study run among the goats of Malarani Rural Municipality, Arghakhanchi, Nepal resulted the overall prevalence of 66% covering seven genera with the majority of *Eimeria* sp. (Khanal, 2019). In addition to this, there was no significant difference in the prevalence of age and sex along with double, triple, and multiple infections. Furthermore, Ghimire *et al.* (2021) studied the adult goats brought to Kathmandu valley, Nepal for commercial purposes by floatation techniques and revealed 92.4% overall *Eimeria* spp. prevalence by 15 different morphologic forms with a prevalence rate as follows: *E. ninakohlyakimovae, E. alijevi, E. capralis, E. masseyensis, E. hirci* larger form, *E. tunisiensis, E. charlestoni, E. jolchejevi* larger form, *E. arloingi, E. caprina, E. aspheronica, E. jolchejevi* smaller form, *E. christenseni, E. hirci* smaller form, and *E. caprovina*.

3. MATERIALS AND METHODS

3.1 Study area

Bhaktapur district is located in the eastern part of Kathmandu valley. It is the smallest among the seventy-seven districts of Nepal. It is part of Bagmati Pradesh. Bhaktapur extends from latitudes N 26º36' to N 27º44' and longitude E 85º21' to E 85º32'. The district is divided into four municipalities Bhaktapur, Changunarayan, Madhyapur Thimi, and Suryabinayak municipality. Among these, Suryabinayak municipality was the study area. Suryabinayak municipality is situated in the southern part of the capital, Kathmandu city. It lies in the latitude of 27.65º north and longitude of 85.44º east. It covers an area of 42.45km^{2} with a population of 78,490. Most of the people of this municipality keep many domestic animals for farming. Buffalo and goats are such domestic animals. The main purpose of the goat by the people is meat, milk, and milk products which are their main sources of earning money.

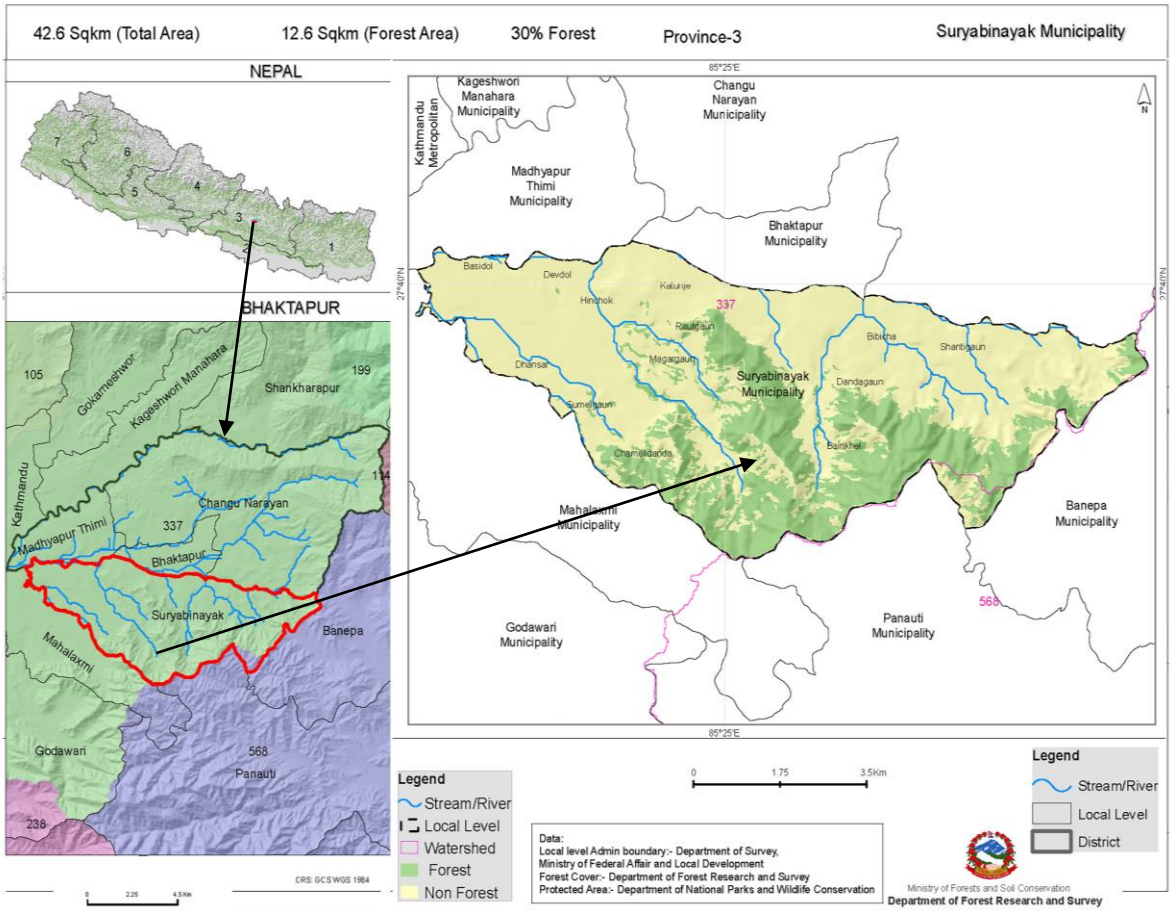


Figure 1 Study area map (Suryabinayak Municipality)

3.2 Study design:

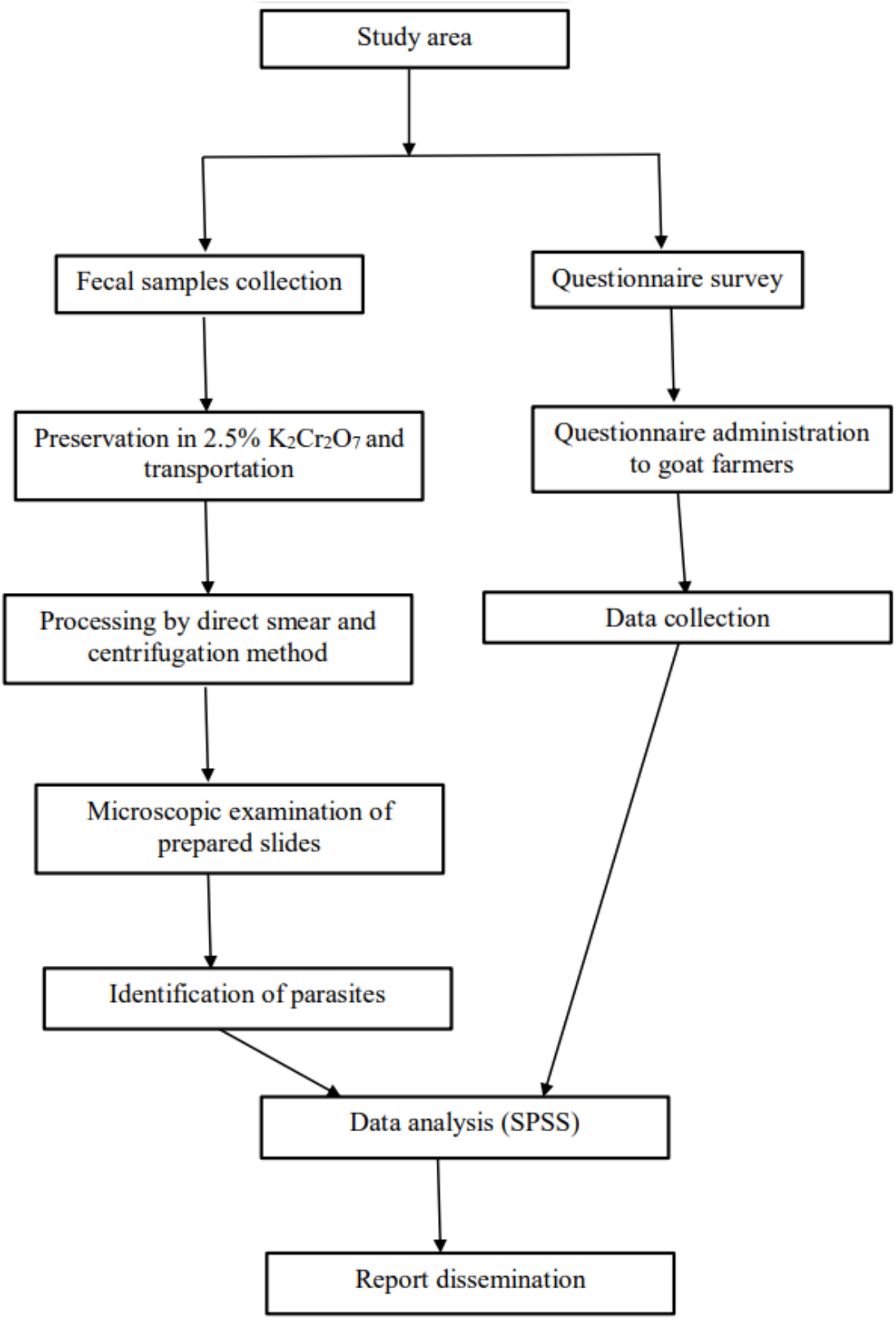


Figure 2 Flowchart showing study design

3.3 Materials required

i. Sample collecting vials	ii. Gloves	iii. Masks
iv. Spatula	v. Mortar and Pestle	vi. Tea strainer
vii. Beakers	viii. Measuring cylinder	ix. Centrifuge tubes
x. Centrifuge machine	xi. Test-tube stand	xii. Droppers
xiii. Glass slides	xiv. Toothpicks	xv. Coverslips
xvi. Cotton buds	xvii. Petri dish	xviii. Glass rod

xix. Compound microscope and camera (OPTIKA MICROSCOPE ITALY and OPTIKA HDMI easy camera)

3.4 Chemicals required

i. 2.5% potassium dichromate ($K_2Cr_2O_7$) solution
ii. Distilled water
iii. 0.9% sodium chloride (NaCl) solution
iv. Gram's iodine
v. Concentrated sodium chloride (conc. NaCl)

3.5 Collection, preservation, and transportation of fecal samples of goats

A total of 300 fecal samples of goats were collected purposively from the study area from July to August 2021. The fecal samples thus collected were immediately preserved in 2.5% $K_2Cr_2O_7$ solution in the sterile airtight vials and were transported to the Animal Research Laboratory of Nepal Academy of Science and Technology (NAST) and further stored at 4°C.

3.6 Laboratory examination.

3.6.1 Macroscopic and microscopic examination of fecal samples

The fecal samples were macroscopically examined for the presence of blood, segments of cestodes, and whole adult nematodes and microscopically examined using direct wet mount techniques directly on 2.5% $K_2Cr_2O_7$ solution and iodine.

3.6.2 Preparation of stained and unstained smear

The small portion of fecal samples preserved at 2.5% $K_2Cr_2O_7$ solution was picked with a clean bamboo toothpick and emulsified with freshly prepared normal saline on a clean glass slide and covered with a cover slip. The setup was examined under the microscope at 10X and 40X. This unstained smear is useful to demonstrate motile forms and cysts of protozoans and also eggs and larva of helminths. The stained smear was prepared

similarly to the unstained smear, the only difference is the addition of a few drops of stain in the slides along with fecal samples. This preparation was required for the identification and study of nuclear matter of the protozoan cysts and trophozoites.

3.6.3 Concentration techniques

There are two types of concentration methods: floatation and sedimentation. Both techniques are used to concentrate helminthic eggs, larva, trophozoites, and protozoan cysts.

a) Saturated salt floatation technique

About 3-4gm of fecal sample preserved at 2.5% $K_2Cr_2O_7$ solution was crushed in the mortar with a few milliliters of 0.9% NaCl and filtered over a tea strainer into the 14ml centrifuge tubes fitted in the test tube stand tightly. Additional 0.9%NaCl was added into the tube to make 14ml. The mixture was centrifuged for 5 mins at 1400 revolutions per minute (rpm) at room temperature. The supernatant was discarded immediately after the completion of centrifugation. Further, concentrated NaCl solution was poured into the centrifuge tube and made a final level of 14ml and the centrifugation process was repeated. Immediately after the completion of centrifugation, the centrifuge tube was kept in the test tube stand tightly and the concentrated solution of NaCl was added to develop a convex surface at top of the tube. The tube was covered by the coverslip to avoid any air bubbles being trapped and was left undisturbed for about 15-20minutes. After 15–20 min, the coverslip was removed and kept on glass slides. The slide was examined under the microscope at 10X and 40X (Ghimire and Bhattarai, 2019). Photographs of reported parasites were taken and identified based on morphology. This technique contributes to detecting lighter ova, cysts, eggs of nematodes, and cestodes if present in the fecal samples.

b) Sedimentation technique

About 3-4gm of fecal sample preserved at 2.5% $K_2Cr_2O_7$ solution was crushed in the mortar with a few milliliters of 0.9% NaCl and filtered over a tea strainer into the 14ml centrifuge tubes fitted in the test tube stand tightly. Additional 0.9%NaCl was added into the tube to make 14ml. The mixture was centrifuged for 5 min at 1400 rpm at room temperature. The supernatant was discarded immediately after the completion of centrifugation. The sediment was gently stirred and a single drop of the sediment was

placed on the glass slides with the help of a plastic dropper and a Gram's iodine-stained smear was prepared. The parasitic stages were examined on the microscope at 10X and 40X (Ghimire and Bhattarai, 2019) and photographs of reported parasites were taken. The concentration sedimentation method aims to separate the eggs from large debris present in fecal microscopy examination by making helminth eggs sediment form at the base of the tube after centrifugation.

3.6.4 Measurement and identification of oocysts, eggs, and larvae of parasites

The measurement of reported parasites was done by using Image J software version ImageJ 1.46r/Java 1.6.0_20 (64-bit), and identification was done based on their morphology. Further, the obtained photographs were compared with the figures in published literature and book by Soulby (1982); Zajac and Conboy (2012).

3.6.5 Intensity of Infection

The intensity of parasitic infection has been calculated based on the number of eggs/oocyst and larvae found per field.

For protozoan parasites (40X): Light infection = 1-3 oocysts per field
Moderate infection = 4-10 oocysts per field
Heavy infection = ≥ 11 oocysts per field

For helminth parasites (10X): Light infection = 1-3 eggs per field
Moderate infection = 4-10 eggs per field
Heavy infection = ≥ 11 eggs per field

3.7 Questionnaire Survey

A questionnaire survey was conducted among the owners of the goats of Suryabinayak Municipality by administering pre-structured questions. The questionnaire survey aimed to assess the knowledge, attitude, and practices on goat diseases.

3.8 Data analysis

The collected data was encrypted and entered into Microsoft Excel 2013 spreadsheet. Statistical analysis was performed using IBM SPSS version 20. The Chi-square test was used to calculate p-values and to analyze the statistical significance of various variables like age, and sex. In call cases, 95% confidence interval (CI) and $p < 0.05$ was considered a statistically significant difference.

3.9 Ethical approval

The ethical approval was granted by the Office of Municipal Executive, Veterinary Department, Suryabinayak Municipality, Bhaktapur. Fecal samples of animals (goats) were taken with the consent of the farmers (owners). Furthermore, permission from the Nepal Academy of Science and Technology was also taken for laboratory use.

4. RESULTS

4.1 General prevalence of gastro-intestinal parasites

A total of 300 fecal samples of goats were collected from Suryabinayak Municipality, Bhaktapur, Nepal. Among which 258 (86%) fecal samples were found to be infected with one or more species of gastro-intestinal parasites.

Furthermore, all the reported gastro-intestinal parasites belonged to mainly four groups of parasites with the highest prevalence of protozoa (53.67%) followed by nematodes, cestodes, and trematodes (Figure 3).

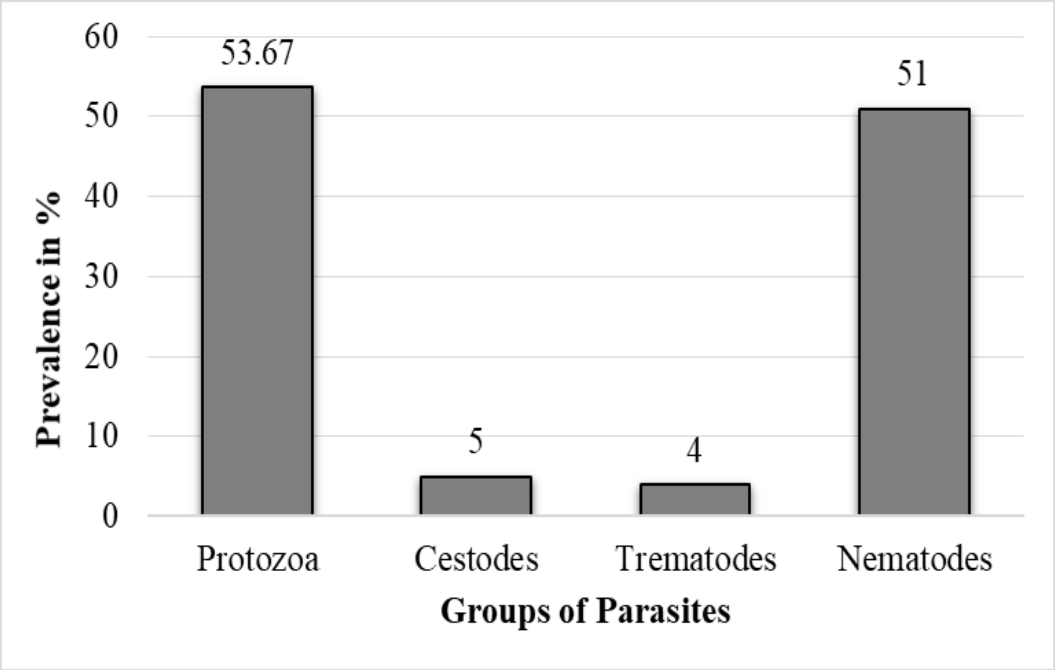


Figure 3 Group-wise prevalence of gastro-intestinal parasites

4.2 Genera-wise prevalence of gastro-intestinal parasites

Out of the total sample examined, 15 genera of gastro-intestinal parasites were identified with a higher prevalence of *Eimeria* spp. (58.33%) and a lower prevalence of *Giardia* sp., *Paramphistomum* sp., and Oxyurids (0.33%) (Figure 4).

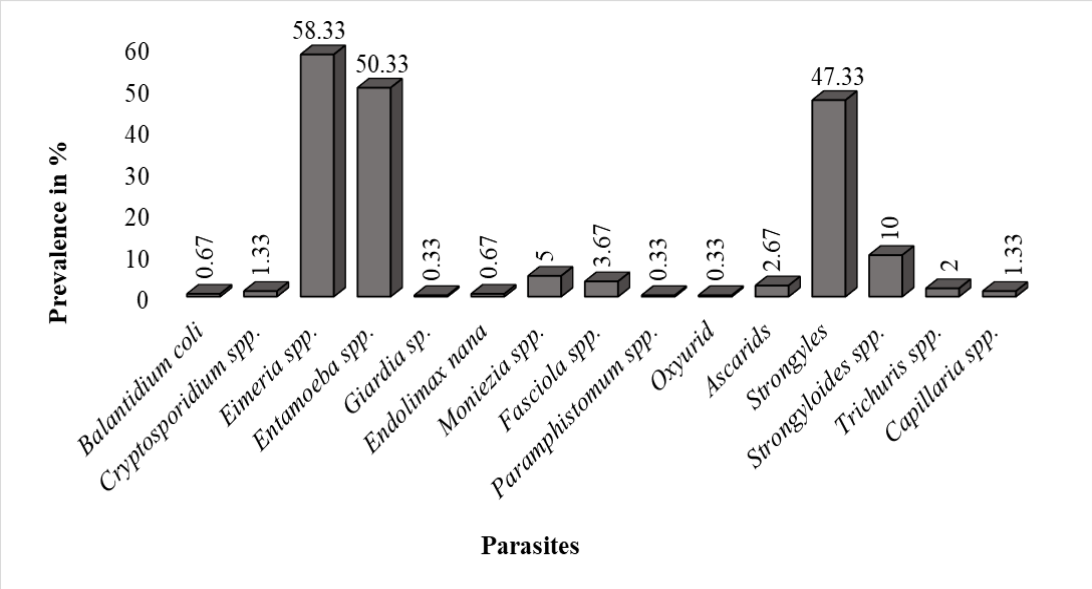


Figure 4 Prevalence of overall gastro-intestinal parasites

4.3 Photographs

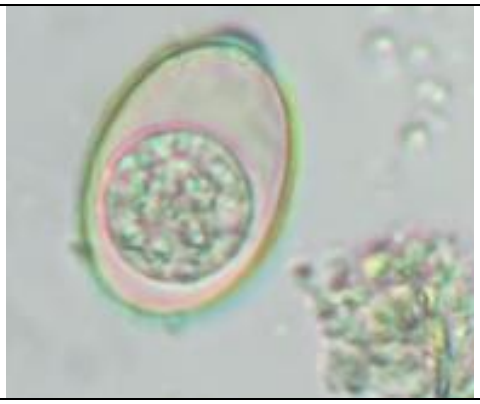
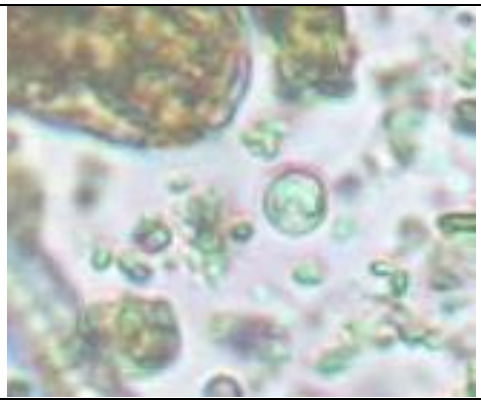
	

Photo 1 Oocyst of *Eimeria* sp. (26µm x 17 µm) 40X	Photo 2 Oocyst of *Cryptosporidium* sp. (5µm x 5 µm) 40X

	
Photo 3 Cyst of *Entamoeba* sp. (8µm x 8µm) 40X	Photo 4 Cyst of *Endolimax nana* (11µm x 7µm) 40

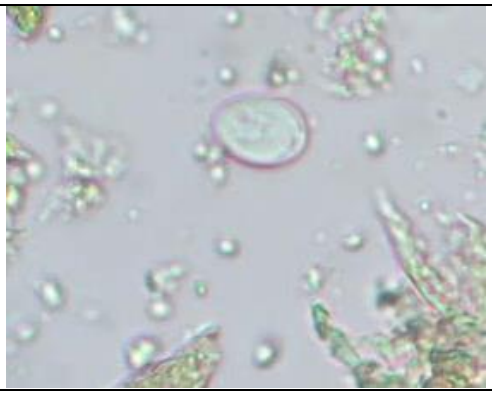
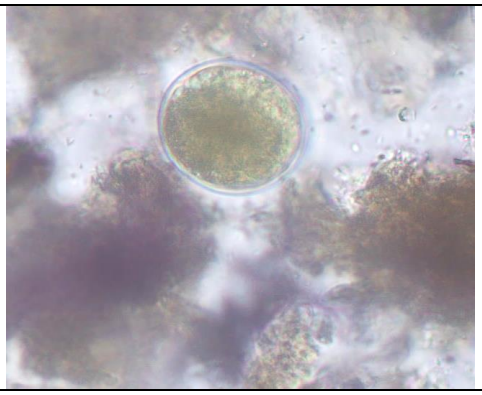

	

Photo 5 Cyst of *Giardia* sp. (12µm x 8µm) 40X	Photo 6 Cyst of *Balantidium coli* (41µm x 40µm) 40X

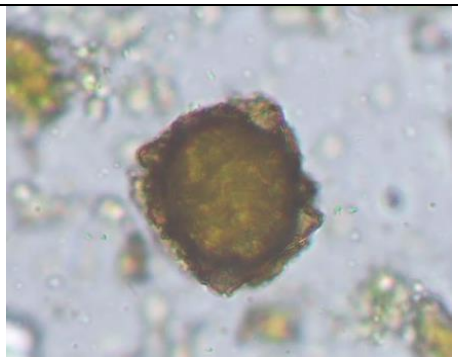
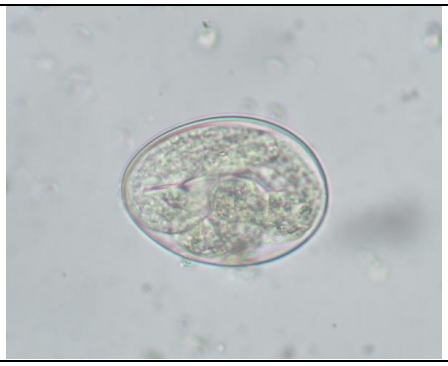
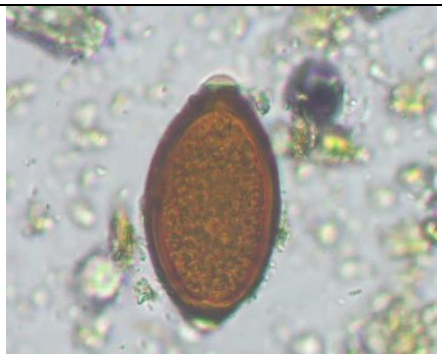



Photo 7 Egg of Ascarid (46µm x 36µm) 40X	Photo 8 Egg of Oxyurid (46µm x 30µm) 40X

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>Photo 9 Egg of Strongyloides sp.
(58µm x 42µm) 40X</td><td>Photo 10 Egg of Strongyle
(74µm x 38µm) 40X</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Photo 11 Egg of Capillaria sp.
(55µm x 30µm) 40X</td><td>Photo 12 Egg of Trichuris sp.
(62µm x 32µm) 40X</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Photo 13 Egg of Paramphistomum sp.
40X</td><td>Photo 14 Egg of Fasciola sp.
(148µm x 77µm) 40X</td></tr>
<tr><td colspan="2">  </td></tr>
<tr><td colspan="2">Photo 15 Egg of Moniezia sp.
(55µm x 53µm) 40X</td></tr>
</table>

4.3 Age-wise prevalence of gastro-intestinal parasites

Overall, goats aged >3 years old have the highest prevalence of both gastrointestinal protozoan as well as helminth parasites.

4.3.1 Age-wise prevalence of protozoan parasites

Among 300 samples, goats aged >3 years old have a maximum prevalence of gastro-intestinal protozoan parasites with 91.67% followed by >1-3 years old, 0-3 months old, and 4-12 months old (Table 1). Statistically, there was no significant difference between the prevalence of gastro-intestinal protozoan parasites and the age of goats (χ^2= 2.4, df =3, p-value= 0.49, i.e. p>0.05).

Table 1 Age-wise prevalence of gastro-intestinal protozoan parasites

Age	Total samples	Total positive	Prevalence (%)	χ^2 value	p-value
0-3 months	34	27	79.41	2.4	0.49
4-12 months	178	135	75.84		
>1-3 years	76	62	81.58		
>3 years	12	11	91.67		
Total	300	235	78.33		

4.3.2 Age-wise prevalence of helminth parasites

Among 300 samples, goats aged >3 years old have a maximum prevalence of gastro-intestinal protozoan parasites with 75% followed by >1-3 years old, 4-12 months old, and 0-3 months old (Table 2). From the table, we found that (χ^2= 18.11., df= 3, p-value= 0.0001 i.e. p<0.05) therefore there is a significant difference in age-wise prevalence among 0-3 months, 4-12 months, >1-3 years and >3 years in helminth infection.

Table 2 Age-wise prevalence of gastro-intestinal helminth parasites

Age	Total	Total positive	Prevalence (%)	χ^2	p-value
0-3 months	34	9	26.47	18.11	0.0001
4-12 months	178	92	51.69		
>1-3 years	76	51	67.11		
>3 years	12	9	75		
Total	300	161	53.67		

4.4 Sex-wise prevalence of parasites

The overall prevalence of female goats was 86.08% and males was 85.85%.

4.4.1 Sex wise prevalence of protozoan parasites

Out of 300 samples collected 106 were male and 194 were female out of which 87 males and 148 females were positive for protozoan parasites. The prevalence of sex-wise prevalence of protozoan infection is summarized in (Table 3) which shows that (χ^2= 1.35, df= 1, p-value= 0.25, i.e. p>0.05) there is no significance difference in sex and prevalence in protozoan parasites.

Table 3 Sex-wise prevalence of protozoan parasites

Sex	Total	Total positive	Prevalence (%)	χ^2 value	p-value
Total male	106	87	82.08	1.35	0.25
Total female	194	148	76.29		
Total	300	235	78.33		

4.4.2 Sex-wise prevalence of helminth parasites

Among 106 males and 194 female fecal samples of goats collected, 51 males and 110 females were positive for helminth parasites. Table 4 shows that there is no significant difference between sex and prevalence in helminth parasites (χ^2= 2.03, df= 1, p-value= 0.15 i.e. p>0.05).

Table 4 Sex-wise prevalence of helminth parasites

Sex	Total	Total positive	Prevalence (%)	χ^2 value	p-value
Total male	106	51	48.11	2.03	0.15
Total female	194	110	56.70		
Total	300	161	53.67		

4.5 Intensity of infection

In case of the intensity of gastro-intestinal parasitic infection, heavy infection of *Eimeria* spp. was found in maximum fecal samples (21) of goats, moderate infection of *Entamoeba* spp. was found in maximum samples (27), and light infection of *Eimeria* spp. was found in maximum samples (137) (Table 5).

Table 5 Intensity of gastro-intestinal parasites

S.N.	Categories	Name of genera	Light infection (+)	Moderate infection (++)	Heavy infection (+++)
1	Protozoa	*Balantidium coli*	2	-	-
2		*Cryptosporidium* spp.	4	-	-
3		*Eimeria* spp.	137	17	21
4		*Entamoeba* spp.	107	27	17
5		*Giardia* spp.	1	-	-
6		*Endolimax nana*	2	-	-
7	Helminths	*Moniezia* spp.	9	5	1
8		*Fasciola* spp.	11	-	-
9		*Paramphistomum* spp.	1	-	-
10		Oxyurids	1	-	-
11		Ascarids	8	-	-
12		Strongyles	123	14	5
13		*Strongyloides* spp.	29	1	-
14		*Trichuris* spp.	6	-	-
15		*Trichuris* spp.	4	-	-

In the present study, the rate of mixed infection was also observed. 80 fecal samples were found to be infected by single parasites, 91 by double, and 87 by multiple parasites with the prevalence of 31.01%, 35.27%, and 33.72% respectively.

4.6 Assessment of knowledge and practices among goat owners, regarding parasitic infection in goats.

26 goat owners were involved in the questionnaire survey where 76.92% were female and 23.08% were male. Among the owners, 19.23% had higher studies 23.08 had studied up to class 10, 26.92% had primary education and the remaining 34.78% had no academic qualification at all. About the training, 11.54% were trained whereas 88.46 were not trained. All the owners prefer kept goats in the group. 73.08% of owners kept by tying and grazing followed by tying and left free in a shed (15.38%) and completely tied (11.54%). Goats were mostly grazed on the roadside and around the home (50%), while 38.46 preferred farms, road, and around the house, and 11.54% fed their goat in the shed. The flooring of the shed was of husk (3.84%), cemented (7.69%), and mud (88.46%). They claim that no symptoms were seen among the goats. Upon getting sick, 96.15% of

owners call the veterinary doctor to treat their goats while 3.85% preferred herbs. 88.46% of owners checked their goats only after getting sick and 11.54% had not checked at all. (Table 6).

Table 6 Assessment of knowledge and practices among goat owners, regarding parasitic infection in goats

Categories	Questionnaires	N= 26	%
Education	Higher studies	5	19.23
	Up to class 10	6	23.08
	Primary	7	26.92
	No study	8	34.78
Training	Yes	3	11.54
	No	23	88.46
Keeping goats	Tying and grazing	19	73.08
	Completely tied	3	11.54
	Tying and left free in a shed	4	15.38
Grazing	Farm, road, and around the house	10	38.46
	Road and around home	13	50
	Shed	3	11.54
Shed floor	Mud floor	23	88.46
	Cemented Floor	2	7.69
	Husk Floor	1	3.84
When goats get sick	I call the vet doctor.	25	96.15
	Feed herbs at home	1	3.85
Treatment period	Not checked	3	11.54
	After getting sick	23	88.46

5. DISCUSSION

The overall parasitic prevalence in a total of 300 fecal samples of goats was 86%. This prevalence was lower than the findings from Lombardy, Italy (96%) (Di Cerbo *et al.*, 2010), Ethiopia (100%) (Dechassa *et al.*, 2012), Egypt (89.33%) (Hassan *et al.*, 2019), and North-eastern Italy (93.2%) (Maurizio *et al.*, 2021) while higher than Korea (69.3%) (Gebeyehu *et al.*, 2013), India (28.65%) (Das *et al.*, 2017), and Bangladesh (75.8%) (Omar *et al.*, 2021). The higher prevalence of gastro-intestinal parasites in the current study might be due to the suitable environmental season for the survival, development, and spread of parasites and their stages (Islam *et al.*, 2017).

The presence of oocysts of *Eimeria* spp. was observed in goats from different countries (Alyousif *et al.*, 1992; Faizal and Rajapakse, 2001; Agyei *et al.*, 2004; Di Cerbo *et al.*, 2010; Cavalcante *et al.*, 2012; Das *et al.*, 2017; Ghimire *et al.*, 2021). The study conducted in Thailand (Jittapalapong *et al.*, 2012) and Bangladesh (Omar *et al.*, 2021) had 58% and 55.2% prevalence of *Eimeria* spp. respectively which is similar to this study. However, the current result was lower in comparison to 100%, and 89.2%, (Dechassa *et al.*, 2012; Yusof and Isa, 2016) and higher to 4%, and 44.19% (Sohail *et al.*, 2017; Abdi-Soojeede, 2018) respectively. Also in the study conducted in Brazil, the prevalence of *Giardia* and *Cryptosporidium* were detected 22.6% and 40.5% respectively which is higher than our outcomes and the prevalence of *Entamoeba* was 1.8% which is lower than this study. On the other hand, the study conducted by Ghimire and Bhattarai (2019) in Nepal showed the prevalence of *Giardia* similar to this study whereas Utaaker *et al.* (2017) showed a lower prevalence of *Cryptosporidium* (0.5%) in comparison to this study. The high prevalence rate of *Eimeria* and detection of numerous protozoan parasites in the present study might be due to crowded conditions, temperature, drinking water, and management.

The trematode observed in the goats of the present study were *Fasciola* sp. and *Paramphistomum* sp. Fasciolopsis and paramphistomosis are two significant parasitic diseases in farmed ruminants worldwide that lead to huge losses in production (Wamae *et al.*, 1998; Mage *et al.*, 2002). In the current study, the overall prevalence of trematode was 3.67% *Fasciola* sp. and 0.33% *Paramphistomum* sp. *Fasciola* sp. and *Paramphistomum* sp. are widely distributed parasitic trematodes and were reported from

various countries such as India (Bhattacharjee *et al.*, 2021), Bangladesh (Sarker *et al.*, 2021; Dey *et al.*, 2022), Nepal (Karki *et al.*, 2012), Malaysia (Tan *et al.*, 2017), Ghana (Win *et al.*, 2020), etc. In the investigation carried out in Kapilvastu, 15.97% of goats were found to be infected with *Fasciola* sp. (Das *et al.*, 2019), whereas in Pokhara, 8.18% of goats were infected (Purja and Maharjan, 2017). Similarly, 10.68% was reported from Pakistan (Ruhoollah *et al.*, 2021) and 39.6% in India (Wani, 2021) which is high in comparison to this study whereas 2.75% in Jammu and Kashmir (Bihaqi *et al.*, 2017), 3.57% in India (Gupta *et al.*, 2013), 4.8% in China (Ma *et al.*, 2014) shows confirmatory with the results of the present study (3.67%). But the present result is much higher than those reported in Jammu (0.64%) (Gadahi *et al.*, 2009) and Egypt (0. 89%) (Hassan *et al.*, 2019). On the other hand, the prevalence of *Paramphistomum* spp. in goats of India, Bangladesh, and Nepal were 16.8%, 39.30%, and 4.09% respectively (Bandyopadhyay *et al.*, 2010; Hassan *et al.*, 2011; Purja and Maharjan, 2017) which are far higher than that of the current study. The infection of *Fasciola* sp. and *Paramphistomum* sp. in goats may have been low due to rearing practice, and the prevalence of intermediate host i.e. snail.

The overall prevalence of *Moniezia* spp. was comparatively higher than trematodes and lower than protozoa and nematodes in the present study. Different countries had a different prevalence of *Moniezia* among goats. Countries like Brazil (2.3%) (Radavelli *et al.*, 2014), Zimbabwe (0.4%) (Zvinorova *et al.*, 2016), and Slovakia (2.65%) (Babják *et al.*, 2017) had a slightly lower prevalence of *Moniezia* than the goats of the present study while Ethiopia (7.8%) (Dechassa *et al.*, 2012), India (10.04%) (Das *et al.*, 2017), Egypt (18.22%) (Hassan *et al.*, 2019) and Thailand (29.91%) (Junsiri *et al.*, 2021) had a higher prevalence. The result of the low prevalence of *Moniezia* spp. in the present study may be due to the rearing practices, and a chance of ingestion of infected intermediate host i.e. oribatid mites by goats.

Gastro-intestinal nematodes are parasitic unsegmented worms that are usually cylindrical and elongated in shape (Soulby, 1982). These nematodes infect animals causing serious diseases, eventually leading to the death of animals and also deleterious physical productivity. In the present study, six different types of nematode parasites were identified namely Strongyles, *Strongyloides* spp., Ascarids, *Trichuris* spp., *Capillaria* spp., and Oxyurids with a prevalence of 47.33%, 10%, 2.67%, 2%, 1.33%, and 0.33% respectively. Strongyles are parasitic nematode worms that belong to the family

Strongylidae and are often found in the gastro-intestinal tracts of ruminants. Prevalence of Strongyles (69.27%) reported from goats of India by Singh *et al.* (2014) is higher than in the present study whereas goats of Nigeria (48%) and Thailand (52.43%) were reported similar (Olanike *et al.*, 2015; Azrul *et al.*, 2017) and India (32.63%) lower (Das *et al.*, 2017). The variation in the distribution of these parasites may be attributed to management practices such as grazing and mud flooring of the shed as mud floor seemed to be the favorable condition for the growth, development, and transmission of these parasites (Dey *et al.*, 2020). Similarly, 10% *Strongyloides* sp. infection was obtained in goats whereas 57.77% has been reported from Thailand (Junsiri *et al.*, 2021) which is higher than the prevalence in the present study. Also, the prevalence from Egypt (Hassan *et al.*, 2019) seemed to be lower than in the current study, and India (Das *et al.*, 2017) had a similar prevalence. The differences in the prevalence of *Strongyloides* in this study may be due to variations in geographical landscape, lack of knowledge about management among the owners irregular treatment.

Trichuris sp. and *Capillaria* spp. have been often observed in goats worldwide. Pakistan (Sohail *et al.*, 2017) and Egypt (Hassan *et al.*, 2019) have a prevalence similar to the current study. Thailand (Jittapalapong *et al.*, 2012) also has a prevalence similar to the current study (2%). Other parasites that were detected during the current study are Oxyurids (0.33%) and Ascarids (2.67%). The study conducted among the goats of Ethiopia had resulted in a comparatively higher prevalence (11.5%) of oxyurids (*Skrjabinema* spp.) than the current study. But in the case of Ascarids, the prevalence of the present study is similar to that of Ghimire and Bhattarai (2019). This variation might be due to deworming habits and differences in farm management practice.

The sex, age, and breed of the host animal play a significant role in influencing the prevalence of gastro-intestinal parasites (Jegede *et al.*, 2015). The present study showed a higher prevalence of parasites among female than the male which are supported by many studies (Azrul *et al.*, 2017; Bihaqi *et al.*, 2017; Omar *et al.*, 2021). The reason for the higher prevalence among females might be due to a decrease in immune status during pregnancy and lactation period and hence more susceptible to helminthic parasites. In the case of age wise prevalence of protozoan parasites, adults were found to be more vulnerable to infection in the current study. But several studies opposed this result (Cavalcante *et al.*, 2012; Sorathiya *et al.*, 2017). Similar results were also shown by the

helminthic prevalence and supported by several studies (Gebeyehu *et al.*, 2013; Bihaqi *et al.*, 2017; Omar *et al.*, 2021). In contrast, some studies revealed a higher incidence of gastro-intestinal parasites in young ones than in adults, which does not support the results of the current study (Faizal and Rajapakse, 2001; Sorathiya *et al.*, 2017). The higher prevalence of overall gastro-intestinal parasites among adult goats might be due to their grazing behavior on the parasite contaminated pasture leading to frequent contact with parasites in comparison to young.

Small ruminants are usually infected with more than one species of gastro-intestinal parasites. In the present study, 31.01%, 35.27%, and 33.72% of samples were found to have single, double, and multiple infections respectively. However, the prevalence of mixed infection differs according to the difference in studies such as 13.38% (Das *et al.*, 2017), 30% (Sohail *et al.*, 2017), and 79.7% (Jittapalapong *et al.*, 2012). The variation may be due to the variation in rearing practice and geographical variation.

A questionnaire survey conducted among the goat farmers revealed that a maximum (34.78%) of them do not have an education and only 11.54% had got training of goat rearing. The majority of the farmers keep goats by tying and grazing while for grazing, most owners preferred road and around the home which may be the reason for the low cestode and trematode infection as their transmission requires an intermediate host which depends on the season for survival (Soulby, 2006). Most of the sheds were mud floored which contribute to the transmission and growth of gastro-intestinal nematodes (Dey *et al.*, 2020). The intestinal status of goats can positively influence pathogenesis depending on various factors, management systems, and environmental conditions (Houdijk *et al.*, 2000). 96.15% call a veterinary doctor when their goats get sick and also 88.46% treat their goats only if their goats get sick. This habit may enhance asymptomatic infections causing unnoticed diseases and finally dead.

6. CONCLUSION AND RECOMMENDATIONS

From the study, it is concluded that the gastro-intestinal parasites were predominantly harbored by the goats with a prevalence of 86% in Suryabinayak Municipality, Bhaktapur, Nepal. The prevalence was based on the microscopic examination of the fecal samples by direct smear, sedimentation, and floatation methods. Goats harbored 15 species of parasites including six genera of protozoan, two trematodes, one cestode, and six nematodes. There were no significant differences between sex-wise protozoan and helminth parasite prevalence but age-wise prevalence showed no significant difference among protozoan parasites and significant difference between helminth parasites. Hence, the sample collected in the season of July to August seemed to be suitable for the development and survival of several gastro-intestinal parasites as the ground was moist and temperature was moderate especially *Eimeria* spp. Both male and female and all aged goats were harboured by one or more parasites. Some of the common factors observed during this study period were grazing on contaminated area, unmanaged shed, and lack of proper treatment. Some of the factors like goat rearing training, management practices, and treatment processes were also observed during the study period which seemed to develop asymptomatic infections causing unnoticed illnesses leading to dead.

Based on the objective, the following recommendations are made to reduce the risk of gastro-intestinal parasites in goats:

- Coccidians are harbored more by the goats, hence mass treatment program is needed against it and must be frequently organized.
- Management practices and knowledge on the treatment of intestinal parasites of goats seemed lacking among the owner, hence regular training on goat rearing should be provided to goat owners focusing on gastro-intestinal parasites, their harm, and control.
- Regular screening of goats for parasitic infection should also be carried out frequently.
- The sheds should be kept dry as far as possible to obstruct the growth and development of helminth parasites.

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ANNEX

Goat rearing practice

Fecal sample collection

Report of medicine used by the owners

Centrifugation process

Slide preparation

Floatation process

Microscopic observation

Questionnaire for the survey of Prevalence of Gastro-intestinal Parasites of Goats (*Capra hircus* Linnaeus, 1758) in Suryabinayak Municipality, Bhaktapur, Nepal.

Age: Sex: Locality:

1. Education
   i. Illiterate ii. Upto 5 class
   iii. Upto 10 class iv. Higher education
2. Have you received any training on goat rearing?
   i. Yes ii. No
3. How many goats are kept in the shed?
   i. Only one ii. Two
   iii. More than two
4. How are you keeping goats?
   i. Completely tied ii. Tying but freed within the shed
   iii. Tying and freed outside
5. Which place do you preferred for grazing?
   i. Forest ii. Field area
   iii. Roadside and around home iv. Field area, roadside and around home
6. How is the floor maintained?
   i. Mud floor ii. Cemented floor
   iii. Husk floor iv. Wood floor
7. Is there any symptoms of disease among the goats?
   i. Indigestion ii. Diarrhoea iii. Weight loss
   iv. Weakness v. Constipation vi. Blood excretion
   vii. Decrease in milk production viii. Others ix. No symptoms
8. What do you do if your goat become ill?
   i. Go to hospital ii. Go to nearby vet pharmacy
   iii. Go to Dhami and Jhankri iv. Feed medicinal herbs at home
   v. Nothing vi. I will not tell
   vii. Do not know
9. How many times do you treat your goats in a year?
   i. Once a year ii. Twice a year iii. Thrice a year
   iv. After getting sick v. Not treated

10. Age of a goat

    i. 0-3 months ii. 4-12 months

    iii. >1-3 years iv. >3 years

11. Sex of goats

    i. Male ii. Female