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PREVALENCE OF PROTOZOAN PARASITES IN RUMINANTS IN DISTRICT NAROWAL, PAKISTAN

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Abstract

The economy of Pakistan is heavily dependent on livestock. It provides year-round work, generates cash revenue, increases crop productivity, produces food, and use for transportation. Animals in Pakistan experience severe losses as a result of protozoan infections, including considerable fluctuates in milk production, miscarriages, preterm deliveries, and occasionally even death. The purpose of this study was to ascertain the frequency of protozoan parasites in ruminant faeces in distinct areas of District Narowal, Pakistan, among parasitic protozoans, the prevalence of *B. coli* in plot and coccidia in Noorkot was the most abundant. A total of 1659 samples was collected and processed by sedimentation technique in District Diagnostic Livestock Lab, Narowal. Overall, 45.33% (752/1659) of animals were infected; the incidence rate of coccidia and *B. coli* was highest in June and November. The prevalence of coccidia in buffaloes, cattle, goats and sheep was found at 46.5%, 41.2%, 28% and 36.6% respectively. While *B. coli* was found within only buffaloes and cattle (0.09% and 0.59%, respectively). coccidia was highly observed in young ones of buffaloes and cattle. In young ruminants, coccidia was observed in goats (15.38%), buck (41.67%), sheep (50%) and ram (27.78%), whilst, *B. coli* was highly observed in adult buffaloes (0.87%) and cattle (0.71%). It is essential to understand the prevalence of these protozoan parasites in District Narowal in order to develop effective control methods against animal diseases.

Key Words: Protozoan Parasites, Coccidia, Balantidium. coli, miscarriage, premature delivery, Narowal.

**VOL-2, ISSUE-6, 2024****INTRODUCTION**

In Pakistan, livestock contributed 11% of the country's GDP and 50% of the revenue generated to agriculture in the years 2005–2006, making them significant contributors to the country's economy. It is also a net source of currency earnings, contributing about 8% yearly (Ishaq & ul Haq, 2007). According to the Economic Survey of Pakistan 2020–21, Pakistan has 51.5 million cattle, 42.4 million buffaloes, 31.6 million sheep, and 80.3 million goats, which together contribute 60.1% of the country's agricultural output and 11.5% of its GDP (Khan, 2021). Its importance can be gauged by the fact that Pakistan's rural economy heavily relies on cattle. It generates monetary income, creates year-round employment, spreads risk, produces food, improves crop output, and also use for transportation (Ishaq & ul Haq, 2007). Significant milk yield loss, miscarriage, premature delivery and sometimes death occurs in ruminants due to the parasitic diseases in different countries (Kaltungo & Musa, 2013). Parasitism is a major risk factor for ruminant fertility and is a source of economic loss in many parts of the world, including Pakistan (Squire et al., 2019). The protozoan disease known as coccidiosis, which primarily affects young animals, develops in the small and large intestines of afflicted animals, is brought on by coccidia parasites of the genus *Eimeria* (Mohamed et al., 2022). The zoonotic pathogen *B. coli*, which affects a range of host species, is a rapidly growing protozoan cause disease in ruminants called Balantidiasis (Ahmed et al., 2020).

Coccidia are the obligate intracellular parasite of intestinal tract of vertebrates (Gardiner et al., 1998). Cattle coccidiosis is caused by species of genus *Eimeria*; which are host specific (Bangoura & Bardsley, 2020; Vandendoren et al., 2022). There are about nine species of Coccidia in cattle but only two species cause severe clinical coccidiosis i.e., *Eimeria zeurnii* and *Eimeria bovis* and *Eimeria barreillyi* is most pathogenic species to water buffalo (Dubey, 2018; Taylor, 2000). The infective form of parasite is an oocyst, which is often shed off by infected cattle in their faeces (Li et al., 2021). Because *Eimeria* oocysts can live in the atmosphere for several weeks or months in ideal conditions of mild heat and moisture, environmental and climatic factors are crucial for the development, survival, and spread of coccidiosis (Alcala-Canto et al., 2020). In cattle, acute diarrhoea either with or without blood is one of the clinical symptoms of coccidiosis (Dauguschies & Najdrowski, 2005). Along with straining while urinating, significant weight loss, dehydration, rough skin, listlessness, growth retardation in young animals, respiratory problems in cattle, and occasionally convulsive seizures are other symptoms (Oglesbee & Jenkins, 2012). Animals that are stressed and in densely populated areas are more likely to contract the disease (Bowen, 2013).

Balantidium coli (*B. coli*) is a ciliated protozoan parasite and a zoonotic parasite i.e transmitted from animals to human and vice versa. It affects large ruminants as well as small ruminants worldwide (Nalbone et al., 2021). *B. coli* is a naturally occurring parasite that lives in the caecum, rectum and colon of animals that appear to be healthy and cause clinical illness balantidiasis (Schuster & Ramirez-Avila, 2008). Pork is the main source of infection in humans from *B. coli*, which is thought to be a pig parasite yet they can also infect domestic ruminants (Ahmed et al., 2020). Small ruminants are frequently raised in Pakistan alongside giant ruminants, usually near to the human population. Therefore, *B. coli* outbreaks in unclean environments are probable (Samad, 2011). *B. coli* involves fecal oral route transmission. Regular monitoring protocols, efficient animal and waste water disposal,



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and adequate water supply infrastructure all can aid in reducing transmission of parasites on farms (Ponce-Gordo & García-Rodríguez, 2021). The acute balantidiasis results in diarrhea, stomach discomfort, tenesmus, nausea, loss of weight, vomiting and sometimes dysentery. Chronic infection also occurs with intermittent diarrhea and blood in the stool and often lead to death (Chalmers, 2014).

The present study was carried out to determine the prevalence of protozoan parasites in fecal sample of ruminants in different areas of District Narowal, Pakistan. The basic aim of study was to gather sufficient information about specific parasitic protozoans which can help in control, management and finding a solution to overcome diseases in ruminants in District Narowal, Pakistan.

MATERIALS AND METHODS

Study Area:

District Narowal was selected as the study area. In Pakistan's Punjab province, the district of Narowal has a total area of roughly 2337 km². It is bounded by the districts of Sheikhupura, Gurdaspur, Jammu and Kashmir, and Sialkot at 32°13'44"N and 74°57'1"E. Its silt-rich, fertile loamy soil is ideal for cultivating a variety of crops because of its good fertility. In Pakistan, Narowal is in the country's sub-humid climate zone (Zereen et al., 2018). The occurrence of protozoan parasites was investigated in various age groups and genders of buffaloes, cows, sheep and goats.

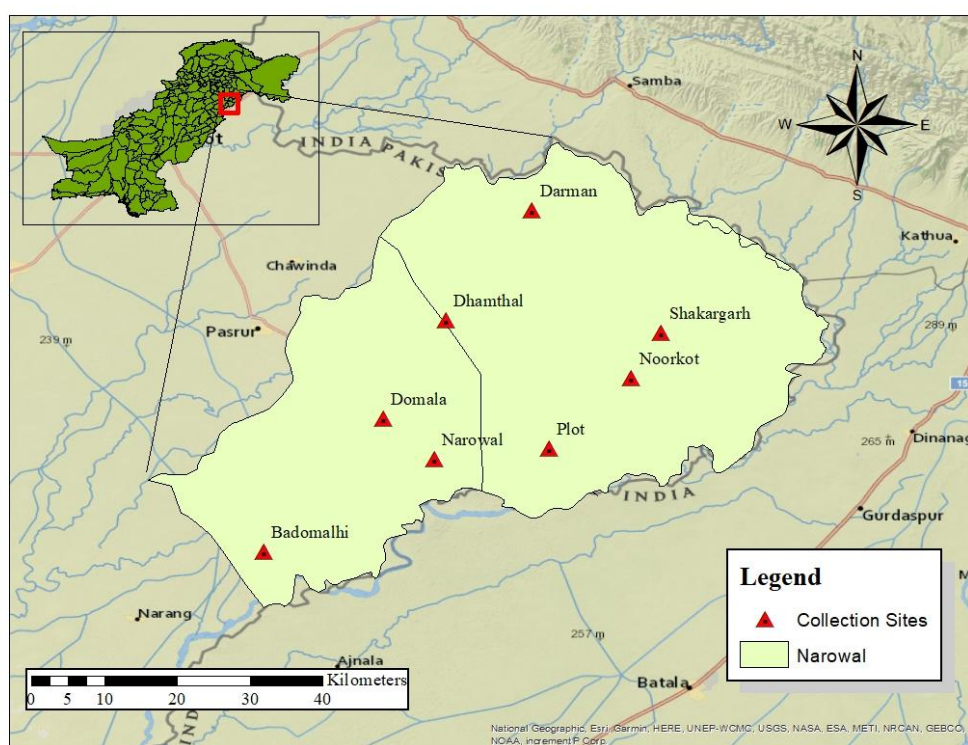


FIG 1: MAP SHOWING SAMPLING SITES IN DISTRICT NAROWAL SAMPLE COLLECTION AND EXPERIMENT:

About 10gm of fecal sample from each animal was collected by wearing plastic gloves from the fresh dung soon after deposition or directly from the rectum by lubricating and inserting the loop into the rectum and swooping to collect fecal material. In small ruminants, fecal sample were also collected by using index finger and thermometer. Then loop/thermometer was removed and transferred the content to



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the polythene bag or in glass container. The fecal samples were kept in refrigerator at 4°C after collection to bring them in Lab and then the sample were processed immediately in lab.

Sedimentation technique was used to diagnose the parasites in sample. In sedimentation technique, 5-gram fecal sample was mixed with salt solution, then strained the solution in another beaker with the help of sieve and pour the strained solution in test tube which was placed in test tube rack for 15 minutes. The debris over the sieve was discarded. After the required time, a drop from the sediment was taken with pipette, then placed in the center of slide and covered it with slide cover. The slide was observed under light microscope by using 10X lens.

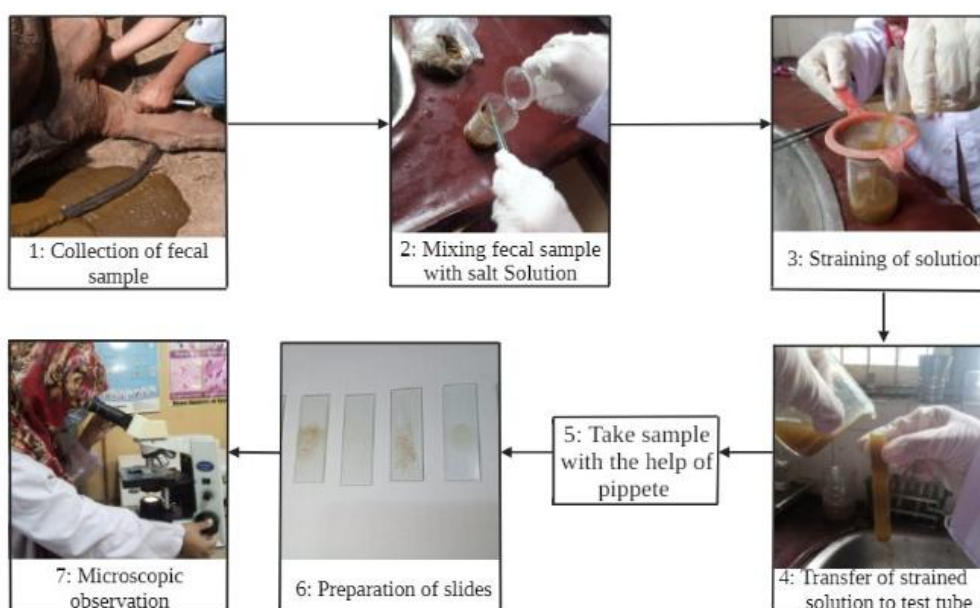


FIG 2: PROCEDURE

STATISTICAL ANALYSIS:

Two-way ANOVA test was used for statistical analysis by Prism graphpad software.

RESULTS:

Total 1659 fecal samples were collected from the different areas of district Narowal during Jan-Dec 2021. These samples were processed and examined in District Veterinary Laboratory, Narowal.

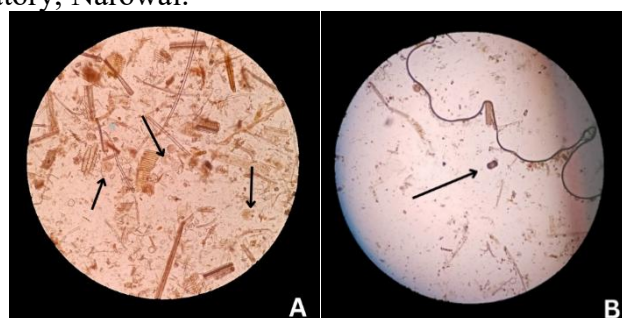


FIG 3: SLIDES SHOWING A-BALANTIDIUM COLI AND B-COCCIDIA

Out of 1659 samples, 752 (45.33%) were infected with different protozoan parasites and 825 (54.67%) were non-infected. Among Buffaloes, cattle, sheep and goats, age



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wise, gender wise, collection site wise, and month wise comparisons were also studied. Out of 1659 samples, 524 (47.55%) buffaloes, 210 (41.83%) cattle, 7 (28%) goats and 11 (36.67%) sheep were infected. Following tables and their respective graphs showed prevalence of parasites in District Narowal.

TABLE 1: PREVALENCE (%) OF PROTOZOAN PARASITES IN RUMINANTS

Organisms (n)	Infected animals (n)	Coccidia (n)	<i>B. coli</i> (n)
Buffaloes (1102)	524 (47.55%)	513 (46.5%)	11 (0.09%)
Cattle (502)	210 (41.83%)	207 (41.2%)	3 (0.59%)
Goats (25)	7 (28%)	7 (28%)	0
Sheep (30)	11 (36.67%)	11 (36.6%)	0
Total=1659	752 (45.33%)	738 (44.8%)	14 (0.84%)

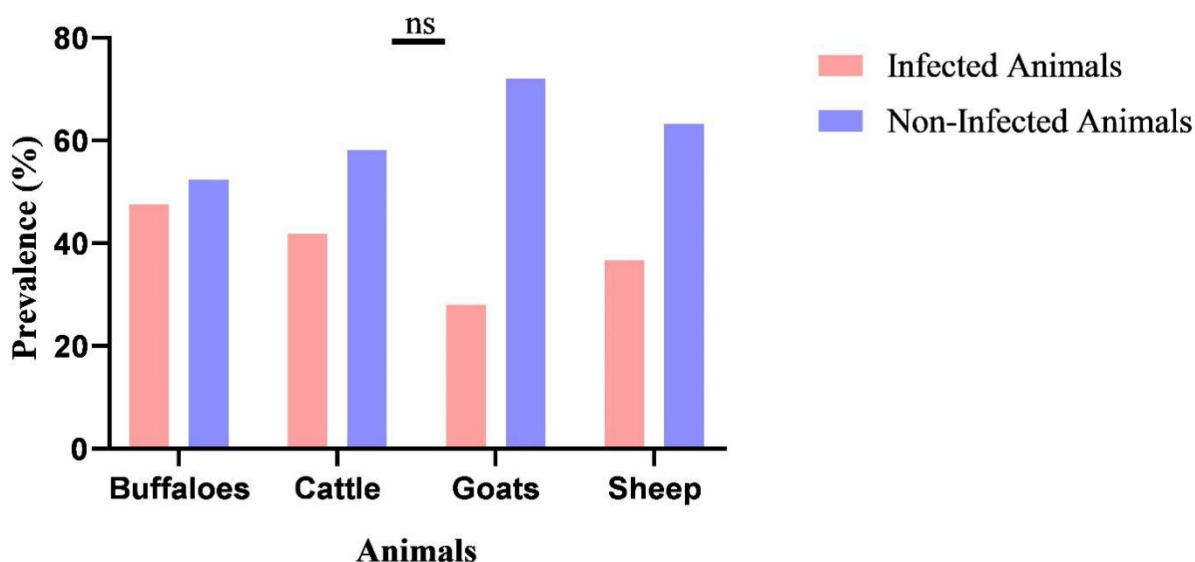


FIG 4: COMPARATIVE PREVALENCE (%) OF PROTOZOAN PARASITES IN RUMINANTS

TABLE 3: PREVALENCE (%) OF PROTOZOAN PARASITES ON THE BASIS OF GENDER

Organism (n)	Coccidia (n)	<i>B. coli</i> (n)	Organism (n)	Coccidia (n)	<i>B. coli</i> (n)
Buffalo calf (19)	12 (63.15%)	0 (0%)	Bull calf (6)	3 (50%)	0 (0%)
Buffalo heifer (28)	12 (42.85%)	1 (3.57%)	Cow heifer (21)	8 (38.1%)	0 (0%)
Buffalo (M) (25)	12 (48%)	1 (4%)	Bull (54)	25 (46.29%)	0 (0%)
Buffalo (F) (1030)	477 (46.31%)	9 (0.87%)	Cow (421)	171 (40.62%)	3 (0.71%)
Goat (13)	2 (15.38%)	0 (0%)	Sheep (12)	6 (50%)	0 (0%)
Buck (12)	5 (41.67%)	0 (0%)	Ram (18)	5 (27.78%)	0 (0%)



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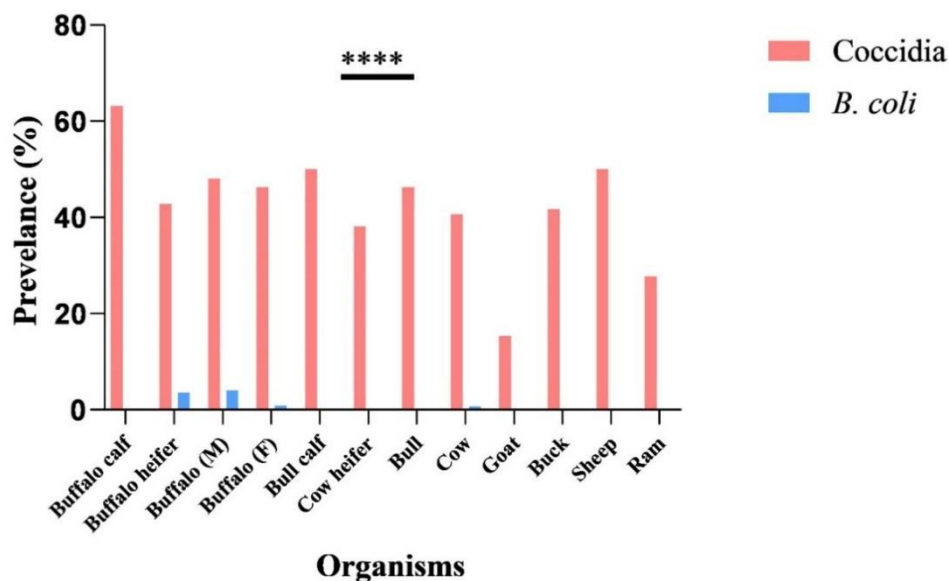


FIG 5: PREVALENCE (%) OF PROTOZOAN PARASITES ON THE BASIS OF GENDER

TABLE 3: PREVALENCE (%) OF PROTOZOAN PARASITES ON THE BASIS OF AGE

Organisms	Age (years)	(n)	Coccidia	<i>B. coli</i>
Small Ruminants	0-1	25	8 (32%)	0
	1-above	30	10 (33.33%)	0
	0-1	25	15 (60%)	0
Large Ruminants	1-3	128	57 (44.53%)	2 (1.56%)
	3-above	1451	648 (44.65%)	12 (0.83%)



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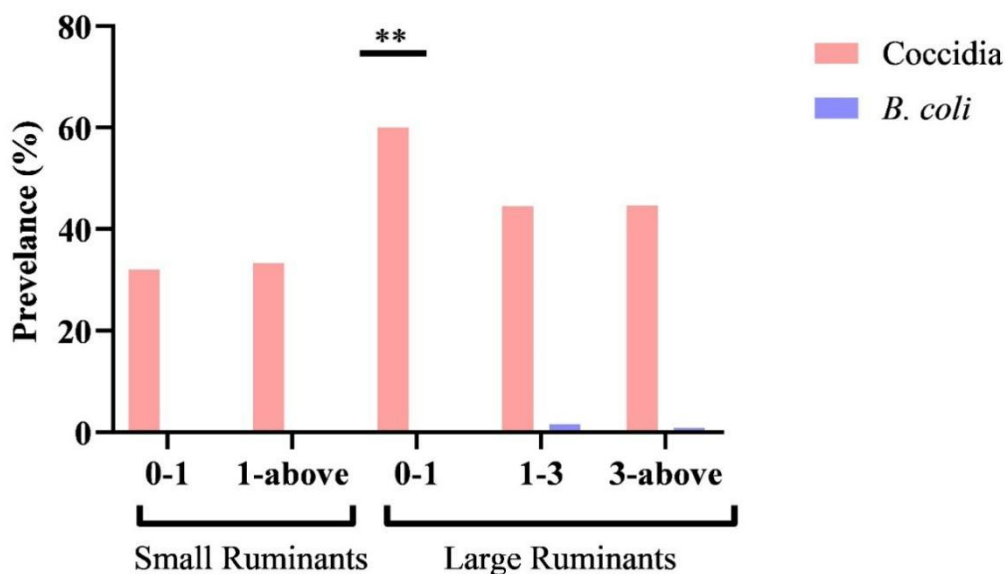


FIG 6: PREVALENCE (%) OF PROTOZOAN PARASITES ON THE BASIS OF AGE

TABLE 4: PREVALENCE (%) OF PROTOZOAN PARASITES ON THE BASIS OF COLLECTION SITES

Location	(n)	Coccidia	<i>B. coli</i>	Location	(n)	Coccidia	<i>B. coli</i>
Shakargarh	230	102 (44.34%)	1 (0.43%)	Dhamthal	124	54 (43.54%)	0
Noorkot	94	48 (51.06%)	0	Narowal	614	295 (48.04%)	6 (0.97%)
Plot	105	43 (40.95%)	3 (2.85%)	Badomalhi	162	63 (38.88%)	0
Darman	52	21 (40.38%)	1 (1.92%)	Domala	278	112 (40.28%)	3 (1.07%)



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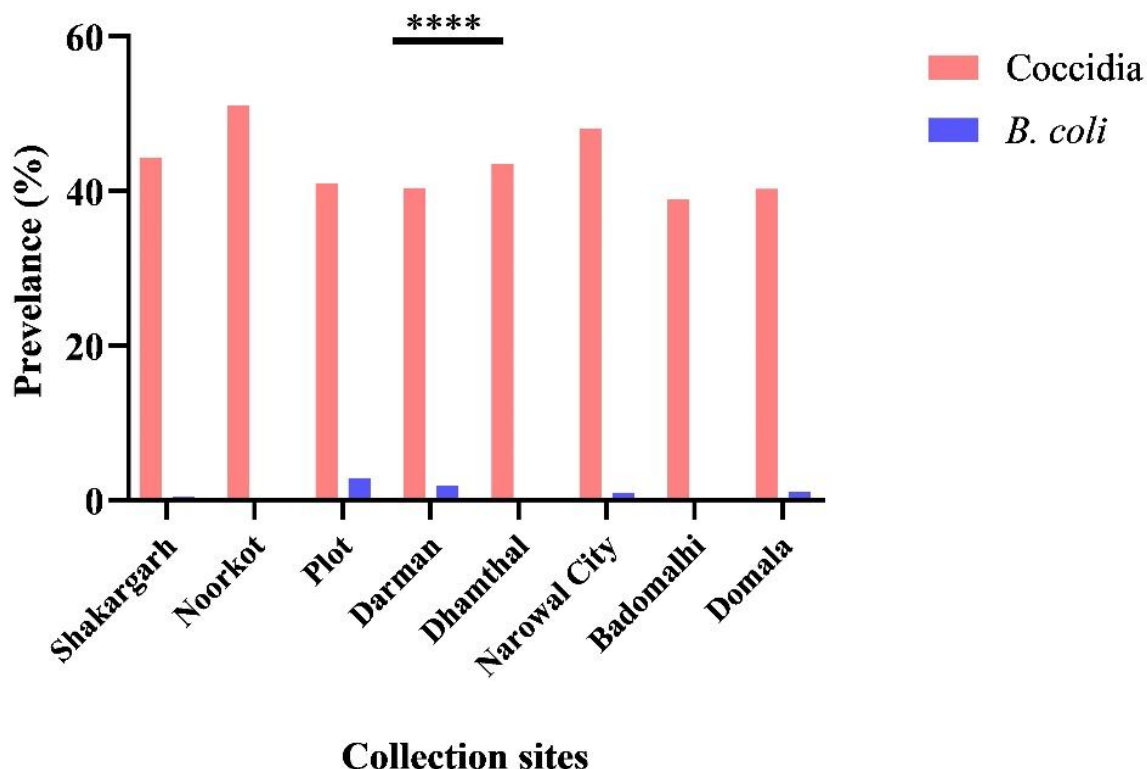


FIG 7: PREVALENCE (%) OF PROTOZOAN PARASITES ON THE BASIS OF COLLECTION SITE

TABLE 6: PREVALENCE (%) OF PROTOZOAN PARASITES ON THE BASIS OF MONTHS OF YEARS

Months	(n)	Coccidia	<i>B. coli</i>	Months	(n)	Coccidia	<i>B. coli</i>
Jan-21	72	24 (33.33%)	0	Jul-21	129	63 (48.83%)	0
Feb-21	125	40 (32%)	2 (1.6%)	Aug-21	176	72 (40.91%)	1 (0.56%)
Mar-21	140	71 (50.71%)	0	Sep-21	168	80 (47.61%)	4 (2.38%)
Apr-21	138	57 (41.30%)	1 (0.72%)	Oct-21	117	58 (49.57%)	0
May-21	135	64 (47.40%)	0	Nov-21	148	56 (37.83%)	5 (3.37%)
Jun-21	183	109 (59.56%)	1 (0.55%)	Dec-21	128	44 (34.37%)	0

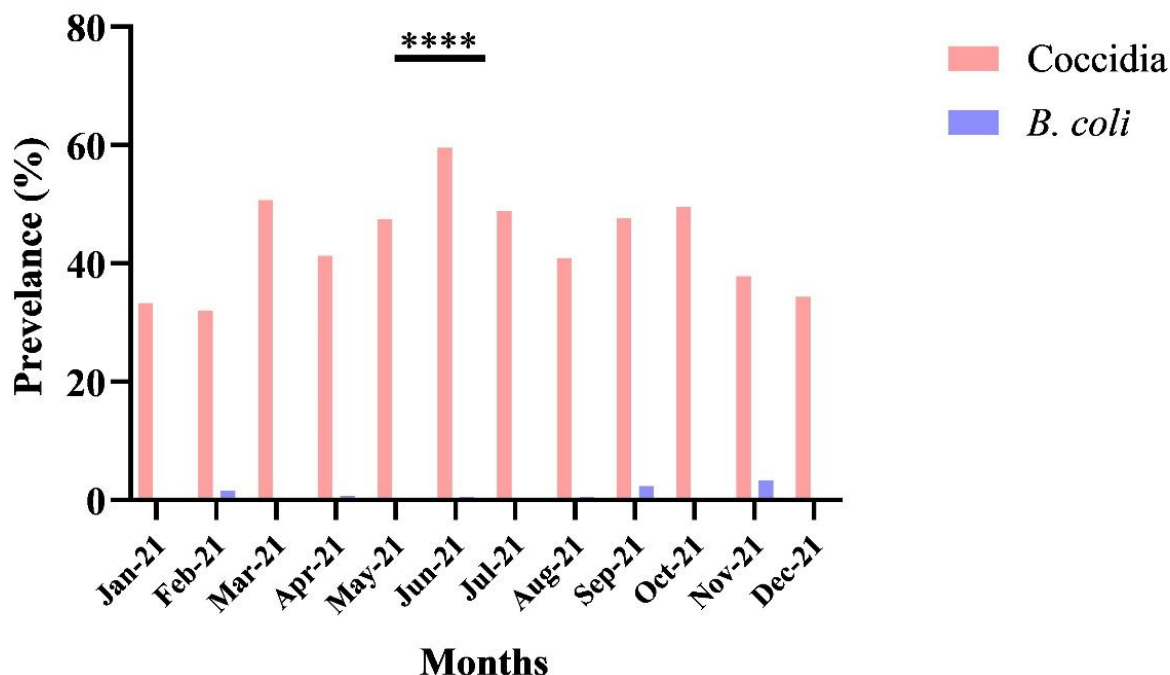


FIG 8: PREVALENCE (%) OF PROTOZOAN PARASITES ON THE BASIS OF MONTHS OF YEAR

DISCUSSION

Protozoan parasitism encompasses a wide range of parasites (Schuster & Ramirez-Avila, 2008). The primary cause of coccidiosis in ruminants is an *Eimeria* species, which results in enormous economic losses for farms and farm animals by considerably reducing milk and meat production, weakening them, and possibly even increasing fatality rates (Mohamed et al., 2022). Pigs, humans, apes, cattle, camels, sheep, goats, horses, and, infrequently, cats and dogs are among the host animals that *B. coli* parasitizes in the intestine (Ahmed et al., 2020). Stressed animals and those living in heavily crowded regions are more susceptible to get the disease (Bowen, 2013). Small ruminants are typically grown with large ruminants in Pakistan, close to the human population. As a result, an unsanitary atmosphere can quickly lead to disease epidemics (Samad, 2011). Our study showed that buffaloes (47.55%) are more prevalent to these parasites as compared to cattle (41.83%), sheep (36.67%) and goat (28%). *Balantidium coli* is barely included among infectious protozoan diseases. It is a cosmopolitan parasitic-opportunistic pathogen (Schuster & Ramirez-Avila, 2008). During the rainy season, the percentage of *B. coli* increases. However, stress and inadequate management have a significant influence in the high frequency of *B. coli* (Biswas et al., 2020). The prevalence of *B. coli* in buffaloes and in cattle was shown to be lower in our study and none of the infected small ruminants i.e., sheep and goats were observed. It might be due to the small sample size, geographical location of study area and climatic conditions. However, an unsanitary environment and grazing by small ruminants, large ruminants, and humans may be the source of *B. coli* infection (Jamil et al., 2015).

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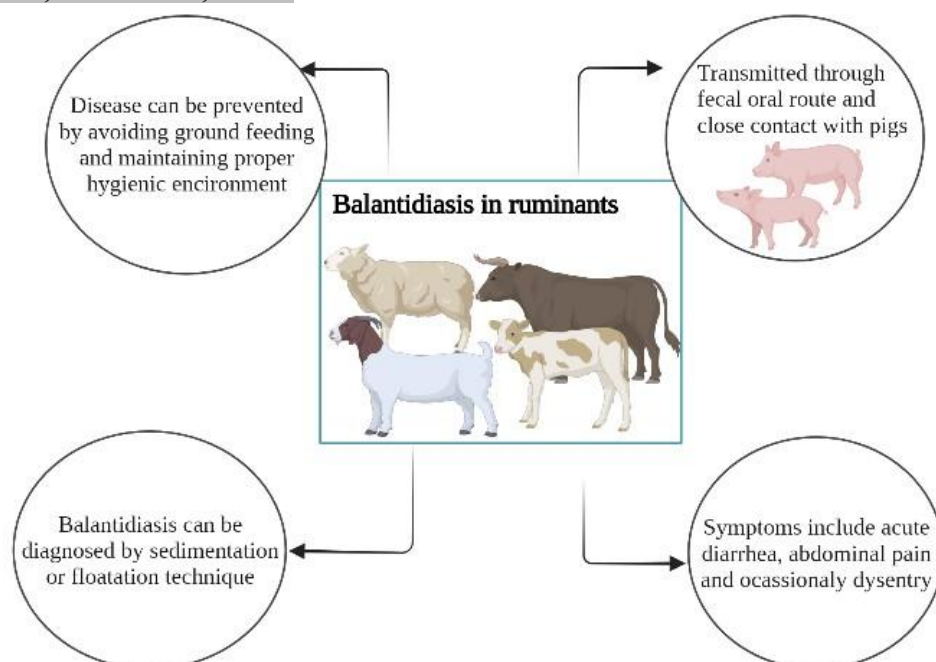


FIG 9: BALANTIDIASIS: AN OVERVIEW

Coccidia was more common in Noorkot with a rate of 51.06% and higher number of cases were observed in June, March, and October, whereas *B. coli* was more common in the Plot region with a rate of 2.85% and more cases were examined in November. Coccidia cases (44.8%) were more frequent than *B.coli* cases (0.84%). The disease, Coccidiosis, which is caused by intracellular protozoan "coccidia" that dwell in intestinal cell linings and specifically targets calves, causing enormous economic losses to the global cattle and dairy sectors (Dauguschies & Najdrowski, 2005; Dedrickson, 2000). The fecal-oral pathway has the potential to transmit oocysts in the environment. Cattle can get infected if they eat polluted feed, water, or pasture. Fever, anorexia, stomach pain, dehydration, weakness, and even death may occur in calves infected with *Eimeria* (Li et al., 2021). Coccidia pathogenicity is mostly influenced by host genetics and age, nutritional state, associated illnesses, and coccidia species. Prevalence was higher in animals that fed on the ground. The disparity may be due to the fact that in non-cemented floor types, urine collects in the floor and raises the temperature, creating a warm and wet environment suitable for sporulation of the Oocysts. Furthermore, a higher incidence of coccidiosis in non-cemented (mud/mud-brick) type of floor may be connected with better chances of coccidian oocysts to survive in cracks and crevices of mud (Lawrence, 2011). Poor sanitation, grazing in unsanitary places, and animals in poor bodily condition may all contribute to the higher occurrence of coccidiosis.

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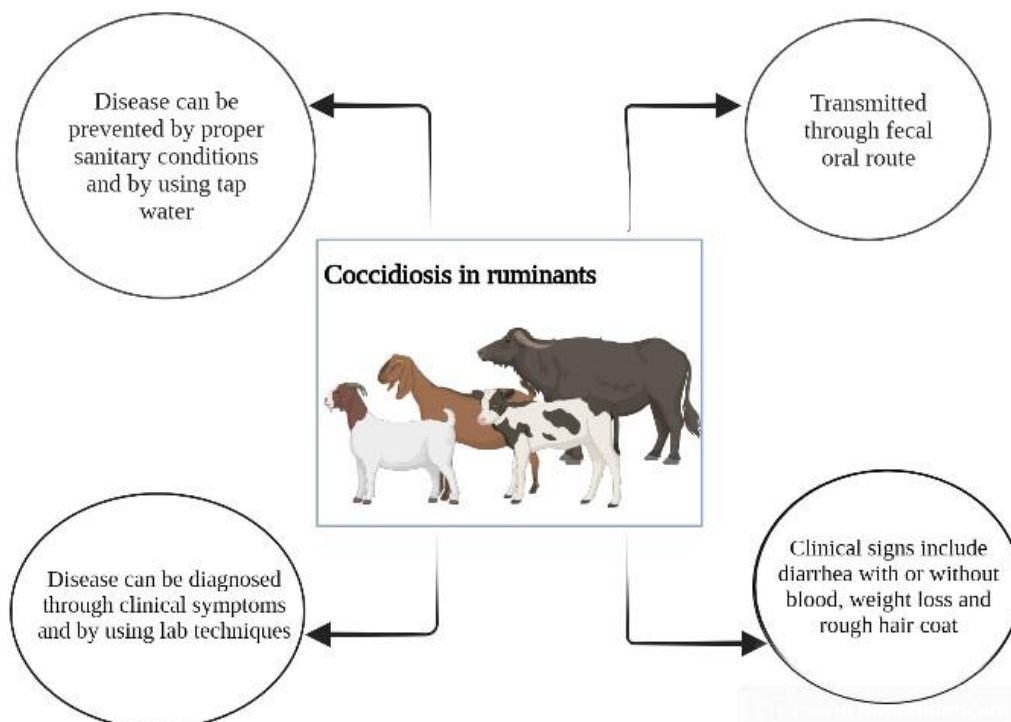


FIG 10: COCCIDIOSIS: AN OVERVIEW

In comparison to Jahanzaib et al., (2017) study, our study showed a prevalence of 46.5% and 41.2% in buffaloes and cattle respectively which was almost similar to the results reported by many researchers. In gender-based study, we found that males had much greater rates of coccidiosis than females, which was contradictory to research findings from the Ravi River region of Lahore (Jahanzaib et al., 2017).

CONCLUSION AND FUTURE DIRECTION

This research was carried out to demonstrate the frequency of protozoan parasites in bovine feces in the District Narowal. Using the spontaneous sedimentation approach, two protozoan parasites, *Coccidia* and *B. coli*, were isolated. In which the frequency of coccidia was found to be much higher than that of *B.coli*. Poor sanitation, unclean water, and unhealthy animals may all be contributing factors to the proliferation of these protozoan parasites. However, it is a disease that will exist as long as there are pigs, and in Pakistan, the tradition of pigs is not prevalent. Its spread can be restricted by sanitary measures and personal hygiene. The best tools for fighting infection are good hygiene and clean water. By keeping an eye on the various contributing causes, disposing of waste water and animal waste effectively, and providing adequate infrastructure for water delivery, these parasites can be prevented from spreading. In order to learn more about the many characteristics of organisms that make them susceptible to these contagious parasites, it is necessary to examine the prevalence of parasitic protozoans at various levels in ruminants of different parts of Pakistan. By doing that, we can identify appropriate strategies for controlling these parasitic protozoans.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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REFERENCES

- Ahmed, A., Ijaz, M., Ayyub, R. M., Ghaffar, A., Ghauri, H. N., Aziz, M. U., Ali, S., Altaf, M., Awais, M., & Naveed, M. (2020). Balantidium coli in domestic animals: An emerging protozoan pathogen of zoonotic significance. *Acta tropica*, 203, 105298.
- Alcala-Canto, Y., Figueroa-Castillo, J. A., Ibarra-Velarde, F., Vera-Montenegro, Y., Cervantes-Valencia, M. E., & Alberti-Navarro, A. (2020). First database of the spatial distribution of Eimeria species of cattle, sheep and goats in Mexico. *Parasitology research*, 119(3), 1057-1074.
- Bangoura, B., & Bardsley, K. D. (2020). Ruminant coccidiosis. *Veterinary Clinics: Food Animal Practice*, 36(1), 187-203.
- Biswas, A., Alam, K., Riad, M., Hanif, S., & Ahmed, M. (2020). Prevalence and associated factors of balantidiasis in buffaloes of Bhola district, Bangladesh. *Bangladesh Journal of Veterinary Medicine (BJVM)*, 18(1), 19-24.
- Bowen, J. S. (2013). Common health challenges for small-scale sheep and goat herds. American Association of Bovine Practitioners Proceedings of the Annual Conference,
- Chalmers, R. M. (2014). Balantidium coli. *Microbiology of Waterborne Diseases*, 135, 277-286.
- Dauguschies, A., & Najdrowski, M. (2005). Eimeriosis in cattle: current understanding. *Journal of Veterinary Medicine, Series B*, 52(10), 417-427.
- Dedrickson, B. J. (2000). Coccidiosis in beef calves. *Alpharma Animal Health Division Fort Lee, NJ*, 7024.
- Dubey, J. (2018). A review of coccidiosis in water buffaloes (Bubalus bubalis). *Veterinary parasitology*, 256, 50-57.
- Gardiner, C. H., Fayer, R., & Dubey, J. (1998). *An atlas of protozoan parasites in animal tissues*. Amer Registry of Pathology.
- Ishaq, M., & ul Haq, Z. (2007). Small Ruminants Farming in Pakistan. *Annals of Arid Zone*, 46(3 & 4).
- Jahanzaib, M., Avais, M., Khan, M., Atif, F., Ahmad, N., Ashraf, K., & Zafar, M. (2017). Prevalence and risk factors of coccidiosis in buffaloes and cattle from Ravi River region, Lahore, Pakistan. *Buffalo Bulletin*, 36(2), 427-438.
- Jamil, M., Ijaz, M., & Ali, M. M. (2015). Prevalence, hematology and treatment of Balantidium coli among small ruminants in and around Lahore, Pakistan. *Kafkas Univ Vet Fak Derg*, 21(1), 123-126.
- Kaltungo, B., & Musa, I. (2013). A review of some protozoan parasites causing infertility in farm animals. *International Scholarly Research Notices*, 2013, 1-6.
- Khan, Z. U. (2021). The Legal Structure and Role of Livestock in Pakistan's Economy. *Pakistan Vision*, 22(2), 60-64.
- Lawrence, S. (2011). The prevalence of coccidiosis of chicken in kalisizo town council. *Rakai District, Uganda*, 58, 689-691.

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- Li, D.-L., Gong, Q.-L., Ge, G.-Y., Wang, Q., Sheng, C.-Y., Ma, B.-Y., Chen, Z.-Y., Yang, Y., Li, J.-M., & Shi, K. (2021). Prevalence and infection risk factors of bovine *Eimeria* in China: a systematic review and meta-analysis. *Parasite*, 28(61), 1-13.
- Mohamed, H. I., Arafa, W. M., & El-Dakhly, K. M. (2022). Ovine coccidiosis and associated risk factors in Minya, Egypt. *Beni-Suef University Journal of Basic and Applied Sciences*, 11(1), 1-11.
- Nalbone, L., Giarratana, F., & Napoli, E. (2021). Balantidiasis: A Neglected Tropical Disease Used as a Study Model for a Holistic Approach to Sustainable Development in the Framework of Agenda 2030 Goals. *Sustainability*, 13(22), 12799.
- Oglesbee, B. L., & Jenkins, J. R. (2012). Gastrointestinal diseases. *Ferrets, rabbits, and rodents*, 193-204.
- Ponce-Gordo, F., & García-Rodríguez, J. J. (2021). *Balantioides coli*. *Research in Veterinary Science*, 135, 424-431.
- Samad, M. (2011). Public health threat caused by zoonotic diseases in Bangladesh. *Bangladesh Journal of Veterinary Medicine*, 9(2), 95-120.
- Schuster, F. L., & Ramirez-Avila, L. (2008). Current world status of *Balantidium coli*. *Clinical microbiology reviews*, 21(4), 626-638.
- Squire, S., Robertson, I., Yang, R., Ayi, I., & Ryan, U. (2019). Prevalence and risk factors associated with gastrointestinal parasites in ruminant livestock in the Coastal Savannah zone of Ghana. *Acta tropica*, 199, 105126.
- Taylor, M. (2000). Protozoal disease in cattle and sheep. *In Practice*, 22(10), 604-617.
- Vandendoren, M., O'Toole, D., Gigley, J., Zhang, R., & Bangoura, B. (2022). Establishment of a cell culture-qPCR system to quantify early developmental stages of *Eimeria zuernii*. *Veterinary parasitology*, 301, 109621.
- Zereen, A., Ahmad, S. S., & Jahan, A. (2018). Determination of correlation between plant distribution and ecological factors in Narowal district Punjab, Pakistan. *Bangladesh Journal of Botany*, 47(3), 451-458.