

Research article

Prevalence of gastrointestinal parasitic infections in cattle and buffalo of Sandwip Island, Chattogram, Bangladesh

Mohammad Abdullah Al Mamun¹, Mohammad Amir Hossen², Mrinmoy Bhowmik¹, Tanvir Ahmad Nizami³, Farazi Muhammad Yasir Hasib¹, Tanjila Hasan⁴, Mohammad Alamgir Hossain¹, Mohammad Abdul Alim^{1*}

¹Department of Pathology and Parasitology, Faculty of Veterinary Medicine, Chattogram Veterinary and Animal Sciences University, Khulshi, Chattogram-4225, Bangladesh

²Veterinary Surgeon, Department of Livestock Services, Sandwip, Chattogram, Bangladesh

³Department of Microbiology and Veterinary Public Health, Faculty of Veterinary Medicine, Chattogram Veterinary and Animal Sciences University, Khulshi, Chattogram-4225, Bangladesh

⁴Department of Medicine and Surgery, Faculty of Veterinary Medicine, Chattogram Veterinary and Animal Sciences University, Khulshi, Chattogram-4225, Bangladesh

ARTICLE INFO

ABSTRACT

Article history:

Received: 21/08/2020

Accepted: 30/12/2020

Keywords:

Buffalo, cattle, gastrointestinal parasitic infections, prevalence

**Corresponding author:*

Cell: +8801712288554

Email:

mdabdul.alim@my.jcu.edu.au

Gastrointestinal (GI) parasitic infections hinder the growth and productivity of large ruminants such as cattle and buffalo. The current study was conducted to investigate the prevalence of GI parasitic infection in cattle and buffalo with its associated risk factors in Sandwip Island under Chattogram of Bangladesh. A total of 440 faecal samples were collected randomly from cattle and buffalo. The routine coproscopy were carried out to identify the eggs/oocysts of GI parasites (helminths and protozoa). Results revealed that the overall prevalence of GI parasitic infections was 50.91% in both cattle and buffalo. The occurrence of GI trematodes and nematodes was the highest compared to cestodes and protozoan infections in both animal types. Adult buffalo had significantly higher GI parasitic infections compared to young, whereas an opposite trend was noticed in cattle. Female buffalo were more prone to suffer from GI parasitic infections than male. As expected, animals with 'poor' body condition score (BCS) were more susceptible to GI parasites compared to other groups. The present investigation has documented the GI parasitic infections in cattle and buffalo in the study sites for the first time which will help the veterinarians and farmers to take preventive and therapeutic measures. Further extensive studies are required to understand the actual epidemiology of those parasitic infections.

To cite this paper: M. A. A. Mamun, M. A. Hossen, M. Bhowmik, T. A. Nizami, F. M. Y. Hasib, T. Hasan, M. A. Hossain and M. A. Alim, 2020. Prevalence of gastrointestinal parasitic infections in cattle and buffalo of Sandwip Island, Chattogram, Bangladesh. *Bangladesh Journal of Veterinary and Animal Sciences*, 8(2): 84-90.

1. INTRODUCTION

Bangladesh is predominantly an agriculture-based developing country. The livestock sector is an important sub-sector of agriculture and contributes significantly to the national economy. According to the recent statistics, this sub-sector contributes 1.43% of national GDP and provides 20% employment for the total population of the country (BBS, 2020, MOFL, 2019). Large ruminants like cattle and buffalo comprise an

important component of the livestock sector. The growth, development and productivity of these animals are adversely affected by many diseases including gastrointestinal (GI) parasitic infections (Thapa et al., 2020). Acute cases of GI parasitic infections may cause the death of the animals while chronic cases lead to loss of appetite, diarrhoea, weight loss, anaemia, abortion, infertility, bottle jaw including reduced disease resistance and higher mortality (Radostits et al., 1994). GI parasitic infections also

contributes economically by adding an extra cost associated with their treatment, control and preventive measures (Silvestre et al., 2000). Various risk factors such as host species, age, sex, body condition, breed of the animals, parasite species and intensity of the worm population play an important role in the pathology of GI parasitic infections in animals (Tariq et al., 2010; Badran et al., 2012). All this information is therefore crucial for their effective control and prevention in an endemic area.

Sandwip Island is a sub-district (upazila) under Chattogram district of Bangladesh. The total area of this island is 762.42 square kilometres (km) with an around 100 km of the coastal belt which is characterized by low and salty lands (BBS, 2013). A significant proportion of the total population of this tiny island depends on the rearing of cattle and buffalo for their livelihood irrespective of other professions (BBS, 2013). The agro-ecological conditions of this island favour the rearing of livestock including cattle and buffalo. In this area, the buffalos are reared mostly on the 'Bathan (a free-range grazing area where animals are housed and maintained) alongside the coastal belt, whereas cattle are mostly kept on the household. The nature of the topography of this island may favour a higher incidence of GI parasitic infections in animals (Bhowmik et al., 2020; Hossain et al., 2019). There is limited epidemiological information available about the range of parasitic infections in this island. A proper understanding of the epidemiology of parasitic diseases is a prerequisite for taking the appropriate preventive and therapeutic measures (Rajajaran et al., 2017). Therefore, the present study was designed to investigate the epidemiology of GI parasitic infections in cattle and buffalo in some selected parts of Sandwip Island.

2. MATERIALS AND METHODS

Study periods and areas

The current research was conducted for June – August 2019 in three different coastal areas of Sandwip Island (Latitude: 22°22' N - 22°34' N, Longitude: 91°26' E), Bangladesh. The island is a sub-district (upazila) of Chattogram which is located along the southeastern coast of Bangladesh. The study areas were namely Santoshpur, Magdhara and Rahmatpur (Figure 1). All the sites represent the low-lands with salty coastal areas.

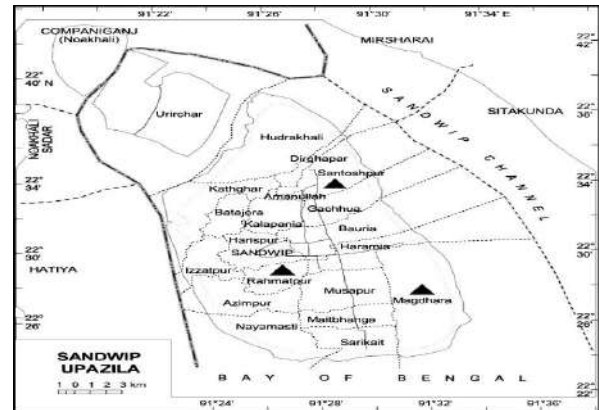


Figure 1. Map of Sandwip Island, Chattogram, Bangladesh. '▲' marked indicates study location.

Study design and sample collection strategies

A cross-sectional study was designed for this investigation. Faecal samples were collected through the random sample collection technique. A predefined questionnaire was used to collect all the demographic information (e.g., owner's name, address, species, age, gender of animals). A standard dentition method was followed to determine the age of animals and categorized them as 'calf' (≤ 1 year), 'young' ($>1 - \leq 3.5$ years) and 'adult' (>3.5 years) (Banerjee, 1964). The health status of the animals was determined based on the standard body condition score (BCS) and categorized them as 'poor' (BCS 1- ≤ 2), 'moderate' (BCS $>2 - \leq 3$) and 'good' (BCS >3) health (Klopèè et al., 2011; Anitha et al., 2010). Cattle and buffalo (indigenous/non-descriptive) were considered as sampling units. Cattle samples were collected from household and the buffalo samples were collected from 'bathan'.

Sample collection, preservation and examination

A total of 440 faecal samples were collected from cattle (N=220) and buffalo (N=220). Standard protocols were followed for the sample collection from animals and their appropriate preservation (Hendrix and Robinson, 2006). Approximately 5-10 g of individual faecal sample was collected from freshly voided/directly from the rectum of each animal. Each sample was then kept in a plastic specimen container and preserved with 10% formalin. All the samples kept in a refrigerator (at 4°C) until further analyses. The routine tests that is 'direct' smear, 'test tube flotation' and 'simple sedimentation' techniques were performed

following standard procedures to identify the morphological features of eggs/oocysts of helminths and protozoan parasites (Hendrix and Robinson, 2006). Duplicate smears were performed for each sample. A 'positive' sample means when minimum one egg/oocyst was detected in that smear tested. However, the species of the parasites were identified up to the genus level based on eggs/oocyst identified. The 'Strongyle-type' eggs indicated in case of parasites' genera (e.g., *Haemonchus*, *Ostertagia*, *Trichostrongylus*, *Nematodirus*) belongs to the superfamily 'Trichostrongyloidea' (Urquhart et al., 1996).

Statistical analysis

The raw data were stored and coded accordingly using the Microsoft Excel-2016™. Chi-square test was carried out to find out the significant variation among the variables using the STATA™ 15.1 (Stata Corporation College Station, Texas). The GraphPad Prism 7.03 software was used to prepare the graphs. The level of

significance was indicated as * $P \leq 0.05$ and ** $P \leq 0.01$.

3. RESULTS

Overall prevalence of gastrointestinal parasitic infections

The overall prevalence of GI parasitic infections was recorded as 50.91% (cattle, 50.45 vs buffalo, 51.36, %, $P = 0.849$). The occurrence of *Fasciola* spp. and *Eimeria* spp. was higher in cattle compared to buffalo. The frequency of *Paramphistomum* spp. and *Toxocara* spp. was higher in buffalo (Table 1). Notably, the frequency of infections caused by trematodes (cattle, 48.64 vs buffalo, 40.91, %, $P = 0.103$) was higher compared to nematodes (cattle, 4.55 vs buffalo, 7.73, %, $P = 0.164$), protozoan parasites (cattle, 6.36 vs buffalo, 4.09, %, $P = 0.254$) and cestodes (cattle, 0.45 vs buffalo, 0.91, %, $P = 0.562$).

Table 1. Prevalence of gastrointestinal parasitic infections in cattle and buffalo.

Parasites	Cattle (N=220)		Buffalo (N=220)	
	Prevalence (%)	95% CI	Prevalence (%)	95% CI
<i>Fasciola</i> spp.	36.36	30.3 - 42.9	11.36	7.8 - 16.2
<i>Paramphistomum</i> spp.	21.36	16.5 - 27.2	30.91	25.2 - 37.3
<i>Moniezia</i> spp.	0.45	0.1 - 2.5	0.91	0.3 - 3.3
Strongyles-type	3.18	1.6 - 6.4	3.18	1.6 - 6.4
<i>Strongyloides</i> spp.	0.91	0.3 - 3.3	0.91	0.3 - 3.3
<i>Trichuris</i> spp.	0.91	0.3 - 3.3	0.91	0.2 - 3.3
<i>Toxocara</i> spp.	0.00	0.00 - 1.7	4.09	2.2 - 7.6
<i>Eimeria</i> spp.	6.36	3.8 - 10.4	4.09	2.2 - 7.6
Overall	49.32	42.1 - 55.2	50.00	43.5 - 56.6

N= total no. of animal; CI= Confidence interval

Area-wise prevalence of gastrointestinal parasitic infections

When different locations of infections were considered, the overall prevalence was significantly higher in Rahmatpur (55.63%) compared to Magdhara (53.63%) and Santoshpur (41.18%) (Figure 2). In cattle, a higher frequency was observed in Magdhara (55.56%) followed by Rahmatpur (51.61%) and Santoshpur (40.68%) ($P = 0.190$). In the case of buffalo, the prevalence was higher in Rahmatpur (58.75%) followed by Magdhara (51.25%) and Santoshpur (41.67%) ($P = 0.135$). In both species, trematode infections were highly prevalent in all the three areas, but the highest was recorded in Rahmatpur (Figure 2). The frequency of nematode infections was the

highest at the animals of Santoshpur compared to the other two areas. A low level of protozoal infection existed in the animals of all the study locations (Figure 2).

Age-specific prevalence of gastrointestinal parasitic infections

The age-specific prevalence of GI parasitic infections was higher in adult (56.21%) followed by young (48.55%) and calf (46.62%) in case of both cattle and buffalo. However, it was statistically insignificant (Table 2). In cattle, the prevalence was higher in younger animals (53.57%) compared to calf (48.75%) and adult (48.21%) (Table 2). In buffalo, the frequency of GI parasitic infections

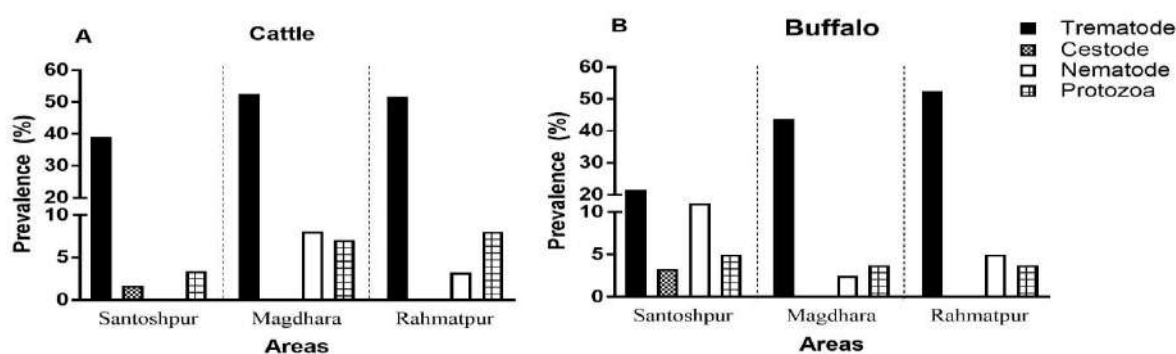


Figure 2. Area-wise prevalence of gastrointestinal parasitic infections in cattle and buffalo.

Table 2. Age-specific prevalence of gastrointestinal parasitic infections.

Parasites	Cattle (N=220)			P-value	Buffalo (N=220)			P-value
	Calf % (n=80)	Young % (n=44)	Adult % (n=27)		Calf % (n=53)	Young % (n=54)	Adult % (n=113)	
<i>Fasciola</i> spp.	35.00	33.33	42.86	0.492	5.66	9.26	15.04	0.177
<i>Paramphistomum</i> spp.	22.50	22.62	17.86	0.693	18.87	24.07	39.82	0.011*
<i>Moniezia</i> spp.	0.00	1.19	0.00	0.443	1.85	1.85	0.00	0.344
Strongyles-type	6.25	1.19	1.79	0.144	7.55	0.00	2.65	0.076
<i>Strongyloides</i> spp.	2.50	0.00	0.00	0.171	1.89	0.00	0.88	0.589
<i>Trichuris</i> spp.	0.00	2.38	0.00	0.195	1.89	1.85	0.00	0.344
<i>Toxocara</i> spp.	-	-	-	-	1.89	9.26	2.65	0.085
<i>Eimeria</i> spp.	10.00	4.76	3.57	0.238	9.43	3.70	1.77	0.066
Total	48.75	53.57	48.21	0.766	43.40	40.74	60.18	0.026*

N= total no. of animal; n=category-wise no. of animals; Level of significance *P<0.05

was significantly higher in adult (60.18%) followed by calf (43.40%) and young (40.74%) (Table 2). Among different parasite species, *Fasciola* spp. was more in adults compared to younger animals. Among protozoan parasites, the infection caused by *Eimeria* spp. was more prevalent in calf compare to young and adult of both animal groups (Table 2).

Sex-specific prevalence of gastrointestinal parasitic infections

The analyses revealed that male cattle were more vulnerable than female (58.62%) (Table 3). In buffalo, an opposite trend was observed (female, 52.87 vs male, 47.62%, P= 0.481). However, compared to male buffaloes, female animals were more susceptible to most of the GI parasites recorded except *Fasciola* spp. In contrast, *Fasciola* spp., Strongyle-type parasites, *Strongyloides* spp.

and *Eimeria* spp. infections were comparatively higher in male cattle in comparison to female (Table 3).

Health status related prevalence of gastrointestinal parasitic infections

The cattle and buffalo with 'poor' body conditional score (BCS)/nutritional status were more prone to suffer from GI parasitic infections compared to animals with 'moderate' and 'good' health status. The overall prevalence of GI parasitic infections was significantly higher in buffalo having 'poor' (60.34%) health condition in comparison to 'moderate' (42.11%) and 'good' (33.33%) (Table 4). A similar trend was also recorded in cattle but was not statistically significant. Both cattle and buffalo with 'poor' health conditions had a significantly higher percentage of *Paramphistomum* spp. infection compared to other health conditions.

Table 3. Sex specific prevalence of gastrointestinal parasitic infections.

Parasites	Cattle (N=220)			Buffalo (N=220)		
	Female % (n=133)	Male % (n=87)	P-value	Female % (n=157)	Male % (n=63)	P-value
<i>Fasciola</i> spp.	33.08	41.38	0.211	10.83	12.70	0.693
<i>Paramphistomum</i> spp.	21.05	21.84	0.889	34.39	22.22	0.077
<i>Moniezia</i> spp.	0.75	0.00	0.418	1.27	0.00	0.368
Strongyles-type	2.26	4.60	0.333	3.82	1.59	0.393
<i>Strongyloides</i> spp.	0.75	1.15	0.761	1.27	0.00	0.368
<i>Trichuris</i> spp.	1.50	0.00	0.251	1.27	0.00	0.368
<i>Toxocara</i> spp.	-	-	-	2.55	7.94	0.068
<i>Eimeria</i> spp.	4.51	9.20	0.164	3.82	4.76	0.750
Total	45.11	58.62	0.050*	52.87	47.62	0.481

N= total no. of animal; n=category-wise no. of animals; level of significance *P<0.05

Table 4. Health status related prevalence of gastrointestinal parasitic infections.

Parasites	Cattle (N=220)			P-value	Buffalo (N=220)			P-value
	Poor (n=98) %	Moderate (n=105) %	Good (n=17) %		Poor (n=116) %	Moderate (n=95) %	Good (n=9) %	
<i>Fasciola</i> spp.	38.78	36.19	23.53	0.482	14.66	8.42	0.00	0.200
<i>Paramphistomum</i> spp.	28.57	18.10	0.00	0.016*	41.38	18.95	22.00	0.002**
<i>Moniezia</i> spp.	0.00	0.00	5.88	0.002**	0.86	1.05	0.00	0.948
Strongyles-type	3.06	3.81	0.00	0.706	1.72	5.26	0.00	0.296
<i>Strongyloides</i> spp.	1.02	0.95	0.00	0.918	0.86	1.05	0.00	0.948
<i>Trichuris</i> spp.	2.04	0.00	0.00	0.285	1.72	0.00	0.00	0.405
<i>Toxocara</i> spp.	-	-	-	-	6.03	2.11	0.00	0.293
<i>Eimeria</i> spp.	6.12	6.67	5.88	0.984	1.72	6.32	11.11	0.136
Total	55.10	49.52	19.41	0.143	60.34	42.11	33.33	0.017*

N= total no. of animal; n=category-wise no. of animals; level of significance *P<0.05 and **P<0.01

4. DISCUSSION

Gastrointestinal (GI) parasitic infection is one of the common problems in cattle and buffalo production impairing their growth and productivity. The current investigation has demonstrated the overall prevalence of GI parasitic infections in cattle and buffalo along with its associated risk factors in three coastal areas of Sandwip Island. The overall prevalence of GI parasites in cattle and buffalo was 50.91%. This finding was in agreement with the prevalence data (47-54%) recorded in large ruminants in Bangladesh and Pakistan (Nath et al., 2013; Raza et al., 2007). However, the prevalence of GI parasites in large ruminants reported in this study was different from other reports indicating 68-73% (Marskole et al., 2016; Gupta et al., 2012). These differences might be due to the variation in sampling strategies and sample size, season, diet, stocking density, geo-climatic conditions, grazing and housing, deworming and overall husbandry practices (Gunathilaka et al., 2018; Marskole et al., 2016). However, the overall frequency of GI

parasitic infections in this study demonstrated no significant difference between cattle and buffalo. This could be due to the sharing of same pasture lands which gave all animal species to be infected with certain parasites (Gupta et al., 2012). The various species of GI parasites reported in this study were also reported in cattle and buffalo at different places of Bangladesh (Ahmed et al., 2015; Biswas et al., 2014; Alim et al., 2012). This variation in the occurrence of such parasites' species might be due to different geographical locations, climate, moisture and humidity and availability of vectors favouring the development of many parasites. The study further revealed a significantly higher occurrence of trematodes infections in both cattle and buffalo compare to nematodes, cestodes and protozoan infections. Similar findings were reported by prior research (Ahmed et al., 2015; Rafiullah et al., 2011). The availability of the intermediate hosts (e.g., snails) could be a possible reason for the higher occurrence of trematodes in the study areas. Although this investigation did not determine

any available vectors in the study sites, this limitation might be overcome by future studies. In this investigation, we observed young cattle were more susceptible to GI parasites compared to calf and adult. Higher prevalence of GI parasites in young cattle was supported by the findings of Raza et al. (2007) and Regassa et al. (2006). However, some researchers also recorded higher occurrence of GI parasites in adult cattle and buffalo (Samaddar et al., 2015; Islam et al., 2014; Biswas et al., 2014) compared to other age groups which further supported the findings of this study. The variation in the occurrence of parasites in different age groups might be due to age-specific immune status and age specificity of the parasites. However, we did not determine the degree of infection to comment on the severity of the infection in these age groups. Future studies could address this drawback. Gender has an influence on the occurrence of GI parasitic infections. We have observed a higher prevalence of GI parasites in female buffalo compared to male although the trend was opposite in cattle. Higher occurrence of gut parasites in male animals was also reported by prior research (Marskole et al., 2016; Samaddar et al., 2015). The higher occurrence of GI parasites in female animals was in agreement with previous research (Biswas et al., 2014) who also recorded a higher frequency in female animals. Immunosuppression induced by hormones (e.g., progesterone, prolactin and other lactating hormones) in female animals during pregnancy and lactation may enable them to be infected with such parasitic infections. Moreover, we did not consider the ‘pregnancy’ and ‘lactation’ status of the animals that could answer the questions. Further, we have observed that no animals including pregnant and lactating animals were supplied additional supplement rather than solely grazing on the fields. This nutritional deficiency may make the female animals more vulnerable to many parasitic infections. In the current study, we have further showed that the occurrence of GI parasites was more in animals with ‘poor’ health’ conditions like other researchers. The ill-health animals might have low immunity to resist parasitic infections.

5. CONCLUSIONS

The current study demonstrated the prevalence of GI parasitic infections in cattle and buffalo where

trematodes and protozoan infections were predominant. Adult buffalo and young cattle were more prone to GI parasitic infections. The ‘poor’ body condition/nutritional status’ of cattle and buffalo was a substantial risk factor for the occurrence of GI parasitic infections. However, the study was conducted for a short period and did not consider the seasonal variation of GI parasites. These limitations could be addressed by future studies.

REFERENCES

- Ahmed, R., Biswas, P. K., Barua, M., Alim, M. A., Islam, K. and Islam, M. Z. 2015. Prevalence of gastrointestinal parasitism of cattle in Banskhal upazila, Chittagong, Bangladesh. *J. Adv. Vet. Anim. Res.* 2, 484–488.
- Alim, M. A., Das, S., Roy, K., Sikder, S., Mohiuddin, Masuduzzaman, M. and Hossain, M. A. 2012. Prevalence of gastrointestinal parasitism in cattle of Chittagong division, Bangladesh. *Wayamba J. Anim. Sci.* 4, 1–8.
- Anitha, A., Sarjan, R. K., Suresh, J., Srinivasa, M. P. R. and Kotilinga, R. Y. 2010. Development of the body condition score system in Murrah buffaloes: validation through ultrasonic assessment of body fat reserves. *J. Vet. Sci.* 11, 1–8.
- Badran, I., Abuamsha, R., Aref, R., Alqisi, W. and Alumor, J. 2012. Prevalence and diversity of gastrointestinal parasites in small ruminants under two different rearing systems in Jenin district of Palestine. *An-Najah Univ. J. Res.* 26, 1–18.
- Banerjee, G. C., 1964. *A Textbook of Animal Husbandry*, 8th ed. Oxford and IBH Publishing CO. PVT. LTD., New Delhi.
- BBS. 2020. *Bangladesh Economic Review 2020*. Finance Division, Ministry of Finance Government of the People’s Republic of Bangladesh.
- BBS. 2013. *District Statistics 2011 Chittagong*. Bangladesh Bureau of Statistics, Statistics & Informatics Division, Ministry of Planning, Government of The People’s Republic of Bangladesh.
- Bhowmik, M., Hossen, M. A., Mamun, M. A. A., Hasib, F. M. Y., Poddar, S. and Alim, M. A. 2020. Prevalence of gastrointestinal parasitic infections in sheep and goats of Sandwip Island, Chattogram, Bangladesh. *Van Vet. J.* 31, 152–157.
- Biswas, H., Dey, A. R., Begum, N. and Das, P. M. 2014. Epidemiological aspects of gastro-

- intestinal parasites in buffalo in Bhola, Bangladesh. *Indian J. Anim. Sci.* 84, 245–250.
- Gunathilaka, N., Niroshana, D., Amarasinghe, D. and Udayanga, L. 2018. Prevalence of gastrointestinal parasitic infections and assessment of deworming program among cattle and buffaloes in Gampaha district, Sri Lanka. *Bio. Med Res. Int.* 2018, 1–10.
- Gupta, A., Dixit, A. K., Dixit, P. and Mahajan, C. 2012. Prevalence of gastrointestinal parasites in cattle and buffaloes in and around Jabalpur, Madhya Pradesh. *J. Vet. Parasitol.* 26, 186–188.
- Hendrix, C. M. and Robinson, E. 2006. *Diagnostic Parasitology for Veterinary Technicians*. 3rd ed. Mosby Inc. and affiliated of Elsevier Inc.
- Hossain, M. M., Hasib, F. M. Y., Bayzid, M., Hassan, M. M., Hossain, M. A. and Alim, M. A. 2019. Prevalence of gastrointestinal parasitic infections in sheep of coastal belt under Noakhali district, Bangladesh. *Bangladesh J. Vet. Anim. Sci.* 7, 32–37.
- Klopèiè, M., Hamoen, A. and Bewley, J. 2011. *Body Condition Scoring of Dairy Cows*. University of Ljubljana, Biotechnical Faculty, Department of Animal Science, Groblje 3, 1230 Domžale.
- Marskole, P., Verma, Y., Dixit, A. K. and Swamy, M. 2016. Prevalence and burden of gastrointestinal parasites in cattle and buffaloes in Jabalpur, India. *Vet. World* 9, 1214–1217.
- MOFL. 2019. Annual Report 2018-2019. Ministry of Fisheries and Livestock (MOFL), Government of the People's Republic of Bangladesh.
- Nath, T. C., Bhuiyan, M. J. U. and Alam, M. S. 2013. Prevalence of gastro-intestinal parasites of calves in Mirsarai upazila of Chittagong district of Bangladesh. *Bangladesh J. Anim. Sci.* 42, 139–142.
- Radostits, O. M., Blood, D. C. and Gay, C. C. 1994. *Veterinary Medicine: A textbook of disease of cattle, sheep, pigs, goats and horse*, 8th ed. Baillere Tindall Publication, London.
- Rafiullah, Turi, A. A., Sajid, A., Shah, S. R., Ahmad, S. and Shahid, M. 2011. Prevalence of gastrointestinal tract parasites in cattle of Khyber Pakhtunkhwa. *J. Agric. Biol. Sci.* 6, 9–15.
- Rajarajan, S., Palanivel, K. M., Geetha, M. and Rani, N. 2017. Epidemiology of gastrointestinal parasitism in small Ruminants in Pudukkottai district, India. *Int. J. Curr. Microbiol. Appl. Sci.* 6, 4924–4930.
- Raza, M. A., Iqbal, Z., Jabbar, A. and Yaseen, M. 2007. Point prevalence of gastrointestinal helminthiasis in ruminants in Southern Punjab, Pakistan. *J. Helminthol.* 81, 323–328.
- Regassa, F., Sori, T., Dhuguma, R. and Kiros, Y. 2006. Epidemiology of gastrointestinal parasites of ruminants in Western Oromia, Ethiopia. *Int. J. Appl. Res. Vet. Med.* 4, 51–57.
- Samaddar, K., Haque, M. H., Ashfia, K. M., Nahar, S. F., Boby, F. and Saha, S. S. 2015. Prevalence of gastrointestinal parasitic infestation of ruminants at Rajbari, Bangladesh. *Int. J. Nat. Soc. Sci.* 2, 27–34.
- Tariq, K., Chishti, M. and Ahmad, F. 2010. Gastrointestinal nematode infections in goats relative to season, host, sex and age from the Kashmir valley. *Indian J. Helminthol* 84, 93–97.
- Thapa, S. U., Adhikari, N., Kafle, S., Shrestha, N., Banjara, M. R., Steneroden, K., Bowen, R., Rijal, K. R., Adhikari, B. and Ghimire, P. 2020. Effect of deworming on milk production in dairy cattle and buffaloes infected with gastrointestinal parasites in the Kavrepalanchowk district of central Nepal. *Vet. Rec. Open* 7, e000380.
- Urquhart, G. M., Armour, J., Duncan, J. L., Dunn, A. M. and Jennings, F. W. 1996. *Veterinary Parasitology*, 2nd ed. Blackwell Science, United Kingdom.