DOI http://dx.doi.org/10.36722/sst.v7i3.1288

Parasites Infection OF Swamp Buffalo (*Bubalus Bubalis*) In East Sumba Regency

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Abstract - **Swamp buffalo (*Bubalus bubalis*) play an important role in supporting the economy and social life of the community in the East Sumba Regency. The prevalence and intensity One of the diseases still a health problem in livestock, including buffalo, is parasite infection. Research on cases of parasite infection in buffaloes in the East Sumba Regency has not been widely reported. Therefore, this study was conducted to identify the parasites that infect the buffalo as well as to measure the prevalence and infection rates. The coprological examination of 105 samples of swamp buffalo feces from the East Sumba Regency was conducted in this study. The simple flotation and the modified McMaster method were used to identify and measure the degree of infection of Nematode, Cestode, and protozoan oocyst, while the modified Danish Bilharziasis Laboratory (DBL) method was used to detect the presence of Trematodes. The results showed that 67 out of 105 buffaloes (63.81%) had parasite infections, which were caused by a single (44.76%) and mix infection (19.05%). The prevalence of infection with Nematodes, Trematodes, and Protozoan oocysts in males (73.33%) was much higher than in female (60.00%) buffalo; nevertheless, the chi-square test results showed that sex was not associated with the prevalence of parasites infection cases ($p>0.05$). Age was a risk factor that had a significant effect ($p<0.05$), with the young age group having the highest odds ratio (OR) value (5.80), followed by the age group of the calf (3.10), and pre-weaned calf (2.98). The highest to lowest infection rates were observed in Cestodes (547.03 EPG), followed by Protozoa (220.70 PG), Nematodes (84.75 EPG), and Trematodes (2.18 EPG). The present study shows that buffalo in East Sumba Regency are infected with several parasites, so control must be made to prevent losses due to the infection.**

Keywords - *Bubalus bubalis, East Sumba, fecal examination, gastrointestinal parasites, the prevalence*

INTRODUCTION

Buffalo (*Bubalus bubalis*) is currently promoted by the Indonesian Government as alternative livestock to produce red meat. This is related to the government's efforts to increase national meat production to meet the high level of animal protein consumption in the community. This livestock also plays the role of draught animal and is a part of traditional ceremonies in Sumba Island, Indonesia. The population of buffalo in East Sumba Regency in 2018 and 2019 was 39,737 and 39,821 heads, respectively [1], [2], this data shows that the livestock sector provides a reasonably significant contribution to the economy of East Sumba Regency.

Parasite infections play an important role in the major constraints on ruminant production in Indonesia and worldwide. This condition can cause health problems and even death of the animal if not treated immediately [3–5], the Central Statistics Agency for East Sumba Regency reported a significant decline in the buffalo population in 2020. The buffalo population in 2020 was recorded at 33,659 from the previous year's population of 39,821 [2], calf mortality due to parasite infection is thought to have contributed to the decline.

Some researchers report that the mortality and morbidity rate caused by Nematode infection in buffalo can reach 30-80% for calves and buffalo worldwide [6], [7], reports on the prevalence and degree of parasite infection in buffalo in East Sumba Regency have been very limited. This causes the lack of epidemiological data needed to control cases of parasite infections. Hence, this study aimed to measure the prevalence and their association with the risk factors as well as the rate of parasite infection in buffalo in the East Sumba Regency.

METHOD

Study Design, Place, And Time

This cross-sectional study was conducted from August to September 2020 in 10 sub-districts of East Sumba Regency, namely Tabundung, Lewa, Lewa Tidahu, Nggaha Ori Angu, Ngadu Ngala, Lewa, Waingapu, Karera, Wula Waijelu, Pahunga Lodu, and Katala Hamu Lingu sub-districts. Fecal samples were taken from 105 swamp buffalo (*Bubalus bubalis*) randomly. From each sub-district, 3-36 samples were taken proportionally based on the buffalo population in the sub-district.

Sample Collection And Coprological Technique

Approximately 10 g of feces were taken directly from the rectum and stored in plastics, labeled with the identity of the buffalo. The samples were then stored in a refrigerator and brought to the Helminthology Laboratory, Department of Animal Infectious Diseases and Veterinary Public Health, Faculty of Veterinary Medicine, IPB University for examination.

Examination of fecal samples was carried out using the modified McMaster method based on Hansen and Perry [8], the fecal sample was weighed at 4 g and put into a plastic cup. The saturated sugar-salt float solution was added as much as 56 ml into a glass filled with feces and stirred. The fecal solution was then filtered through a tea filter several times and pipetted 1 ml using a Pasteur pipette into the McMaster counting chamber. The solution was allowed to stand for 5 minutes, then observed and counted the number of helminth eggs and oocysts found with 100 times magnification.

A fecal examination for identifying and counting trematode eggs was carried out using a modified Danish Bilharziasis Laboratory's method [9], [10] the fecal sample was weighed as 4 g, and 56 ml of tap water was added. The solution was then stirred and filtered using a series of graded sieves (400 µm, 100 µm, and 45 µm). The fecal material retained on a 45 µm sieve was then transferred to a petri dish and observed using a microscope with a magnification of 400 times. Identification of the helminth eggs and protozoan oocyst was carried out based on their morphology using the identification keys of Thienpont *et al.*[11].

Data Analysis

The data from the identification, prevalence, and calculation of the degree of infection are presented descriptively using Microsoft Excel® 365. The intensity of infection of helminth and protozoan oocysts is expressed by eggs per gram of feces (EPG) and oocysts per gram of feces (OPG) and converted to the geometric mean with the 95% confidence interval. The association between prevalence and several risk factors (sex and age) was measured using the Chi-Square test. The test was then continued by measuring the odds ratio (OR) value using multivariate analysis through a binary logistic regression test. All statistical analyses were performed using the Minitab® software version 18.

RESULTS AND DISCUSSION

The identification of fecal samples showed that buffaloes in East Sumba Regency were infected by several types of gastrointestinal (GI) parasites, consisting of the Nematodes, Cestodes, and protozoa from the Coccidia group. The identified Nematode eggs were ascarid, strongyle, Strongyloides, trichurid, and capillary, while the identified Cestode eggs came from the genus *Moniezia*. The identification carried out also found the presence of oocysts originating from the protozoan *Eimeria* sp. Trematodes were also found and identified in this study. The identified trematodes were *Paramphistomum* sp. and *Fasciola gigantica*.

Toxocara vitulorum is a species of Ascaridae Nematodes that is commonly found infecting buffalo [4], [12], several genera of Strongyle that may infect sample buffalo include *Nematodirus, Trichostrongylus, Cooperia, Bunostomum, Haemonchus*, and *Mecistocirrus,* Eggs of Strongyloides, Capillarid, and Trichurid helminth were also found. The possible species of helminth derived from the three types of eggs are *S. papillosus, C. Bovis, C. bribes*, *Trichuris discolor*, and *T. globulosa* [11], [13]. The Cestode eggs that were found were identified as *Moniezia* sp. [11].

The microscopic examination revealed the parasite infection in 67 buffalos (63.81%), which were caused by a single (44.76%) and mix infection (19.05%). Single infection was caused by one group of parasites. The prevalence found was 13.33% for Nematode, 1.90% for Cestode, 9.52% for Trematode, and 20.00% for *Eimeria* sp. oocyst. Mix infection was caused by more than one group. In this study, we found five types of mix infection that are caused by Nematode-Trematode (2.86%), Nematode-*Eimeria* sp. (10.48%), Trematode-*Eimeria* sp. (1.90%), Nematode-Cestode-*Eimeria* sp. (1.90%), and Nematode-Cestode-Trematode-*Eimeria* sp. (2.86%).

The Nematode infection consisted of *T. vitulorum* (3.81%), Strongyle group (6.67%), *Trichuris* sp. (0.95%), *Capillaria* sp. (0.95%), and Strongyloides group (0.95%). The prevalence of Trematode group, *Paramphistomum* sp. in this study was found to be higher than *F. gigantica*, which were 9.52% and 1.90%, respectively.

The prevalence of Nematode and *Eimeria* single infections of buffaloes was lower than the results from Nurhidayah *et al.*,[14], in which they found that the prevalence of Nematode and *Eimeria* sp. in buffaloes from Banten, West Java were 15.00% and 30.00%, respectively. *Eimeria* sp. single infection was found higher than Nematodes. Swamp buffalo and dairy cattle less than six months old in Southwest Iran and Nahir Dar, Northwest Ethiopia are most susceptible to infection by the protozoan *Eimeria* sp. This vulnerability appears to be related to the calf's immune system which has not worked perfectly. At the beginning of its life, the calf needs colostrum obtained from the mother to get an adequate immune system to avoid various diseases [15], [16].

The prevalence of Trematode infection in swamp buffalo from this study was much lower than in buffalo from Java. [5], reported that the prevalence of trematodes in swamp buffalo originating from Banten and Brebes was 64.83%. In this study, *Paramphistomum* sp. had a higher prevalence (9.52%) than *F. gigantica* (1.90%). Infection of GI parasites found in this study was also higher when compared to buffalo in other Asian countries. Malathi *et al.* [17] reported that Nematode infection in buffalo in India was 5.06%. Slightly different results were reported by Williams [18], that the prevalence of Nematode, Cestode, and Protozoal oocysts in Punjab, Pakistan were 29.55%, 1.36%, and 5.35%, respectively.

In general, the prevalence of parasitic infections in males (73.33%) was higher than that of females (60.00%) (Figure 1). Variations in the prevalence of infection were found in age categories (Figure 2). The young age group (> 18-32 months) had the highest prevalence value, followed by the calf (> 8-18 months), the pre-weaned calf (0-8 months), and the adult (> 32 months). The results of the Chi-square test showed that only age was associated ($p<0.05$) with the prevalence of GI parasitic infections in this study (Table 1). Age is a factor that significantly affects the prevalence of infection (Table 2). The highest OR value was found in the young age group, with an OR value of 5.80. This value means that the young age group has a 5.80 times higher risk of being infected with GI parasites than the adult age group used as reference data. The calf and pre-weaned calf group also had a risk of infection with GI parasites, which was 2.98 times and 3.10 times compared to the adult age group.

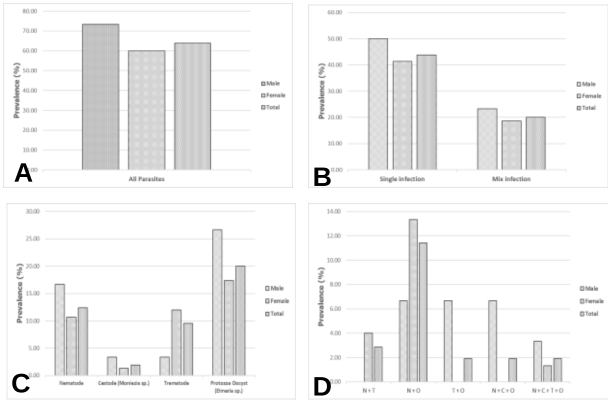

Figure 2. Prevalence of parasites infection based on sex categories. A: total prevalence; B: single and mix infection; C: Single infection; D: Mix infection

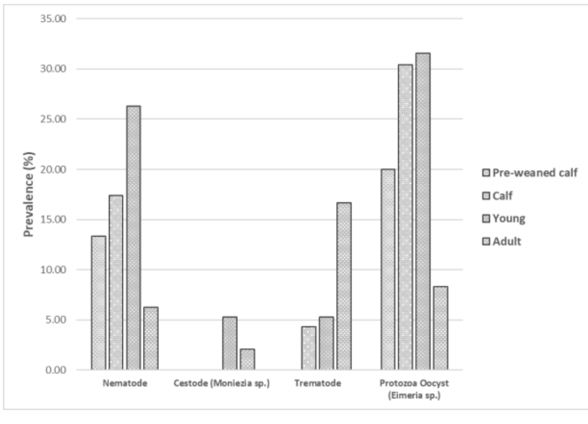

Figure 1. Prevalence of parasites infection based on ages categories.

The results found in this study are in accordance with the reports of Nurhidayah *et al.* [14], and Karim *et al.* [19], which states that GI parasites infections are common in male buffaloes compared to females. Some literature states that female animals are much more sensitive to parasitic infection. The physiological conditions of the host cause the sensitivity. Female animals will be susceptible when they are pregnant or postpartum, while the sensitivity of male animals is associated with their use as working animals [13], this condition is associated with the host's immune system, which significantly affects the sensitivity and high degree of parasite infection. The weaker the host's immune system, the higher its impact on its health [20], the findings of Nurhidayah *et al*. [14], [21], tated that the sex of buffalo did not have significant relationship with the incidence of infection. Both sexes are infected with GI parasites, and each individual is infected with at least one type of parasite.

Table 1. Chi square analysis for the risk factors of parasites infection in swamp buffalo from East Sumba Regency

Variables	**Number infected (n = 67)**	**Number uninfected (n = 38)**	**p-value**
Sex			0.199
Male	22	8	
Female	45	30	
Ages			0.016*
Pre-weaned calf	11	4	
Calf	17	6	
Young	16	3	
Adult	23	25	

*Statistically significance ($p < 0.05$)

Table 2. Multivariate analysis for risk factor analysis of parasites infection in swamp buffalo from East Sumba Regency

Factors	**Significant**	**OR**	**p-value**
Ages			0.014*
Pre-weaned calf	0.093	2.90	
Calf	0.043	3.08	
Young	0.011	5.80	
Adult	Reference		

*Statistically significane ($p < 0.05$)

In this study, the age of the animals had a significant effect on parasite infections. The young age group is the most at risk of infection than the adult age group. There was no pattern of infection associated with the increasing age of buffalo in this study. On the contrary, [5], [14], reported that the age group of pre-weaned is the group most at risk, and GI parasitic infections form an age pattern in which the older the age, the less the infection. Such difference may be due to the different types of parasite groups found in this study. They only found two types of GI parasites that cause infection: Nematodes and Protozoa, while the current study also found Trematodes and Cestode infections. The presence of Trematodes and protozoa found in this study may also influence the pattern of infection. Trematode infections are generally found in adult animals compared to young animals, while protozoa are mostly found infecting calves and children. This is evidenced by the prevalence values of protozoan and Trematode infections in this study, which showed that the adult group had the highest prevalence value for Trematode infection, while the calf age group had the highest prevalence value for protozoal infection.

Table 3. The infection rates of parasites found in swam buffalo from East Sumba Regency

Parasites	**Geometric Mean EPG/OPG (CI 95%0**
Nematodes	84.75 (52.93-135.72)
T. vitulorum	194.11 (31.99-1180.17)
Strongyle	68.11 (42.56-109.02)
Trichuris sp	67.86 (17.83-258.32)
Capillaria sp.	50.00 (50.00-50.00)
Strongyloides	105.96 (30.80-364.51)
Cestode	547.03 (125.74-2379.77)
Trematode	2.18 (1.59-2.99)
F. gigantica	1.00 (1.00-1.00)
Paramphistomum	2.40 (1.76-3.28)
Oocyst (*Eimeria* sp.)	220.70 (143.78-338.76)
Total	**70.56 (42.22-117.93)**

EPG: egg pre gram; OPG: oocyst per gram; CI: confindence interval

The highest to lowest infection rates were observed in Cestodes, followed by Protozoa, Nematodes, and Trematodes (Table 3). The rate of infection in this study was identified as a low category. GI parasite infection was categorized into low (50-200 EPG), moderate (200-800 EPG), and severe (> 800 EPG) [8], trematode infections were categorized as mild if the EPG value was < 10 for *F. gigantica* and < 50 for *Paramphistomum*, moderate if the EPG value was 10-25 for *F. gigantica* and 50-99 for

Paramphistomum, and severe if the EPG value was > 25 for *F. gigantica* and 100 for *Paramphistomum* [22], [23]. Like helminth infections, the mild intensity of protozoa infection has 50-1000 OPG, moderate (1001-5000 OPG), and severe (> 5000) [24].

The infection rates of parasites can provide an overview of the infected host's clinical condition and level of illness. High prevalence does not necessarily cause clinical symptoms. The morbidity rate can be measured by looking at the degree of infection. An asymptomatic host may indicate a mild degree of infection or mild clinical symptoms, and vice versa. However, this study's mild GI parasite infection should not be ignored. Hosts with a mild degree of infection can still produce large feces quantities, affecting the number of eggs released into the environment [25], more eggs released into the environment will cause an increase in the incidence of infection.

This study provides new information on the prevalence and infection rates of parasites found in buffalo from the East Sumba regency. The differences in the results compared to others are, of course, caused by several factors, such as the number of samples taken, weather conditions, climate, physiological conditions of the host, and management of host maintenance. Some literature states that the risk factors that may cause the high prevalence of parasite infections are age, climatic conditions, maintenance management, and animal health examinations [21], based on that statement, it was proven that age is a risk factor that significantly affects parasite infections in this study.

Nematodes are the helminth group that infects buffalo the most in this study. Nematode infection begins with the host accidentally eating grass contaminated by the infective phase of each type of Nematodes, such as infective larvae (L3) or infective eggs. This infective phase develops from eggs under optimum conditions, namely at a temperature of 22-26 C and 85-100% humidity [8], the high prevalence of nematodes in buffalo in this study may indicate the abundance of the infective larvae in the study site. This is also related to the local buffalo rearing system, which is kept extensively. In addition, climatic and environmental conditions can also affect the high prevalence [14].

The sampling of this research was carried out from mid-August to September 2020. East Sumba Regency is classified as a dry area that has two seasons, namely the dry season (May-December) and the rainy season (January-April) (BPS East Sumba 2021). This condition is different from the climate in Java Island, characterized by an average time of dry and rainy seasons that are relatively the same, around 5-6 months. This can make it difficult for buffalo to find fresh grass, so they will indirectly graze in areas contaminated with feces. [26], reported that a greater level of insolation can cause buffalo to stay away from areas contaminated with feces. In this study, the researchers suspected that an arid pasture area required buffaloes to graze near areas contaminated with feces. Contaminated areas and environmental conditions in suitable research sites have a high potential for the development of parasites, which can cause buffalo to become infected. This is thought to cause the high prevalence of Nematodes' infection in this study.

Dry weather conditions may cause a lower prevalence of Trematodes' infection when compared to Nematodes. Trematodes have a complex life cycle and require an intermediate host in the form of either aquatic snails or amphibian snails [13], dry weather with low rainfall in the East Sumba Regency causes no stagnant water, which is a habitat for these snails. The infective phase of Trematodes can only develop from a series of life cycles that occur in the snail's body. Unfavorable habitat and weather conditions and a relatively dry climate might have contributed to the low prevalence of trematodes in buffalo in the East Sumba Regency.

CONCLUSION

67 out of 105 buffaloes (63.81%) had parasite infections, which were caused by a single (44.76%) and mix infection (19.05%). The prevalence of infection with Nematodes, Trematodes, and Protozoan oocysts in males (73.33%) was much higher than in females (60.00%); nevertheless, the chi-square test results showed that sex was not associated with the prevalence of parasites infection cases ($p>0.05$). Age was a risk factor that had a significant effect ($p<0.05$), with the young age group having the highest odds ratio (OR) value (5.80), followed by the age group of the calf (3.10), and pre-weaned calf (2.98). The highest to lowest infection rates were observed in Cestodes (547.03 EPG), followed by Protozoa (220.70 PG), Nematodes (84.75 EPG), and Trematodes (2.18 EPG). Control of parasite infections must be carried out to avoid losses that can arise. Control can be done by regularly giving anthelmintics or applying good

grazing management. This simple effort is expected to reduce the prevalence of parasite infection cases found in this study.

ACKNOWLEDGEMENT

This research is a part of the "Riset Aksi Penanganan Surra pada Ternak Besar di Kabupaten Sumba Timur", collaboration research between Lembaga Penelitian dan Pengabdian kepada Masyarakat, IPB University and Badan Penelitian dan dan Pengembangan Daerah (Balitbangda), East Sumba Regency. The authors would like to thank Balitbangda and the Livestock Service Office of East Sumba Regency who assisted in this research.

REFERENCE

[1] [BPS]Badan Pusat Statistik sumba Timur, *Sumba Timur dalam Angka 2019*. Waingapu: Badan Pusat Statistik Kabupaten Sumba Timur, 2019.

[2] [BPS]Badan Pusat Statistik sumba Timur, *Kabupaten Sumba Timur dalam Angka 2021*. Waingapu: Badan Pusat Statistik Kabupaten Sumba Timur, 2021.

[3] J. M. Burke and J. E. Miller, "Sustainable Approaches to Parasite Control in Ruminant Livestock," *Vet. Clin. North Am. - Food Anim. Pract.*, vol. 36, no. 1, pp. 89–107, 2020, doi: 10.1016/j.cvfa.2019.11.007.

[4] F. Satrija, Y. Ridwan, and E. Retnani, "Efficacy of piperazine dihydrochloride against Toxocara vitulorum in buffalo calves," *J. Vet.*, vol. 12, no. 2, pp. 77–82, 2011.

[5] N. Nurhidayah, F. Satrija, E. B. Retnani, D. A. Astuti, and S. Murtini, "Prevalence and risk factors of trematode infection in swamp buffaloes reared under different agro-climatic conditions in Java Island of Indonesia," *Vet. World*, vol. 13, no. 4, pp. 687–694, 2020, doi: 10.14202/vetworld.2020.687-694.

[6] L. Rast, S. Lee, S. Nampanya, J. Toribio, S. Khounsy, and P. Windsor, "Prevalence and clinical impact of Toxocara vitulorum in cattle and buffalo calves in Northern Lao PDR," *Trop. Anim. Heal. Prod.*, vol. 45, no. 2, pp. 539–546, 2013, doi: 10.1007/s11250-012-0256-4.

[7] R. Ahmed, Z. Wani, I. Allaie, M. Buhsra, and H. Hussain, "Toxocara vitulorum in a suckling calf: A case study.," *J. Parasit. Dis.*, vol. 40, no. 4, pp. 1330–1331, 2016, doi: 10.1007/s12639-015-0682-0.

[8] J. Hansen and B. Perry, *The Epidemiology, Diagnosis, and Control of Helminths Parasites of Ruminants*. Nairobi: International Laboratory for Research on Animal Diseases, 1998.

[9] A. Willingham, M. Johansen, and E. Barnes, "A new technique for counting Schistosoma japonicum eggs in pig feces," *Southeast Asian J Trop Med Public Heal.*, vol. 29, no. 1, pp. 128–130, 1998.

[10] B. Xu *et al.*, "A Novel Procedure for Precise Quantification of Schistosoma japonicum Eggs in Bovine Feces," *PLoS Negl. Trop. Dis.*, vol. 6, no. 11, 2012, doi: 10.1371/journal.pntd.0001885.

[11] D. Thienpont, F. Rochette, and O. Vanparijs, *Diagnosing Helminthiasis by Coprological Examination.*, 3rd ed. Beerse: Janssen Animal Health, 2003. [Online]. Available: www.elsevier.com/locate/vetpar

[12] Z. Audu and S. E. Abalaka, "Toxocara vitulorum intestinal impaction in male White Fulani calves: a case report from Nigeria," *J. Parasit. Dis.*, vol. 43, no. 4, pp. 597–600, 2019, doi: 10.1007/s12639-019-01133-3.

[13] M. A. Taylor, R. L. Coop, and R. L. Wall, *Veterinary Parasitology*, 4th ed. Chichester: Wiley Blackwell, 2016.

[14] N. Nurhidayah, F. Satrija, and E. B. Retnani, "Gastrointestinal parasitic infection of swamp buffalo in Banten Province, Indonesia: Prevalence, risk factor, and its impact on production performance," *Trop. Anim. Sci. J.*, vol. 42, no. 1, pp. 6–12, 2019, doi: 10.5398/tasj.2019.42.1.6.

[15] S. Bahrami and A. R. Alborzi, "Prevalence of subclinical coccidiosis in river buffalo calves of southwest of Iran," *Acta Parasitol.*, vol. 58, no. 4, pp. 527–530, 2013, doi: 10.2478/s11686-013-0167-1.

[16] H. Tamrat, N. Mekonnen, Y. Ferede, R. Cassini, and N. Belayneh, "Epidemiological study on calf diarrhea and coccidiosis in dairy farms in Bahir Dar, North West Ethiopia," *Ir. Vet. J.*, vol. 73, no. 1, Jul. 2020, doi: 10.1186/S13620-020-00168-W.

[17] S. Malathi, U. Shameem, and M. Komali, "Prevalence of gastrointestinal helminth parasites in domestic ruminants from Srikakulam district, Andhra Pradesh, India," *J. Parasit. Dis.*, vol. 45, no. 3, pp. 823–830, 2021, doi: 10.1007/s12639-021-01367-0.

[18] N. F. Ojeda-Robertos *et al.*, "Study of

gastrointestinal parasites in water buffalo (Bubalus bubalis) reared under Mexican humid tropical conditions," *Trop. Anim. Health Prod.*, vol. 49, no. 3, pp. 613–618, Mar. 2017, doi: 10.1007/s11250-017-1237-4.

[19] W. A. Karim, A. Farajallah, and B. Suryobroto, "Exploration and prevalence of gastrointestinal worm in buffalo from West Java, Central Java, East Java and Lombok, Indonesia," *Aceh J. Anim. Sci.*, vol. 1, no. 1, pp. 1–15, 2016, doi: 10.13170/ajas.1.1.3566.

[20] S. H. M. Hendawy, "Immunity to gastrointestinal nematodes in ruminants: effector cell mechanism and cytokines.," *J. Parasit. Dis.*, vol. 42, no. 4, pp. 471–482, 2018, doi: 10.1007/s12639-018-1023-x.

[21] P. P. Roy, N. Begum, A. R. Dey, S. Sarker, H. Biswas[2], and T. Farjana1, "Prevalence of gastrointestinal parasites of buffalo at Mongla, Bagerhat," *Int. J. Nat. Soc. Sci.*, vol. 3, no. 1, pp. 59–66, 2016.

[22] D. M. Pfukenyi, S. Mukaratirwa, A. L. Willingham, and J. Monrad, "Epidemiological studies of Schistosoma mattheei infections in cattle in the highveld and lowveld communal grazing areas of Zimbabwe," *Onderstepoort J. Vet. Res.*, vol. 73, no. 3, pp. 179–191, 2006, doi: 10.4102/ojvr.v73i3.144.

[23] R. Njoku-Tony and B. Nwoko, "Prevalence of paramphistomiasis among sheep slaughtered in some selected abattoirs in Imo State, Nigeria," *Sci. World J.*, vol. 4, no. 4, pp. 12–15, 2009, doi: 10.4314/swj.v4i4.51401.

[24] B. Lassen and T. Järvis, "Eimeria and Cryptosporidium in Lithuanian cattle farms," *Vet. ir Zootech.*, vol. 48, no. 70, pp. 24–28, 2009.

[25] N. G. Budiono, F. Satrija, Y. Ridwan, D. Nur, and . Hasmawati, "Trematodosis pada Sapi dan Kerbau di Wilayah Endemik Schistosomiasis di Provinsi Sulawesi Tengah, Indonesia," *J. Ilmu Pertan. Indones.*, vol. 23, no. 2, pp. 112–126, Aug. 2018, doi: 10.18343/jipi.23.2.112.

[26] H. L. S. Seó, L. C. P. M. Filho, L. A. Honorato, B. F. Da Silva, A. F. T. Do Amarante, and P. A. Bricarello, "The effect of gastrointestinal nematode infection level on grazing distance from dung," *PLoS One*, vol. 10, no. 6, p. e0126340, Jun. 2015, doi: 10.1371/journal.pone.0126340.