Prevalence of Gastrointestinal Nematodes in Local Indonesian Sheep Based on Rearing Systems and Animal Age

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Abstract. This study aimed to evaluate the prevalence of gastrointestinal nematodes (GIN) in local Indonesian sheep based on the rearing system and animal age. Fecal samples were taken transrectally from lamb (<8 months) and adult sheep (>1 year), which were reared intensively and semi-intensively, each with a total of 25 samples. Furthermore, the fecal samples were processed using the floating method with a saturated salt solution (NaCl). Fecal Egg Counting (FEC), larvae, and nematode types were carried out microscopically in the Universal Whitlock counting chamber. The general linear model (GLM) analyzed the data with 95% confidence and continued with Tukey's test if interactions between factors were found. The results showed that the rearing system or age of the sheep did not have a significant influence and did not show an interaction (p>0.05) on the FEC. However, the average FEC of sheep reared semi-intensively, both in lambs and adult sheep, respectively, tended to be higher than in those reared intensively (898.75±280.36 vs 469.09±120.40 and 692.50±220.57 vs 513.00±106.88). It can be concluded that the semi-intensive rearing system and lambs are more susceptible to Gastrointestinal Nematode (GIN) infections if they are not accompanied by good rearing management, and the dominant type of worm found in sheep feces is *Strongyloides spp*.

Keywords: Indonesian thin-tailed sheep, Infection, parasitic disease

Abstrak. Penelitian ini bertujuan untuk mengevaluasi prevalensi nematoda gastrointestinal (NGI) pada domba lokal Indonesia berdasarkan sistem pemeliharaan dan umur hewan. Sampel feses diambil secara transrektal dari anak domba (<8 bulan) dan domba dewasa (>1 tahun) yang dipelihara secara intensif dan semi-intensif, masing-masing sebanyak 25 sampel. Selanjutnya, sampel feses diproses menggunakan metode pengapungan dengan larutan garam jenuh (NaCl). Penghitungan Fecal Egg Counting (FEC), larva, dan jenis nematoda dilakukan secara mikroskopis di dalam kamar hitung Universal Whitlock. General Linear Model (GLM) digunakan untuk menganalisis data dengan tingkat kepercayaan 95% dan dilanjutkan dengan uji Tukey jika ditemukan adanya interaksi antara faktor. Hasil penelitian menunjukkan bahwa sistem pemeliharaan dan umur domba tidak memberikan pengaruh yang signifikan dan tidak menunjukkan adanya interaksi (p>0,05) terhadap FEC. Namun demikian, rata-rata FEC domba yang dipelihara secara semi-intensif, baik pada anak domba maupun domba dewasa cenderung lebih tinggi dibandingkan dengan domba yang dipelihara secara intensif (898,75±280,36 vs 469,09±120,40 dan 692,50±220,57 vs 513,00±106,88). Dapat disimpulkan bahwa sistem pemeliharaan semi-intensif dan domba lebih rentan terhadap infeksi Nematoda Gastrointestinal (NGI) jika tidak disertai dengan manajemen pemeliharaan yang baik, dan jenis cacing yang dominan ditemukan pada feses domba adalah *Strongyloides spp.*

Kata kunci: domba ekor tipis, infeksi, penyakit parasit

Introduction

Gastrointestinal nematode (GIN) infections are one of the leading health problems in sheep farming. These parasites affect animal welfare and decrease productivity, with a significant economic impact on the livestock industry. Chaudhry et al. (2019) reported that in some cases, the overall economic effect of GIN infections could amount to billions of dollars annually in production losses across the livestock industry. Furthermore, Cruz-Tamayo (2021) stated that GIN could cause a weakened immune response, making animals more susceptible to infection. Nematode types such as *Haemonchus contortus*, *Trichostrongylus spp*., and *Ostertagia circumcincta* are often found in sheep's digestive systems. GIN can precipitate severe gastrointestinal disturbances, resulting in diarrhea. The pathophysiological mechanisms involve direct damage to the intestinal mucosa and alterations in gut microbiota composition

due to the inflammatory response elicited by the parasites (Mamun et al., 2020). Furthermore, infection intensities have been directly correlated with feed consumption. The infected sheep often exhibit reduced feed intake and efficiency, thus hindering overall productivity (Mavrot et al., 2015). The loss of blood and subsequent nutrients results in not only anaemia but also underutilization of dietary resources, negatively The lambs are growth and production (Hayw, 2022).

Differences in the age of sheep, particularly between lamb and adult sheep, have important implications for the prevalence and intensity of GIN infections. ambs are often more susceptible to severe infections due to their immature immune systems. Research conducted by Marques et al. (2018) highlights that lambs, are more affected by gastrointestinal nematodes due to their underdeveloped immune systems. This study observed that lambs had significantly lower plasma protein levels, indicating a severe impact of heavy parasite loads compared to adult ewes. Similarly, Da Silva et al. (2021) found that lambs had mean fecal egg counts (FEC) of 1297 ± 270 eggs per gram (EPG), whereas ewes exhibited much lower counts of 232 ± 79 EPG, demonstrating a clear disparity in infection levels between these two age categories.

Another factor that may influence the concentration level of GIN in the bodies of livestock is the rearing system. Sheep-rearing systems, whether intensive or semi-intensive, also play an essential role in the prevalence of GIN. Several research results report that the grazing habits of sheep, coupled with nutritional deficiencies and poor pasture management, can significantly contribute to high GIN infection rates (Omoruyi et al., 2017). Malnutrition in grazed sheep leads to reduced immunity, increasing their susceptibility to parasitic infections (Baihaqi et al., 2019). Furthermore, the average infection rate in sheep grazed in contaminated areas can reach levels approaching 100%. Proximity to feces from infected animals further increases the likelihood of reinfection, placing grazed sheep at a significant disadvantage compared to intensively raised sheep (Eye et al., 2020). However, to our knowledge, the prevalence of GIN in intensively reared sheep has yet to be widely published. The extent to which the prevalence of GIN differs in sheep between those reared semi-intensively and intensively and between lambs and adult sheep is an interesting topic to know.

This study aimed to observe the prevalence of gastrointestinal nematodes in sheep by considering two main variables, namely the rearing system (intensive vs. semi-intensive) and the age of the sheep (lambs vs. adults), and measuring the interaction between these two factors. The findings from this research are expected to significantly contribute to livestock rearing management, particularly in optimizing gastrointestinal nematode control strategies.

Materials and Methods

Fecal samples were taken from sheep reared semi-intensively and intensively and grouped based on age (lambs and adult sheep), 25 each. A total of ±3 g of sheep feces was taken transrectally to ensure the surrounding environment did not contaminate the feces. Other materials used in this research include saturated NaCl (salt) solution and distilled water, which were used for testing using the floating method. The study was conducted in Kertajati District, Majalengka Regency—West Java (108°03'-108°15' E and 6°37'-6°46' S) during the dry season (July-August 2023). This location was one of the sheep farming centers with two rearing systems (semi-intensive and intensive). Based on data from BPS Kabupaten Majalengka (2022), the sheep population at that location is 66,331 heads, which is in third place after the Jatitujuh and Panyingkiran sub-districts.

Furthermore, the tools included plastic gloves for transrectal fecal collection and laboratory examination. Other tools, such as sample pots and labels, were used to hold and

label feces, and coolboxes are used to store feces samples. Blenders were used to homogenize fecal aggregates, pipettes with filters were used to take fecal samples during testing, and universal counting chambers with locks were used to count the number of eggs, larvae, and nematode worms. A microscope with 4-10x magnification was used to observe the morphology of the types and number of eggs, larvae, and nematode worms.

The study was conducted observationally in the field, and microscopic tests were performed in the laboratory. In this study, no interventions were made; only natural phenomena were observed. Samples were collected purposively based on the rearing system (semi-intensive and intensive) and animal age (lambs and adults). From these two factors, four combinations of criteria factors were formed (lambs reared semi-intensively, lambs reared intensively, adult sheep reared semi-intensively, and adult sheep reared intensively). For each combination of criteria, 25 sheep were randomly selected, and their feces were taken directly from their rectum. Furthermore, 100 fecal samples were analyzed microscopically in the laboratory.

Variable Measurement Procedure

The collected fecal samples were processed using the floating method using a saturated salt solution (NaCl). Three grams of each feces sample was taken for further processing, and the number of eggs, larvae, and nematode worms were counted. The study objects found were then grouped based on their morphology. The procedures or techniques for measuring variables used the method of Suhardono et al. (2002), in which 3 g of sheep feces was put into a 60 ml bottle, and 17 ml of distilled water was added. The sample was left overnight in the refrigerator. Furthermore, the feces in the bottle were crushed with a blender, and 40 ml of saturated salt solution was added. While stirring using a pipette with a filter at the end, the fecal suspension was sucked up and put into two Universal Whitlock counting chambers. The fecal sample was left for 1–2 minutes, after which it was ready for examination under a microscope at low magnification (4–10× objective). The eggs, larvae, and worms were counted. Eggs per gram of feces (EPG) were calculated as (number of eggs, larvae, and worms counted) × 20. Furthermore, the GIN infections were grouped into three classes, namely those with high fecal egg count (FEC) (>1000 epg), medium (500–1000 epg), and low (200–499 epg) (Borkowski et al., 2020).

Statistical Analysis

The average fecal egg count (FEC) was analyzed using a general linear model (GLM) at the 95% confidence level and continued with Tukey's test if interactions between factors were found. The data were presented as mean ± standard error (SEM) values. They were processed using the SPSS 27.0 version (IBM SPSS Inc., Chicago, Illinois, USA). Other data are presented in percentage form and descriptively.

Results and Discussion

From each fecal sample observed, the average number of nematode worms tended to be higher in lambs reared semi-intensively. This condition was seen in contrast to lambs reared intensively with a lower average number of nematode worm eggs (898.75 ± 280.36 vs. 469.09 ± 120.40). Likewise, for adult sheep, the average number of nematode worm eggs found in the feces of sheep reared semi-intensively tended to be higher than those reared intensively (692.50 ± 220.57 vs. 513.00 ± 106.88). One of the primary reasons for the high prevalence of GIN infections in grazing sheep is the environmental conditions that favor the survival and development of nematode larvae. Optimal conditions for developing infective larvae (L3) include warm temperatures and adequate moisture, often present in grazing pastures (Ruiz-Huidobro et al., 2019). The duration for gastrointestinal nematode eggs to

develop into larvae in a sheep pasture typically spans between 5 and 14 days, based on species and environmental conditions. Environmental factors such as temperature and humidity, like those in the pasture, are very influential on the hatching success and timing of larval development. Optimal conditions are in warm and moist climates, which promote faster growth and higher survival rates for nematodes (Almeida et al., 2018; Bartley et al., 2021; Mahlehla et al., 2021). However, the statistical analysis results show that neither the rearing system factor nor the animal's age has a significant influence, and there is no interaction ($p>0.05$) between the factors (Table 1). When compared with the results of research conducted in temperate climate areas (CW2) by Hernandez et al. (2007), the prevalence of Gastrointestinal Nematode (GIN) infections in this area reached 78.63%, with an average fecal egg count (FEC) of 598.52 ± 119.78 epg. This number is less than the sheep reared semi-intensively in this research.

This condition showed that sheep grazed or raised semi-intensively are more susceptible and have the chance to be infected with GIN. As reported by Mavrot et al. (2015), GIN infections are a global problem in pastured sheep. The harm caused by this infection includes weight loss, anemia, diarrhea, and serious loss of protein and blood in the body. Grazing behavior also plays a significant role in the prevalence of GIN infections. Sheep tend to graze close to fecal matter, which can contain high nematode eggs and larvae concentrations. This behavior is particularly pronounced in communal grazing systems where multiple animals share the same pasture, leading to a higher likelihood of exposure to contaminated areas (Getachew et al., 2017). The greater FEC found in grazed sheep is also possible due to the high stocking rate factor. The fact found at the research location is that each herd of livestock grazed has an average of more than 20 heads. Sinclair et al., (2016) state that high stocking rate can lead to greater concentrations of gastrointestinal nematode eggs and larvae, thus heightening the risk of infection for the grazing sheep. The optimal climatic and environmental conditions can exacerbate this situation, facilitating the hatching and development of eggs into infective larvae.

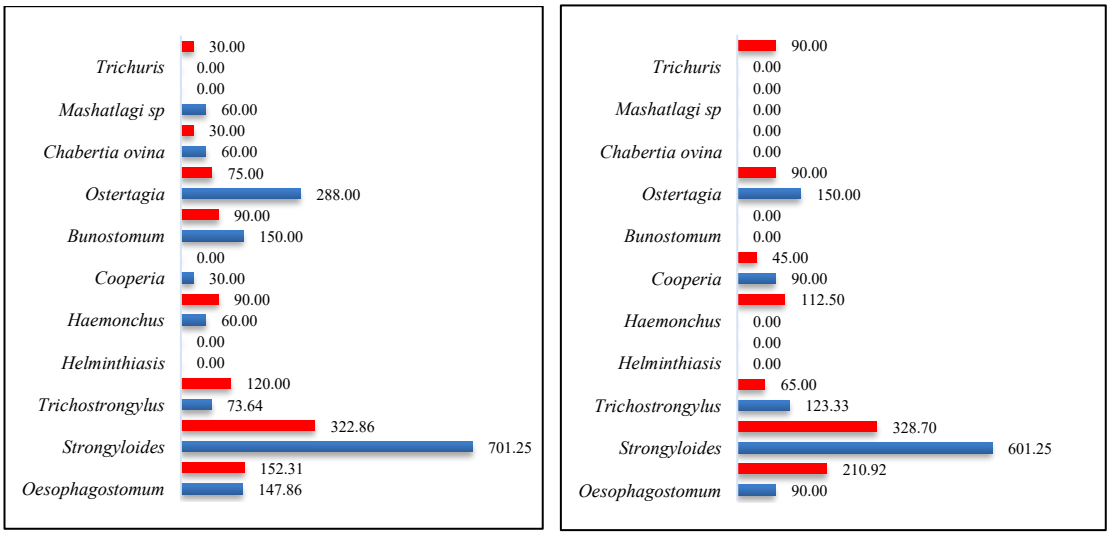
Table 1. Prevalence of Gastrointestinal Nematode Infection in Local Indonesian Sheep Based on Rearing System and Animals Age

Variable	Semi-Intensive		Intensive		Significant level (p-Value)		
	Lambs	Adult sheep	Lambs	Adult sheep	Rearing	Age	Interaction
Number of sheep (head)	25	25	25	25	-	-	-
Total of fecal egg count (epg)	21570	16620	10320	12312	-	-	-
Average of fecal egg count (epg)	898.75 ±280.36	692.50±220.57	469.09±120.40	513.00±106.88	0.129	0.684	0.530
% of GIN-infected sheep	76 (19/25	72 (18/25)	56 (14/25)	56 (14/25)	-	-	-
• % of low GIN-infected sheep	24 (6/25)	32 (8/25)	32 (8/25)	20 (5/25)	-	-	-
• % of medium GIN-infected sheep	36 (9/25)	28 (7/25)	12 (3/25)	16 (4/25)	-	-	-
• % of high GIN-infected sheep	16 (4/25)	12 (3/25)	12 (3/25)	20 (5/25)	-	-	-
% of not GIN-infected sheep	24 (6/25)	28 (7/25)	44 (11/25)	44 (11/25)	-	-	-

Notes:The average fecal egg count was not affected by rearing and age factors and did not show an interaction ($p<0.05$), GIN = Gastrointestinal Nematode

Apart from the high stocking rate, the transmission process of GIN infections could be caused by many factors. Mahlehla et al., (2021) stated that rainfall and humidity are critical factors in the seasonal pattern of GIN infection, with the rainy season being the most conducive for this transmission. Additionally, Beaumelle et al. (2023) highlighted that the potential for transmission of GIN infections between domestic sheep and other hoofed animals could be a reservoir for resistant strains. Similar to the results of this study, Thorne et al., (2022) reported that the prevalence of nematode infections was more significant in lambs. Furthermore, nematode development is higher in pasture environments, increasing the risk of infection in lambs grazing in these areas (Seyoum et al., 2018). In contrast, penned sheep are typically managed in a controlled environment, where the risk of GIN exposure is significantly reduced due to limited interaction with contaminated pasture (Campbell et al., 2021). The type of grass in the pasture is thought to influence infection rates, and specific cultivars increase the risk (da Silva Roberto et al., 2020). However, using clean pastures and good nutrition could help reduce infection rates (Almeida et al., 2018).

Furthermore, the highest number of sheep infected with GIN occurred in the group of lambs reared semi-intensively, namely 76% (19/25 heads). Meanwhile, the overall ratio of the number of sheep infected with GIN was higher in semi-intensive than intensive rearing systems, namely 74% (37/50) vs. 56% (28/50) (Table 1). This phenomenon is very likely related to pasture and animal conditions. (Vatta et al., 2002) stated that pasture conditions are essential in spreading internal parasites and animal performance. The lack of adequate pasture challenges providing the nutrition needed by animals and is also an obstacle to increasing ruminant productivity. Furthermore, parasitic diseases are closely related to the condition of the animal's body. Jansen et al. (2020) reported that GIN infections were more common in pastured lambs. Other factors that cause this incident include environmental conditions with high humidity levels, unhealthy, stress, and high-density conditions.



a. Lamb b. Adult sheep

Figure 1. Comparison of the types and fecal egg count in lamb and adult sheep feces (epg) between those reared semi-intensive and intensively (blue = semi-intensive; red = intensive)

The number of GIN types that attack lambs is greater than that of adult sheep. However, the kinds of GIN that attack both are dominated by the same type, namely *Strongyloides spp, Oesophagustonum spp, Ostertagia spp*, and *Trichostrongylus spp* (Figure 1). This is different from the research results of Hernandez et al. (2007), who reported that the nematodes commonly found in sheep grazed in temperate climates were *Haemonchus spp* 32%, *Cooperia spp* 30%, *Trichostrongylus spp* 17.33% and *Oesophagostomum spp* 13.67%. At the same time, the *Strongyloides spp* was only found in 7.0%. The two dominant types of GIN, *Strongyloides spp.* and *Haemonchus spp*. have a very detrimental impact on animal productivity, impacting farmers' income levels. Environmental factors may be necessary in determining nematode species diversity in this case. Climatic conditions such as temperature and humidity can affect the survival and development of nematode larvae in grasslands. Certain nematodes, such as *H. contortus* and *T. circumcincta*, are more common in temperate regions. Meanwhile, in tropical regions, the diversity may include other species, such as *Strongyloides spp*., that thrive in warmer conditions (Hamel et al., 2017; Keidane et al., 2022).

Kumar et al. (2015) reported that sheep infected with *Strongyloides spp* nematodes could cause serious leukocytosis and reduce hemoglobin, cell volume, and serum biochemical profile. On the other hand, Jacobson et al. (2020) stated that *Strongyloides spp* infection in sheep could cause diarrhea through direct impacts on the intestinal mucosa and indirect effects mainly related to the host response. Meanwhile, sheep that are predominantly infected with *Haemonchus spp* could cause symptoms of anemia because these nematodes are blood-sucking parasites and, in some cases, can cause death, resulting in economic losses for the farmer (Adduci et al., 2022, Flay et al., 2022). This case shows that intensive or semi-intensive sheep raising requires good rearing and animal welfare management.

Conclusions

The semi-intensive rearing system and lambs are more susceptible to Gastrointestinal Nematode (GIN) infections if not accompanied by good rearing management. The dominant type of worm found in sheep feces is Strongyloides spp. The farmers are advised to improve sheep rearing management, especially in disease control.

Conflict of interest

We, the authors, declare that there are no financial, personal, or other relationships with any person or organization related to the material covered in the manuscript.

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