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Prevalence of different gastrointestinal parasite horse infections in Riyadh, Saudi Arabia

ABSTRACT

Gastrointestinal parasites are a significant health concern for horses, affecting their overall health and performance. Detecting intestinal parasites in horses is crucial for maintaining their health and preventing disease outbreaks, which can lead to significant economic and performance-related losses. This research provides essential data that can inform better management practices and parasite control strategies, ultimately enhancing horse health and productivity. This study was conducted to estimate the prevalence of different gastrointestinal parasites in horses in Riyadh, Saudi Arabia, and to investigate the relationship between infection rates and the horses' age, sex, and species. A total of 113 fecal samples from horses were gathered and examined using NaCl flotation and direct fecal smear techniques to detect gastrointestinal parasites. The results showed that among the 113 samples examined, 44 (38.93%) were found positive for various gastrointestinal parasites. The detected parasites included *Entrobilus* spp. (10.6%), *Eimeria* spp. (6.19%), *Anoplocephala* spp. (2.65%), *Parascaris equorum* (1.76%), *Ascaris* spp. (1.76%), and *Gastrodiscus* spp. (0.88%). Additionally, 29.2% of the infections were attributed to unidentified oocysts, larvae, or eggs. These findings suggest that gastrointestinal parasites are common in horses in Riyadh, Saudi Arabia, and underscore the need for targeted parasite management and control strategies to improve equine health and welfare in the region.

KEYWORDS: Gastrointestinal parasites, Prevalence study, Horse Health, Helminths, Fecal examination

INTRODUCTION

Equine companionship with humans' spans epochs, and horses have taken on important responsibilities beyond ordinary utility. Horses are valued for their strength, agility, and historical significance, which are intertwined with the fabric of human society. According to the Food and Agriculture Organisation of the United Nations (FAO), there are an estimated over 60 million horses worldwide. Despite their vast numbers, it is crucial to recognize that not all horses roam freely; a substantial portion of them, approximately 70%, are tamed and domesticated by humans (FAO, 2022). This close interaction between humans and horses highlights the long-standing relationship developed over millennia.

From serving as indispensable companions in agriculture, transportation, and sport to becoming loyal partners in therapy and leisure, horses have seamlessly integrated into human civilization. As we explore the intricate roles and connections between horses and humanity, it becomes evident that their impact extends far beyond their physical presence, reaching into the realms of culture, art, and emotional well-being (Birke & Hockenhull, 2015). In Saudi Arabia, the horse population is estimated to be more than 33,000, and more than 500 horses are imported annually from different countries such as the United Arab Emirates, the United States, and Europe to be used for various purposes, including husbandry activities, transportation, racing, showing, and breeding (Anazi *et al.*, 2011).

Like any living being, horses are susceptible to various diseases caused by viruses, bacteria, and parasitic microorganisms that can impact their health and well-being. Equine diseases range from common infections to more severe conditions such as colic and laminitis. A comprehensive understanding of these illnesses is crucial for effective prevention and management in equine healthcare (Kolk & Kroeze, 2022). By staying informed about prevalent diseases and their symptoms, horse owners and caretakers can enhance these remarkable animals' overall health and longevity.

Colic is a common horse illness that causes gastrointestinal pain and a high mortality rate. In 2015, it caused 31% of deaths in horses aged one to twenty years, making it the most common cause of equine death in the United States (Maskato *et al.*, 2020). The gastrointestinal tract nematodes are the most frequently reported parasitic infections in horses, often causing colic. Animals with infections lose their appetite, leading to severe underweight. Parasitic infections, which seriously impair animal health, remain a significant concern (Panova *et al.*, 2023). Protozoa, trematodes, cestodes, and nematodes can be found in a horse's digestive system (Denizhan & Karakuş, 2023).

Globally, gastrointestinal parasite infections are acknowledged as one of the biggest risks to horses' health, resulting in significant economic losses due to their deteriorating condition and reduced ability to grow physically and compete effectively in sports. (Carminatti *et al.*, 2023). *Strongyle*, *Cyathostomes*, *Triodontophorus* species, *Strongyloides westeri*, *Parascaris equorum*, *Dictyocaulus arnfieldi*, *Oxyuris equi*, *Gastrodiscus*, and *Fasciola* species are the most often recognized gastrointestinal helminths of equines in various regions (Mathewos *et al.*, 2021). Equine bloodworms, or *Strongylus vulgaris*, are known as "the horse killer" and are the most dangerous gastrointestinal parasite (Nielsen *et al.*, 2021). Peritonitis is the most common symptom of the clinical sickness produced by this parasite, and studies have demonstrated that this condition is linked to *S. vulgaris* positivity, confirming that this parasite can kill animals (Pihl *et al.*, 2018). *S. vulgaris* is the most well-known due to its ability to induce significant health issues, including potentially fatal colic, because of its intricate life cycle, which involves migrating through the arteries and producing thrombosis and damage that can result in necrotic lesions in the intestinal wall (Halvarsson, 2024).

Cyathostomins infect nearly all horses, and infections with 10 or more species per horse are common. Despite possible species bias in disease development and anthelmintic resistance, species-specific knowledge is scarce (Bellaw *et al.*, 2020). Cyathostomins form in the lumen and wall of the large intestine, and horses seldom acquire substantial protective immunity. As a result, substantial Cyathostomin loads are possible in animals of all ages. Cyathostomins cause various clinical symptoms, including impaired performance, slower development rates, weight loss, coarse hair coat, asthenia, diarrhea, and various forms of colic (Pergrine *et al.*, 2014).

In this study, we assess the prevalence of various gastrointestinal parasites (GIPs) in horses within the Riyadh region of Saudi Arabia. Our approach combines the NaCl flotation and direct fecal smear techniques, providing a comprehensive assessment of parasitic infections. This dual-method approach is noteworthy because it increases the detection sensitivity for a broad spectrum of parasites, addressing limitations in existing diagnostic methods that often rely on a single technique. Using these complementary techniques, our method improves the accuracy and reliability of parasite detection and provides a clearer understanding of the parasite load and diversity within the equine population. This research contributes to better-informed strategies for parasite management and control, ultimately enhancing horse health and performance in the region.

This study is particularly significant due to the cultural importance of horses in Saudi Arabia. Despite the prominence of equines in the region, there is a notable lack of contemporary research on gastrointestinal parasites affecting these animals. By addressing this gap, our study aims to provide critical insights and practical solutions to support the health and well-being of horses, thereby preserving their valued role in Saudi society.

Methods and Materials

Study area:

The study area includes eleven stables in the Kingdom of Saudi Arabia, Riyadh region, and its provinces. Samples were taken between March and April 2023. Seven Stables are in eastern Riyadh, one is in western Riyadh, two are in Al-Muzahimiyah, and one is in Al-Diriyah, Riyadh.

Animal Samples:

With the owners' permission, 113 fecal samples were collected from randomly selected horses of varying sexes (65 males and 48 females), ages (below 1 year, 1 to 5 years, 5 to 10 years, and above 10 years), and breeds (80 Arabian, 28 English, 2 French, 1 Spanish, 1 British, and 1 Hybrid).

Samples collection:

The study was conducted using a simple random sampling method to examine the prevalence of infected horses. Fecal samples were collected from each selected animal from freshly dropped feces using a disposable plastic specimen container, and each sample was labeled with a description of the animal, which includes species, age, sex, and body condition. Management was recorded on a paper equivalent to the label to exclude repetition of sample collection of the same animal. Then samples were transported to Princess Nourah Bint Abdulrahman University- College of Science's laboratory for analysis. All samples were either processed immediately or kept in the refrigerator at 4°C and processed within 48 hours.

Examination methods:

In the laboratory, fecal samples were processed and examined microscopically as per standard procedure by fecal floatation and direct smear for any presence of parasites (Englar & Dial, 2022). Parasite identification was made based on their morphology (Bawmann, 2009).

Results

Table 1: Detection of (GIPs) and associated with risk factors among horses in Riyadh.

	No. of examined Horses	No. of Positives (%)
Species		
Arabian	80	27 (23.89)
English	28	14 (12.38)
French	2	1 (0.88)
British	1	1 (0.88)
Spanish	1	1 (0.88)
Mixed	1	None
Sex		
Male	65	23 (20.35)
Female	48	21 (18.58)
Age		
>1 year	7	5 (4.42)
1 - 5	48	15 (13.27)
5 - 10	44	19 (16.8)
< 10 years	14	5 (4.42)
Housing		
Organized	91	30 (26.54)
Unorganized	22	14 (21.38)
Body conditioning		
Good	93	39 (34.5)
Moderate	9	1 (0.88)
Poor	11	4 (3.53)
Region		
Eastern Riyadh	57	29 (25.66)
Western Riyadh	12	6 (5.3)
Al-Muzahmimiyah	38	8 (7)
Al-Diriyah	6	1 (0.88)

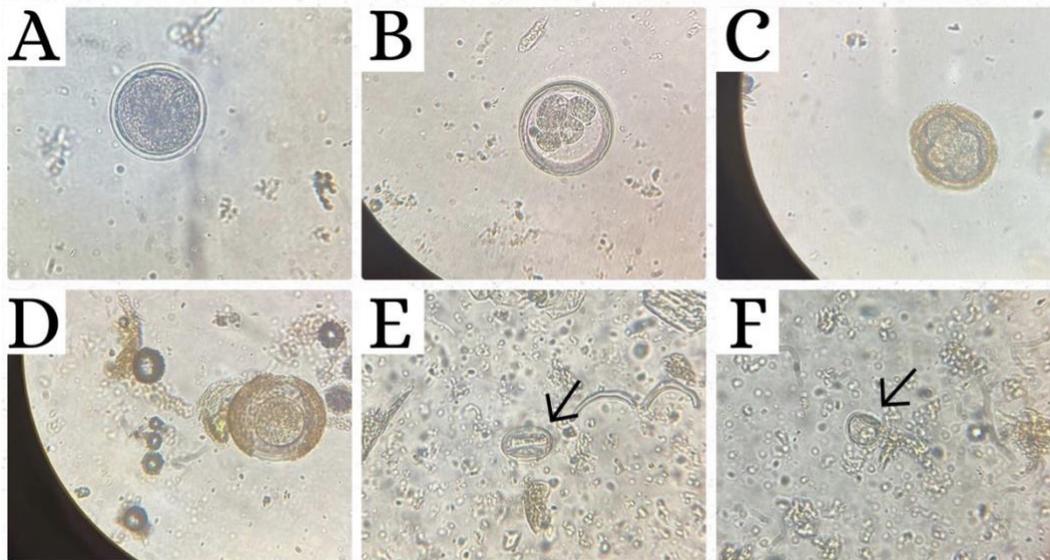
Coprological examination of 113 horses' fecal samples revealed that 44 were positive for some gastrointestinal parasites, indicating that the overall prevalence was 38.94%. (Table 2) Shows that horses were infected with *Entrobilus* spp. (10.6%); *Eimeria* spp. (6.19%); *Anoplocephala* spp. (2.65%); *Parascaris equorum* (1.76%); *Ascaris* spp. (1.76%); and very low prevalence (0.88%) for *Gastrodiscus* sp. and *Trichuris* sp.

Table 2: Comparison of parasitological techniques for the diagnosis of (GIPs) in horses feces

Parasites	Infection No.	%
<i>Parascaris equorum</i> .	2	1.76
<i>Eimeria</i> spp.	7	6.19
<i>Entrobilus</i> spp.	12	10.6
<i>Ascaris</i> spp.	2	1.76
<i>Anoplocephala</i> spp.	3	2.65
<i>Gastrodiscus</i> sp.	1	0.88
Mixed infection	33	29.2
Total	44	38.93

Table 3: Prevalence types of (GIPs) in horses.

Detection technique	Samples No.	%
Flotation	6	5.3
Direct fecal smear	40	35.39

**Figure 1:** Microscopic view X40 of different parasites, A) Unsporulated oocyst of *Eimeria* spp. B) Sporulated oocyst of *Eimeria* spp. C) *Ascaris* spp. D) *Parascaris equorum*. E) *Entrobius* spp. F) *Anoplocephala* spp.

Discussion

The results of the current study indicate that parasitic infections are prevalent among horses in the Riyadh region of Saudi Arabia. However, compared with a previous report, the prevalence in horses observed in the current study (38.93%) is far lower than that reported earlier (86.6%) by Anazi *et al.* (2011) despite being the same study area, which can be due to the increased awareness in horse health in recent years. Also, Anazi *et al.* relied on conventional parasitologic examinations and serologic assays. DNA based technologies, including PCR, have been widely used in the diagnosis of infections in horses, camels, and cattle, given their sensitivity and specificity in detecting all stages of parasitic infection, which we did not use in our study and only depended on standard coprological tests-direct and floatation methods due to its accessibility and availability for students.

In line with our study, Al Qudari *et al.* (2015) reported a 30.46% prevalence of parasitic infections in horses from the Eastern Province of Saudi Arabia. Comparing these results to other regions in the world, studies by Scala *et al.* (2020), Papazahariadou *et al.* (2009), Valibasha *et al.* (2019), and Nagar *et al.* (2022) showed an overall prevalence of 40%, 34.5%, 31.80%, 30.85%, in Italy, Central and Northern Greece, India, respectively which is almost in agreement with the present findings. Moreover, Wannas *et al.* (2012), Elmajdoub *et al.* (2022), Khanum *et al.* (2021), Roba & Hiko (2022), Pandit *et al.* (2008), Oli *et al.* (2018), and Adeppa *et al.* (2016) reported parasitic infection prevalence to be 100%, 98.0%, 97.92%, 96.6%, 93.26%, 84.76%, 84.0 % in Iraq, Libya, Bangladesh, central Ethiopia, Kashmir valley of India, Nepal, Shimoga region of India respectively, which identifies higher rates of infestation as compared with our study. The detection of intestinal parasites among

horses' based on their sex was 23/113 (20.35%) for males, while the prevalence of females was 21/113 (18.58%). Males had a higher incidence than females, which agrees with Umar *et al.* (2013), who reported a prevalence of 80.9% for males and 38.5% for female horses in Nigeria.

However, Oli & Subedi (2018), Khanum *et al.* (2021), Romero *et al.* (2020), Kompi *et al.* (2021) and Ogbein *et al.* (2022) reports did not agree with our findings where there was a high incidence in females when compared to males with a prevalence of 92.30% and 82.27%, 100% and 95.45%, 25.23% and 22.02%, 92.2% and 85.3%, 79.5% and 68% in Nepal, Bangladesh, Central Mexico, Lesotho, Nigeria respectively.

In this study, a relatively higher prevalence of gastrointestinal parasites (16.8%) was recorded in adult horses aged between 5-10 years, which is in stark contrast with the previous findings of Elmajdoub *et al.* (2022), who reported a higher prevalence in young horses between 1-4 years. Moreover, Beley *et al.* (2016) study reported that horses above 10 years are more vulnerable to (GIPs).

The parasites detected in horses' feces belonged to *Parascaris equorum*, *Eimeria* spp., *Ascaris* spp., *Anoplocephala* spp., and *Gastrodiscus* sp., which is in agreement with reports by Umar *et al.* (2013), Ola *et al.* (2019), Sinaga *et al.* (2022), Roba & Hiko. (2022), Oli *et al.* (2018).

Gastrodiscus spp., infection rates were low (0.88%) and akin to the low rate reported by Mathewos *et al.* (2021) (5.6%), which was obtained around Hawassa in Ethiopia. Adeppa *et al.* (2016) also reported that *Gastrodiscus* spp. in Karnataka were similar (4.76%).

Furthermore, the infection prevalence was relatively low for *Parascaris equorum* (1.7%) and *Anoplocephala* spp. (2.65%) and similar to previous studies by Belay *et al.* (2016), Mirian *et al.* (2019), and Belete *et al.* (2015) for *P. equorum*, 3.1%, 4.42%, and 1.8%, respectively, and 3.1%, 6%, and 2% respectively for *Anoplocephala* spp.

We encountered negligible rates of infections with *Strongylus* spp., which aligns with reports by Elmajdoub *et al.* (2022). However, several other studies by Fikru *et al.* (2005), Ioniță *et al.* (2013), Liu *et al.* (2022), Pandit *et al.* (2008), and Umar *et al.* (2013) have found it to be a highly prevalent infection in horses (92.8%, 87.97%, 82.26%, 81.19%, and 68.8% respectively). The lower prevalence in the present study could be explained by the fact that all the tested horses were less exposed to contaminated food/water and underwent regular deworming treatment. Another reason might be because *Strongylus* spp. cannot tolerate and survive hot and dry environments (Cargi wood, 2020).

Conclusion

The current study revealed the presence of more than six genera of gastrointestinal parasites (GIPs) in horses in Riyadh, observing a prevalence of 38.93% of infected horses. These findings emphasize the vulnerability of horses to a spectrum of significant health challenges that may include gastrointestinal disorders, nutritional deficiencies, compromised immune function, decreased performance, and economic burdens associated with treatment costs. Furthermore, it is essential to explore the complex interplay of factors, including species, age, sex, housing conditions, and geographical location, which may influence susceptibility to gastrointestinal parasite infections in equine populations. By addressing these challenges and advancing our understanding of parasite epidemiology, we can develop more robust strategies for effective parasite control and safeguard equine health and welfare. However, it is important to acknowledge the limitations inherent in our study. The study's scope was constrained by the limited availability of diagnostic tests, with only fecal direct smear and flotation tests accessible within the research environment. Additionally, time constraints restricted using more advanced diagnostic techniques, such as polymerase chain recognition (PCR). Consequently, a portion of parasitic eggs remained unidentified, potentially impacting the comprehensiveness of the findings.

Recommendations

It is imperative to combine more advanced techniques, such as Polymerase Chain Recognition (PCR), Next-Generation Sequencing (NGS), and Fecal Egg Count Reduction Test (FECRT) That offer higher sensitivity and precision alongside conventional methods like direct smear and flotation tests, enhance equine parasite diagnostics. Expanding sample sizes and diversity will enhance the reliability and applicability of findings, necessitating the inclusion of horses from various geographical regions and management systems. Longitudinal studies are vital for monitoring parasite dynamics and informing targeted intervention strategies. Collaborative efforts among horse owners, researchers, veterinarians, and industry stakeholders are crucial for developing tailored parasite control strategies. Upholding rigorous quality assurance measures in diagnostic procedures is essential for maintaining the integrity of results. Ultimately, research outcomes should inform evidence-based policies and guidelines, guiding equitable parasite control practices for the welfare of equines worldwide.

REFERENCES

- Adeppa, J., Ananda, K. J., Krishna Murthy, C. M., & Satheesha, G. M. (2016). Incidence of gastro-intestinal parasites in horses of Shimoga region, Karnataka state. *Journal of Parasitic Diseases*, 40(3), 919-921
- Al-Qudari, A., Al-Ghamdi, G., & Al-Jabr, O. (2015). Prevalence of gastrointestinal parasites in horses in the Eastern Province of Saudi Arabia. *Scientific Journal of King Faisal University (Basic and Applied Sciences)*, 16(2), 37-47.
- Anazi, A. D. A., & Alyousif, M. S. (2011). Prevalence of non-strongyle gastrointestinal parasites of horses in Riyadh region of Saudi Arabia. *Saudi Journal of Biological Sciences*, 18(3), 299-303.
- Belay, W., Teshome, D., & Abiye, A. (2016). Study on the Prevalance of Gastrointestinal Helminthes Infection in Equines in and around Kombolcha. *Journal of Veterinary Science and Technology*, 7(5), 367-372.
- Belete, S., & Derso, S. (2015). Prevalence of major gastrointestinal parasites of horses in and around Mekelle (Quiha and Wukro). *World journal of animal science research*, 3(3), 1-10.
- Bellaw, J. L., & Nielsen, M. K. (2020). Meta-analysis of cyathostomin species-specific prevalence and relative abundance in domestic horses from 1975–2020: emphasis on geographical region and specimen collection method. *Parasites & Vectors*, 13(1), 1-15.
- Birke, L., & Hockenhull, J. (2015). Journeys together: Horses and humans in partnership. *Society & Animals*, 23(1), 81-100.
- Cargi wood, Jan (2020). Strongyles in horses in extension horses vol 2. supported in part by New Technologies for Agriculture Extension grant no. 2020-41595-30123.
- Carminatti, A., Chitolina, M. B., Ribeiro, A. B., Forest, M., Collet, S. G., Prestes, A. M., & Camillo, G. (2023). Occurrence and risk factors associated with gastrointestinal parasitism in horses reared in different systems. *Veterinary Parasitology: Regional Studies and Reports*, 42, 100890.
- Denizhan, V., & Karakuş, A. (2023). Incidence of gastrointestinal parasites by stool examination methods in horses in Van. *Turkish Journal of Veterinary Research*, 7(1), 27-32.
- Dwight, D. BOWMAN (2009). *Georgi's parasitology for veterinarians*. Saunders Elsevier, St. Louis.
- Elmajdoub, L. O., Mosaab, O., Alsaghir, O. A., & Shima, S. S. (2022). Investigation and Prevalence of gastrointestinal parasites of Equestrian Clubs Horses in Misurata, Libya. *European Journal of Biology and Biotechnology*, 3(6), 5-9.
- Englar, R. E., & Dial, S. M. (2022). *Low-cost veterinary clinical diagnostics*. John Wiley & Sons.
- Fikru, R., Reta, D., Teshale, S., & Bizunesh, M. (2005). Prevalence of equine gastrointestinal parasites in Western highlands of Oromia. *Bulletin of animal health and production in Africa*, 53(3), 161-166.
- Food and Agriculture Organization of the United Nations (FAO). (2022). Global Horse Population Statistics. FAOstat. <https://faostat.fao.org/>

- Halvarsson, P., Grandi, G., Hägglund, S., & Höglund, J. (2024). Gastrointestinal parasite community structure in horses after the introduction of selective anthelmintic treatment strategies. *Veterinary Parasitology*, 326, 110111.
- Ioniță, M., Buzatu, M. C., Enachescu, V., & Mitrea, I. L. (2013). Coprological prevalence and intensity of gastrointestinal parasites in horses in some Romanian studs: preliminary data. *AgroLife Scientific Journal*, 2(1), 207- 212.
- Khanum, H., Musa, S., Zaman, R. F., Sarkar, F., & Mitu, R. A. (2021). Seasonal Occurrence of gastrointestinal parasites in Horse (*Equus Ferus Caballus*) From Dhaka City Bangladesh. *Bangladesh Journal of Zoology*, 49(2), 301-319.
- Kompi, P. P., Molapo, S., & Ntsaoana, M. E. (2021). Prevalence and faecal egg load of gastrointestinal parasites in horses in maseru district, lesotho. *J. Anim. Health Prod*, 9(1), 5-12.
- Liu, S. H., Fan, X. Z., Li, K., & Hu, D. F. (2022). Analysis of the Major gastrointestinal parasites Community in Yili Horses in Zhaosu of Xinjiang, Western China. *Open Access Journal of Biological Sciences and Research*, 10(2), 2022.
- Maskato, Y., Dugdale, A. H., Singer, E. R., Kelmer, G., & Sutton, G. A. (2020). Prospective feasibility and revalidation of the equine acute abdominal pain scale (EAAPS) in clinical cases of colic in horses. *Animals*, 10(12), 2242.
- Mathewos, M., Girma, D., Fesseha, H., Yirgalem, M., & Eshetu, E. (2021). Prevalence of gastrointestinal helminthiasis in horses and donkeys of Hawassa District, Southern Ethiopia. *Veterinary Medicine International*, 2021.
- Mirian, S. J., Mohammadi, A., Asadi, M., & Ferdowsi, H. (2019). A survey on horse gastrointestinal worms in Tehran province. *Journal of Animal Environment*, 11(3), 63- 68.
- Nagar, S. R., Khatoon, S., Hakim Manzer Alam, K., Purohit, J. K., & Dixit, A. K. (2022). Epidemiological studies on gastrointestinal helminths of horses of Udaipur Rajasthan. *The Pharma Innovation Journal*, SP-11(9), 82-86.
- Nielsen, M. K., Facison, C., Scare, J. A., Martin, A. N., Gravatte, H. S., & Steuer, A. E. (2021). Diagnosing *Strongylus vulgaris* in pooled fecal samples. *Veterinary parasitology*, 296, 109494.
- Ogbein, K. E., Dogo, A. G., Oshadu, D. O., & Edeh, E. R. (2022). gastrointestinal parasites of horses and their socio-economic impact in Jos Plateau–Nigeria. *Applied Veterinary Research*, 1(2), e2022010-e2022010.
- Ola Fadunsin, S. D., Daodu, O. B., Hussain, K., Ganiyu, I. A., Rabi, M., Sanda, I. M., ... & Aiyedun, J. O. (2019). gastrointestinal parasites of horses (*Equus caballus* Linnaeus, 1758) and risk factors associated with equine coccidiosis in Kwara and Niger States, Nigeria. *Sokoto Journal of Veterinary Sciences*, 17(3), 35-4.
- Oli, N., & Subedi, J. R. (2018). Prevalence of gastro-intestinal parasites of horse (*equus caballus linnaeus*, 1758) in seven village development committee of rukum district, Nepal. *Journal of institute of science and technology*, 22(2), 70-75.
- Pandit, B. A., Shahardar, R. A., & Jeyabal, L. (2008). Prevalence of gastrointestinal parasitic infestation in equines of Kashmir valley. *Vet Scan*, 3, 22.
- Panova, O., Baranova, M., Kurnosova, O., & Khrestalev, A. (2023). Horse gastrointestinal parasites in the Moscow region. In *BIO Web of Conferences* (Vol. 71, p. 01064). EDP Sciences.
- Papazahariadou, M., Papadopoulos, E., Diakou, A., & Ptochos, S. (2009). gastrointestinal parasites of stabled and grazing horses in Central and Northern Greece. *Journal of Equine Veterinary Science*, 29(4), 233-236.
- Peregrine, A. S., Molento, M. B., Kaplan, R. M., & Nielsen, M. K. (2014). Anthelmintic resistance in important parasites of horses: does it really matter?. *Veterinary parasitology*, 201(1-2), 1-8.
- Pihl, T.H.; Nielsen, M.K.; Olsen, S.N.; Leifsson, P.S.; Jacobsen, S. Nonstrangulating intestinal infarctions associated with *Strongylus vulgaris*: Clinical presentation and treatment outcomes of 30 horses (2008–2016). *Equine Vet. J.* 2018, 4, 474–480
- Romero, C., Heredia, R., Miranda, L., & Arredondo, M. (2020). Prevalence of gastrointestinal parasites in Horses of Central Mexico. *Open Journal of Veterinary Medicine*, 10(8), 117-125.
- Scala, A., Tamponi, C., Sanna, G., Predieri, G., Dessì, G., Sedda, G., Buono, F., et al. (2020). Gastrointestinal Strongyles Egg Excretion in Relation to Age, Gender, and Management of Horses in Italy. *Animals*, 10(12), 2283. MDPI AG. Retrieved.
- Sinaga, L., & Tanjung, M. (2022, December). Manifestation of endoparasitic helminths in Sumba Horse (*Equus caballus*) in Citra Pesona Ladangku Animal Park. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1115, No. 1, p. 012015). IOP Publishing.
- Umar, Y. A., Maikaje, D. B., Garba, U. M., & Alhassan, M. A. F. (2013). Prevalence of gastro-intestinal parasites in horses used for cadets training in Nigeria. *J. Vet. Adv*, 3(2), 43-48.

- Valibasha, H., D'Souza, P. E., & Dhanalakshmi, H. (2019). Prevalence study of gastro-intestinal parasites in horses. *Intas Polivet*, 20(2), 229-234
- van der Kolk, J.H., & Veldhuis Kroeze, E.J.B. (2022). *Infectious Diseases of the Horse: Diagnosis, pathology, management, and public health* (2nd ed.). CRC Press.
- Wannas, H. Y. (2012). Prevalence of gastro-intestinal parasites in horses and donkeys in al diwaniyah governorate. *Al-Qadisiyah Journal of Veterinary Medicine Sciences*, 11(1), 148-155.