A review of endo- and ecto-parasites of equids in Iraq

Review Article

Firas Alali[1a]
Marwa Jawad[2b]
Qaes Talb Al-Obaidi[2c]

[1]Department of Veterinary Parasitology, Faculty of Veterinary Medicine University of Kerbala, Kerbala ,Iraq
[2]Faculty of Science, Department of Biology, University of Kerbala, Kerbala ,Iraq
[3]Department of Internal and Preventive Medicine, Faculty of Veterinary Medicine, University of Mosul, Iraq

ORCİD-
[a]0000-0002-3438-6453
[b]0000-0003-2927-9220
[c]0000-0002-1334-3745

Correspondence
Firas Alali
firas.o@uokerbala.edu.iq

Article info
Submission: 22-05-2021
Accepted: 27-01-2022
Online First: 26-04-2022
Publication: 30-04-2022

e-ISSN: 2548-1150
doi prefix: 10.31797/vetbio
• http://dergipark.org.tr/vetbio

ABSTRACT

This article summarizes the findings of the majority of Iraqi studies and lists the most common zoonotic and non-zoonotic parasites. As a result of the proper reporting of protozoa, helminthes, hard and soft ticks, a large number of parasites have been described and distributed throughout Iraq. *Toxoplasma, Theileria, Babesia, plasmodium, Anaplasma, Microfilaria, cryptosporidium, giardia, Eimeria, Balantidium,* and *Entamoeba* were among the protozoa that were frequently recorded. Helminths of the genera *Dicrocoelium, Habronema, Echinococcus, Dictyocaulus, Trichostrongylus, Parascaris, Oxyuris, Cyathostomum, Anoplocephala, Setaria*, and *Fasciola* have been reported to affect all types of horses, whether they are on grass or in stalls. Hard and soft ticks, as well as Sarcoptes, were the only ectoparasites that were frequently observed. Parasitic fly species from the *Gasterophilus* genus were also discovered. In Iraq, parasitic infections in horses are common and caused by a variety of parasites, posing a health risk and causing significant economic losses. Emaciation, fever, pale mucosal membranes, jaundice, colic, and diarrhoea are all symptoms of infected equines with piroplasms, which are also accompanied by anemia, leukocytosis, and hyperbilirubinemia. Parasitic infections are linked to a number of risk factors (age, gender, activity, location, and season), and zoonotic parasites pose a greater risk to horsemen. All parasitic infections should be treated intramuscularly, with the exception of ivermectin, which should be taken orally. Not only are coprological examinations to identify distributed species and chronic infections, but also modern methods are used to control vectors and conduct further research.

Keywords: Equine protozoa, piroplasma spp., Ticks, Equine helminths, Iraq

INTRODUCTION

Horses (*Equus ferus caballus*), donkeys (*Equus africanus asinus*), mules, zebras (*Equus zebra*), and other animals with similar characteristics are classified as "equine." The equine family serves a variety of functions in the agricultural economy, including transportation of farm products, firewood, water, recreational activities, and farm ploughing. Horses, donkeys, mules, and zebras are infected with a variety of parasite species that differ in life cycles, pathogenicity, epidemiology, and the drugs used to combat parasite infections (Scoles and Ueti 2015). Infection in these animals can be single or mixed, resulting in a variety of clinical signs. Intestinal, blood, and ectoparasite infections are all possible. Ectoparasites are a common target for many parasite species. Anemia, fever, diarrhea, colic, hemorrhage, pale mucosal membranes, jaundice, hyperbilirubinemia, emaciation, and death are some of the diseases that the infective parasites can cause in animals. Due to significant economic losses worldwide, the identified gastrointestinal (GI) and equine piroplasmosis (EP) parasites are the most serious problems for equids (Raue et al., 2017, Camino et al., 2019, Zhao et al., 2020).

How to cite this article
Alali, F., Jawad, M., Al-Obaidi QT. (2022). A review of endo- and ecto-parasites of equids in Iraq. *Journal of Advances in VetBio Science and Techniques*, *7*(1), 114-128. https://doi.org/10.31797/vetbio.940901

Babesiosis is a globally distributed infectious disease that causes equine babesiosis. It can be acute, sub-acute, or chronic. Equine piroplasmosis is a disease that is found in most subtropical and tropical regions of the world. The distribution and seasonal activity of biological vectors (ticks) that transmit and cause equine piroplasmosis (*Theileria* spp., *Babesia* spp., and *Anaplasma* spp.) have been linked (Scoles and Ueti 2015). Toxoplasmosis risk factors have been linked to equine protozoal myeloencephalitis (EPM), but clinical signs are uncommon. A neurologic disease caused by two apicomplexan protozoal parasites (*Neospora hughesi* and *Sarcocystis neurona*), which were previously unknown and limited to the autumn season (James et al., 2017). *Toxoplasma gondii* parasites were isolated from slaughtered horses destined for horsemeat as a possible source of human infection. One of the major risk factors for human toxoplasmosis is eating undercooked or insufficiently cured meat. In Serbia, *T. gondii* infection was found in slaughter horses, and viable *T. gondii* type III was discovered and isolated (Klun et al., 2017). Equine piroplasmosis is a tick-borne or transmitted disease of horses caused by single or mixed infections of two hemoprotozoal parasites (*Theileria equi* and *Babesia caballi*) (Hodgkinson, 2006, Ueti et al., 2008). Several infected equids are parasite carriers who show no clinical signs, making them one of the most dangerous factors in parasite transmission to other equids (Sunday Idoko et al., 2020). *T. equi* is thought to have a wider distribution and is more pathogenic than *B. caballi* in endemic (tropical and temperate) areas. *B. caballi*-infected horses have more severe hemolytic anemia; however, *T. equi* infections are mostly associated with leukocytosis (Camino et al., 2019). Equine piroplasmosis is a disease that affects horses, donkeys, mules, and zebras, as well as DNA parasites in camels and dogs. With *T. equi* infection, infected equids remain carriers for a long time, whereas infection with *B. caballi* is detected after only a few years (Onyiche et al., 2019). Horses and donkeys are infected with blood-parasites (*T. equi* and *B. caballi*) that can cause serious clinical diseases and have genetic diversity, as shown by phylogenetic analyses. In Jilin, China, two *T. equi* genotypes (A and E) were discovered (Zhao et al., 2020). Equid roundworms (Parascaris equorum) are uncommon but can affect young animals' growth and cause intestinal and respiratory symptoms. Other parasitic nematodes, such as *Oxyuris equi* (pinworm), are primarily irritants or nuisances, but persistent infection in some animals can lead to destruction around the perineum and tail head (Raue et al., 2017). There are three *Eimeria* species found in equids. *E. uninugulata* and *E. solipedum*, both named after horses, are considered invalid; only *E. leuckarti* is considered valid. Only oocytes and gamonts of *E. leuckarti* have been found recently; no asexual stages have been found. *E. leuckarti* infection has no clinical significance and is considered coincidental (Dubey and Bauer, 2018). Donkeys, unlike mature horses, are susceptible to infection by large strongyle (*Strongylus*) species and *Dictyocaulus arnifieldi*. Adult horses and donkeys can be significant sources of pasture contamination, and when they return from overwork, they can cause health problems and poor nutrition, as well as poor performance and physical condition, as well as serious pathological conditions such as severe diarrhea, colic, and even death (Brady and Nichols, 2009; Sazmand et al., 2020). The use of macrocyclic lactones (ML), ivermectin, and moxidectin reduced large strongyle infections in equine populations, while strongyle resistance to ivermectin, doramectin, and fenbendazole increased. In adults and small animals, the previous anthelmintics were highly effective against pathogenic larval stages (Hodgkinson, 2006). Cestocides, which were once widely regarded as pathogenic, could be to bear responsibility for the decrease in anoplocephalid infection (Raue et al., 2017, Hodgkinson, 2006).

Anoplocephala perfoliata is a common parasite that affects horses and donkeys. It has an indirect life cycle that involves an oribatid mite. While common trematodes (*Fasciola hepatica*) that affect donkeys, the adult fluke of *A. perfoliata* is found in the bile ducts and clinical signs are not usually detected in infected donkeys, the intensity was mostly in donkeys over the age of 8 years (Matthews and Burden, 2013). Coproscopical methods have been widely used in veterinary parasitological diagnostics, and their sensitivity (Se) and egg recovery rate have been validated (Becker et al., 2016). Different species of Ixodides were previously recorded as hard ticks with a cosmopolitan distribution, especially in moderate regions among the Ixodidae. Agents are transmitted by ticks belonging to the genera *Rhipicephalus* spp., *Hyalomma* spp., and *Dermacentor* spp. Because they transmit various protozoal, bacterial, and viral agents to humans and animals, they are of enormous medicinal and veterinary importance. Tick-borne protozoans may be transferred vertically across generations as well as transstadially and intrastadially within one tick generation. The protozoal pathogen was efficiently acquired by *Rhipicephalus microplus* male ticks during acute and chronic infections, and they transmitted it intrastadially to naïve horses and persistently infected horses, indicating that they should be targeted for disease prevention (Scoles and Ueti 2015, Ueti et al., 2008). Many articles about equid parasites have been published in Iraq, describing the various infections that are endemic and widespread across the country's governorates. Because this breed is primarily used for presentations, Iraqi Arabian horses have a high value among Arabian horses, which is primarily associated with their exterior conformation. The body shape of Iraqi Arabian horses is characterized by an increase in body length when compared to body weight, as well as a short back line. The Iraqi Arabian horse excels in sporting events and has a high lyse for long distances (Mohamed, 2017). The parasites infection, particularly gastrointestinal parasites, was encountered in 100% of the horses and donkeys, and the factors cold, hot, and rainy season had an effect on the distribution of infections (Albadrani and Aldelami, 2009; Esmaeel, 2010; Wannas, 2012; Zangana et al., 2013).Equine piroplasmosis (EP) is a tick-borne protozoal disease of horses, donkeys, mules, and zebra that has been infected by blood protozoal parasites (*Theileria equi* or *Babesia caballi*) in Iraqi horses (Fig. 1,2). It results in significant economic losses for the equids (Khalid Jabar et al., 2019; Sray et al., 2019). The EP is characterized by fever, jaundice, anemia, loss of appetite, and, in some cases, sudden death, and is found in most regions of Iraq (Alsaad, 2014). In equids, four 18S rRNA genotype clades were found for *T. equi* (A, B, C, and D) and two for *B. caballi* (A and B) (Aziz et al., 2019). Infected equids may be long-term carriers of these protozoal parasites (Alsaad et al., 2012). Equine anaplasmosis (*Anaplasma phagocytophilum*) is a bacterial/protozoan disease diagnosed in horse blood and transmitted by various ticks. Some reservoir hosts of agents, such as *Hyalomma* spp. and *Rhipicephalus* spp., also play a role in their transmission (Albadrani and Al-Iraqi, 2019). Other coccidian parasites have been infecting animals, such as *Toxoplasma gondii* in horses (Mikaeel and Al-Saeed, 2020; Hussain, 2011), Microfilaria and *Plasmodium* sp. in horses and Donkeys (Hadi and Atiyah, 2014), and only Microfilaria (*Setaria* spp.) in horses (Suleiman et al., 2020). Equine babesiosis is a tick-borne illness that affects horses and is caused by the protozoan parasites (*T. equi* and *B. caballi*) (Albadrani and Al-Iraqi, 2019). Fever, icterus, pale mucous membranes, and hemoglobinuria are among the symptoms of equine babesiosis, which may lead to a loss of condition and even death (Alsaad et al., 2010). The protozoan parasites are naturally transferred from host to host by hard tick vectors, and vertical transmission of *T. equi* and *B. caballi* infection in utero has been recorded (Khalid Jabar et al., 2019). *Babesia* may infect a fetus at any stage of pregnancy, and it can also induce abortions in enzootic areas. Infected horses may carry *T. equi* infections for the rest of their lives, while infected equids can carry *B. caballi* for up to four years. Furthermore, unlike *B. caballi*, *T. equi* is not totally cleared from horses' blood following natural recovery or therapy (Alsaad et al., 2012; Aziz and AL-Barwary, 2020). In certain cases, the clinical indications of piroplasmosis infection are non-specific and varied. The sickness may be acute, chronic, or sub-clinical, with the diseased animal aiding in the transmission of the agents. However, in chronic and sub-clinical cases, it is sometimes difficult to identify the protozoans in blood smears of carrier equids. High fever, jaundice, petechiation, depression, anemia, dyspnea, sweating, eyelids, decreased appetite, colic, incoordination, and distal limb edema are all symptoms of an acute infection (Al-Rammahi et al., 2020; Al-Saad, 2009). Infections with zoonotic gastrointestinal protozoa (*Cryptosporidium* spp., *Giardia* spp., and *Eimeria* spp.) have been found in wild and farmed equines, suggesting that they might be sources of contamination. People may get infected by direct contact with horsemen and other humans, as well as recreational horses (Altaee et al., 2014). *Cryptosporidium* spp. and *Giardia doudenalis*, which cause watery diarrhea in horses and foals and must be prevented from spreading to people and causing substantial losses, were among the most zoonotic protozoan infections (Fig. 3 and 4). Horse *Cryptospridium* oocytes are 4-5 microns in diameter, have a tiny spherical form, and are pink in color (Mahdi and Ali, 2002; Butty, 2011; Moosa, 2019). *Eimeria leuckarti* is more frequent in foals, although the prevalence of other species is unknown (Kalef, 2015).

Microscopical assays, including Giemsa stain, direct smear, sedimentation, zinc sulphate flotation, Sheather's sugar saturated flotation method, acid ether technique, formalin-ether sedimentation concentration method, modified Ziehl-Neelsen method, cellophane tape methods, and the McMaster method, are the most commonly used diagnostic methods in Iraq. Although serological approaches have lower sensitivity than contemporary tests, they are beneficial in chronic infections. Molecular methodology is a highly important and reliable diagnostic procedure for the identification of hemoparasite species (Albadrani and Aldelami, 2009; Esmaeel, 2010; Wannas, 2012; Zangana et al., 2013; Khalid Jabar et al.,2019; Albadrani and Al-Iraqi, 2019; Mahdi and Ali, 2002; Abdul-Majeed and Al-Saad, 2006; Faraj et al., 2019; Alali et al, 2021b).

Mange mites, lice, and ticks are among the ectoparasitic diseases that pose a significant concern to humans, including horse owners, farmers, and even pigeon fanciers, and may transmit a variety of zoonotic parasites (Alali et al., 2020a; Faraj, 2013; Hasson, 2016). Ticks are distinguished by different species within the same genus and different distributions of disease vectors (ticks), resulting in the most prevalent diseases and widespread distribution in northern Iraq (Mustafa, 2019; Aziz and AL-barway, 2019), central Iraq (Mohammad, 2015), and southern Iraq (Hajeel and Abd Alfatlawi, 2019).

Helminth infections in horses and donkeys might appear healthy, and donkeys seldom exhibit indications of significant illness (weight loss, diarrhea, poor condition, or colic), but horses do (Zangana et al., 2013). Many species of horse helminthes were found in fresh vegetables, including *Echinococcus* sp., *Oxyuris equi*, *Habronema* sp., *Parascaris equroum*, and *Strongyloides westrei*. This is due to urban gardeners increasingly irrigating their agriculture regions with waste water, and the spread of parasites in the north and middle of Iraq may be due to the reuse of equine feces for man (Hadi, 2011). The giant strongyle (*Strongylus vulgaris*) is the most pathogenic strongyle species in Iraq, causing thrombosis and thromboembolic colic. *Strongylus vulgaris* is more common and harmful among equid parasites, and it is widely dispersed among grazing horses, posing a danger to equine health across the globe (Zangana et al., 2013).

Draught horses were infected with gastrointestinal and lung worms, which could be recognized by coprological tests. Many kinds of nematodes and cestodes were found. Emaciation, pale mucous membranes, rough coat, loss of appetite, black spots on the gum and lip, diarrhoea and/or constipation, colic, worms with mucoid feces, anal pruritis, moist raised, high heartbeat, and coughing are all symptoms of helminth infection. Worms infect diseased horses, causing macroscopical and histological lesions in one or more organs (Abdul-Majeed and Al-Saad, 2006; Esmaeel, 2010). *Gastrophilus* species, particularly *G. intestinalis*, are gastrointestinal parasites that adhere to the stomach's surface. The pathophysiology of the larvae is linked to inflammatory reactions (Daoud et al., 1989). This study have been conducted to summarize the previous studies in field of equids of Iraq.

MATERIAL and METHOD

For the survey evaluation, electronic databases of endo, ecto, and blood-borne parasites in equids in Iraq were obtained for the survey. Dissertations, Google Scholar, Research Gate, Academia, and the official site of higher education and scientific research (https://www.iasj.net) are all examples of references. The references were arranged in one table by type of infection (external, internal, tissue, and blood parasites) and by date of publication (oldest to newest) as well as type of host, methods of diagnosis, number of specimens, percentage of infection, province, genera and species of agents, and provinces. All relevant papers were found by searching the titles of publications using the phrases (equids, horse, donkey, ecto-, endoparasites, and hemoparasites). The relevant publications were evaluated, and important information about equids was chosen and provided, including author information and publication year (Table 1).

Table.1. A summary of the prevalence of parasitic infections in Iraqi equids.

Host type	ectoparasite/protozoa	helminth	Diagnostic Technique	Sample Size	Prevalence (%)	Province	Reference
Horses	*Boophilus annulatus, Hyalomma detritum, Hyalomma anatolicum anatolicum Rhipicephalus turanicus, Rhipicephalus sanguineus sanguineus*	-	Microscopic examination	----	6.6%, 20%, 40%, 26%, 6.6%	Nineveh	Al-Moula and Rahemo, 2004
Drought horses	*1- Tick species Rhipicephalus sanguineus , Boophilus annulatus and Hyalomma anatolicum excavatum* *2- Theileria equi, , Babesia caballi, Mixed infection* *3- Sarcoptes scabiei*	-	Microscopic examination	21	1- 27.7% 2- 15.5%,14.4% , and 10% 3- 16.6 %	Baghdad	Faraj, 2013
1-Horses **2-Donkeys**	Ixodid ticks *(Hyalomma anatolicum Rhipicephalus (Boophilus) annulatus*)	-	Microscopic examination	1- 10 2- 5	50% 20%	Baghdad, Wasit, Babil, Al-Diwaniya, Al-Muthana, Al- Najaf Al-Ashraf, Kerbala, Missan, Basrah and Thi Qar.	Shubber et al., 2014
1-Horses **2-Donkeys**	Ixodid ticks1-*(Hyalomma anatolicum, H. scupense and Rhipicephalus annulatus)*, 2-*(Rhipicephalus annulatus)*	-	Morphological features	1- 8 2- 6	1-1(12.5%) 2-1(16.7%)	central region of Iraq	Mohammad, 2015
Equine (horse, mule	*Boophilus annulatus Boophilus microplus Hyalomma marginatum Hyalomma excavatum*	-	Microscopic examination	349 equids	39.8%, 16.3%, 12.2%, 10.2%, 21.4%	Erbil	Aziz and AL-barwary, 2019

donkey and pony)	*Rhipicephalus turnicus*						
Equids	*Hyalomma marginatum marginatum, H. anatolicum exacavatum), Boophilus microplus,* *B. annulatus* *Rhipicephalus turanicus)*	-	1-conventional 2- multiplex polymerase chain reaction technique (c-PCR, m-PCR) targeting 18S rRNA gene	349	1-98% 2-20%	Erbil	Aziz and AL-Barwary , 2020
Horse	Mange (*sarcoptes scabei var equi*)		Morphological characteristics	72	1.4%	Diyala	Hasson, 2016
Foals	*Babesia equi* *Babesia caballi*	-	c-ELISA test	105 Blood	81.11% , 18.88%	Mosul	Al-Saad, 2009
Drought horses	A- *Babesia equi* B- *Babesia caballi*	-	c-ELISA	115	A-78/90, (86.58%) B-49/90 (54.39%)	Basrah	Alsaad et al.,2010
1-Horses **2-Donkeys**	A-*Babesia equi* B- *Babesia caballi*		c-ELISA	1-(46) horses 2-(45) donkeys	A-1-33(71.73%) horses and 19 (42.22%)donkey B- 9(19.56%) horses and 2 (4.44%)donkeys	Mosul	Alsaad et al., 2012
Newborn foals	*Babesia equi*		1-Microscopical 2-Competitive c-ELISA	62	1-3/62(53.22%) 2-33/33(100%)	Mosul	Alsaad, 2014
Horse, Mule Donkey, Pony	*Theileria equi* , *Babesia caballi* Mixed infection		1-Microscopic examination 2-c-ELISA	Total 349 blood	1- Total=10.6% 8.3%, 1.7%, 0.6 2-otal=38.97% 20.9%, 11.2%, 6.9%	Erbil	Khalid Jabar et al.,2019
Horse, Mule Donkey, Pony	*Theileria equi* , *Babesia caballi* Mixed infection		mPCR	136 blood	Total= 55.88% 41.91%, 8.82%, 5.15%	Erbil	Aziz et al., 2019
Dragging horses	*Theileria equi and Babesia caballi*		1-Microscopical 2-Molecular (18s rRNA gene)	150	1-25/150 (16.66%) 2-9/25(36%)	Baghdad	Faraj et al., 2019
Horse	*Theileria equi*		-c-ELISA -Polymerase chain reaction (PCR).	130	- 36.92% -5.38%	Baghdad, Al-Qadisiyah, Wasit	Sray et al.,2019
Horse	*Theileria equi* (equine theileriosis)		-Polymerase chain reaction (PCR).	110 blood	38.18%	Al-Najaf	Al-Rammahi et al., 2020
Horses	*Anaplasma phagocytophilum*		Blood smears or buffy coat smears	45 blood smears	33.3 %	Mosul	Albadrani and Al-Iraqi, 2019
Horses	*Toxoplasma gondii*		Indirect ELISA PCR	62 Blood	17.7% , 18.2%	Duhok	Mikaeel and Al-Saeed, 2020
Donkey	*Toxoplasma gondii*		Latex agglutination test, Modified latex agglutination test , 2-mercaptoethanol test and Indirect ELISA test (Indirect IgG ELISA)	52 Blood	46.15 %, 8.33%, 91.67 %, 22.72%	Mosul	Hussain, 2011
Horse **Donkey**	*Plasmodium* sp.	Microfilaria	Microscopic examination of blood smear	54 blood	11.11% 5.55%	Baghdad university	Hadi and Atiyah, 2014

Horses	*Cryptosporidium muris*		Direct smear method, Modified acid fast stain and then formalin-ether sedimentation	25	3(12%)	Basrah	Mahdi and Ali, 2002
Horse	1-*Cryptosporidium sp*., 2-*Giardia doudenalis*		Wet mount, Flotation, lugol's iodine, Modified Ziehl Nelsecn (hot), Giemsa	107 fecal	Total=19.63% 27.10, 19.63	Nineveh	Butty, 2011
Horses	1-*Giardia spp.*, 2-*Cryptosporidium spp.*		1-Direct wet smear, 1-Lugol's iodine smear 2-Modified Ziehle Nelseen stain.	180 fecal (92 horses,	1- 4.45% 2- 64.13%	Baghdad	Altaee et al., 2014
-Adult Drought Horses -foals	*Cryptospridium sp. oocyst*		Microscopical examination (Modefied acid fast stain and Lugol's iodine stain)	50 fecal	30% (4%, 26%)	Mosul	Moosa, 2019
1-Draught horses. 2-Fourosia club horses	*Eimeria* oocysts		Direct method a Flotation technique.	Total 369 fecal 136 , 233	Total= 20.32% 30.14%, 14.59%	Baghdad	Kalef, 2015
Horse	-	*Gastrophilas intestinalis*	By Grossly	1-horse	------	Mosul	Daoud et al.,1989
Draught stallions	-	*Large strongyles, Parascaris equorum, Small strongyles (Cyathostomins), Dictyocaulus arnfieldi, Strongyloides westeri, Trichostrongylus axei, Oxyuris equi, Anoplocephala perfoliata, Parapnocephala mamillana and Gasterophilus intestinalis*	Flotation,sedimentation and Baermann technique	150	125(83.33%)	Mosul	Abdul-Majeed and Al-Saad, 2006
Draught stallions	-	*Large strongyles, Parascaris equorum, Small strongyles (Cyathostomins), Strongyloides westeri, Trichostrongylus axei, and Oxyuris equi*	Comparison treatment Between ivermectin(Oral paste 0.2mg/kg) and Oxybendazole(Oral suspension 10mg/kg)	20	Ivermectin in 14 days, while Oxybendazole 21 days	Mosul	Al-Saad and Abdul-Majeed, 2006
Drought horses	-	*Strongylus spp, Oxyuris equi* and *Parascaris equorum*	-Flotation method, Sedimentation method. -Single dose of mixture of ivermectin and Closantel	19 fecal	31.58%, 15.75%, 10.52%	Mosul	Albadrani and Aldelami, 2009
Native Donkeys	*Habronema musca,*	Large strongyles *Strongylus* spp., *Triodontophorus* s	Coprological examinations	70 fecal	70%, 36.6%, 33.3%, 33.3%, 20%, 13.3%,	Mosul	Esmaeel , 2010

		pp., Small strongyles (caythostomines), *Trichostrongylus axei*, *Parascaris equorum*, *Dictyocaulus arnfieldi* *Strongyloides westeri*, *Oxyuris equi*, *Gastrodiscus* spp +*Dicroceolium* sp p.			10%, 10%, 6.6%, 3.3%.		
Horse		*Oxyuris equi*, *Habronema sp.* *Parascaris equroum*, *Strongyloides westrei*	Sedimentation	60	27(45%),27(45 %)19(31.6%), 18(30%)		Hadi, 2011
1- Horses 2-Donkeys	*Cryptosporidium* spp., *Balantidium coli* and *Eimeria* spp. and *Entamoeba coli*	*1-Strongylidae*, *Parascaris equorum*, *Strongyloides westri*, *Trichostrongylus axei*, *Oxyuris equi*, *Strongylidae*, *Parascaris equorum*, *Strongyloides westri*, *Trichostrongylus axei*, *Oxyuris equi*, *Dictyocaulus arnfieldi*,	Flotation method, Sedimentation method Direct smear method.	100: fecal 1- 44 2- 56 100% In 1-& 2-	1- 50%, 40.90%, 22.72%, 25%, 11.36%, 0.45%, 15.90%, 6.81% 2- 57.14%, 2.14%, 28.57%, 7.85%, 17.85%, 7.85%, 19.64, 17.85%, 10.71% , 3.57%	Al Diwaniyah	Wannas, 2012
Horses	*Eimeria leukarti*	*Strongylus vulgaris*, *Parascaris equorum* *Oxyuris equi*, *Strongyloides westeri* *cestoda* *Anoplocepha spp.*,	Acid ether technique, Flotation concentration Cellophane tape methods	92 fecal	29.35%, 19.56%, 8.7%, 5.43%, 4.35%, 3.26%.	Erbil	Zangana et al., 2013
Horses		Microfilaria (*Setaria spp.)*	Knott's technique	78	30.76%	Mosul	Suleiman et al.,2020

Risk factors of endo and ectoparasites in equids

Several studies in Iraq have shown differences in hard tick infestation rates and their relationship to monthly frequency. The prevalence of infestation of hard ticks increases during rainy seasons and decreases during dry seasons and this is linked to the necessity for tick eggs to have a high humidity rate for hatching, which may reach 60% (Estrada-Pea et al., 2006). The number of mites decreases in the summer and grows in the winter owing to changes in temperature and humidity, which impact the mite's spread, the rate of egg laying and growth, and the mite's reproductive activity, which increases in the fall and is more active in the winter (Littlewood, 2011). In Iraq, the largest percentage of equid infestation was observed in April, while the lowest infection rate was recorded in November, with no infestation reported in December, January, or February (Aziz and AL-barwary, 2019; Faraj, 2013). This explains why the environmental parameters, such as humidity and temperature, are insufficient for tick reproduction and movement. These variances might be related to variations in environmental parameters, such as rainfall, temperature, and relative humidity. Erbil province is situated between mountains and hills, as well as plains. The northern parts are mountainous, the eastern areas are semi-mountainous with hills, and the western sections are hilly, but the southern areas are flat. Furthermore, there are differences in the rates of infestation across various locales. The North zone of Erbil province had the highest rate of hard tick infestation, while the West zone had the lowest rate. There were no statistical differences between the East and South zones (Aziz and AL-barwary, 2019). *Boophilus annulatus* was the most common species among equids in this study in Iraq's Erbil provinces (Aziz and AL-barwary, 2019). Furthermore, Shuber et al. (2014) and Mohammed (2015) observed *B. annulatus* infestation rates of 12.5% and 16.7% in horses and donkeys in central Iraq, respectively. This might be because the majority of horses were transported from Baghdad and central Iraq to the province of Erbil. In Iraq, the greatest occurrence of *Sarcopties sacbiei* mange in horses was in November, with 10%, and the lowest incidence was in January, with no infection recorded in September, October, April, or May (Faraj, 2013). Equine piroplasmosis (EP) susceptibility is influenced by a variety of parameters, including the type of equid, gender, age, breed, health state, origin, activity, pregnancy, seasons, management, and the presence of ticks on the animal (Garca-Bocanegra et al., 2013; Sumbria et al., 2016). (Aziz and AL-Barwary, 2019) said that there were no significant variations in the types of equids, gender, or age categories, indicating that EP is common in Iraq's Erbil governorate. According to Alsaad et al. (2012), the seroprevalence of *Babesia caballi* and *Theileria equi* was much greater in horses than in donkeys, and vice versa. Furthermore, infection rates were substantially greater in females than in males according to gender (Sray et al., 2019; Al-Rammahi et al., 2020). Female horses appeared to be infected with microfilariae at a greater rate than male horses (Hadi and Atiyah, 2014). The rationale is that stress-induced immune suppression during the third trimester of pregnancy and parturition may be the outcome of greater protozoan infections in female equids, particularly if continuously infected, increasing their risk of disease exposure (Afridi et al., 2017). Significant age differences were found between infected horses with EP, with equines under 2 years old being more infected than equines over 2 years old (Al-Rammahi et al., 2020). Prochno et al., 2014 and Faraj et al., 2019 concluded that the prevalence of *T. equi* and *B. caballi* in all ages of equids was the same. Theileria equi levels were significantly higher in recreational equines than in racing equines (Aziz and AL-barwary, 2019; Sray et al., 2019).This might be due to a physical stressor that temporarily suppresses the immune system, and animals with impaired immune systems have been proven to be more vulnerable to infection (Sevinc et al., 2008). Significant differences in horse theileriosis were also observed across geographical locations. This difference might be attributed to differences in the distribution of the disease vector (tick), as well as the availability of ideal weather that aided in the multiplication of intermediate vectors (Al-Rammahi et al., 2020). When equids infected with ticks were compared to equids not infested with ticks, the prevalence of *T. equi* was significantly higher. Furthermore, when equids maintained with other animals were compared to equids kept alone in the stable, the seroprevalence of EP was two times greater (Aziz and AL-barwary, 2019). In general, geographical areas within and across governorates in Iraq had a substantial impact on the seroprevalence of *T. equi*, *B. caballi*, and both protozoa infections (Sray et al., 2019; Al-Rammahi et al., 2020). Management techniques, host activity, sample size, the existence of competent tick vectors, and other meteorological conditions such as temperature, humidity, and rainfall that affect tick habitat (Kouam et al., 2010, Garca-Bocanegra et al., 2013), may all have a role in seroprevalence. In addition, as compared to May, the seroprevalence of EP was significantly higher in July, November, and December (Aziz and AL-barwary, 2019). Also, Golynski et al., 2008, who found that EP prevalence is influenced by seasonal factors. These results, however, contradict those of Moretti et al. (2010), who reported that the season had no effect on the incidence of EP infection. The prevalence of the genus *Eimeria* in draught horses in Iraq varied significantly during the months. April, May, and June had the greatest prevalence, while January and December had the lowest (Kalef, 2015). Within the group of draught horses infected with *Eimeria* spp., there was no statistically significant difference in prevalence between males and females. Furthermore, the seroprevalence of *Eimeria* spp. was considerably greater in draught horses and Fourosia club horses at the ages of 2-4 and 4-6 years (Kalef, 2015). Furthermore, male horses were infected with *Cryptosporidium* spp. and *Giardia* spp. at a much higher rate than female horses.In Iraq, Cryptosporidium infection is very common in both humans and animals (Alali et al., 2021b). While the age of the horse has no effect on the infection rate with these protozoa, the prevalence of *Cryptosporidium* spp. and *Giardia* spp. in horses has been shown to vary significantly across geographical areas (Butty, 2011; Altaee et al., 2014). In contrast, Moosa, 2019 stated that the infection rate of Cryptosporidium spp. was substantially greater in foals than in adults. Furthermore, infection with equine worm eggs is common in the north and center of Iraq, may be owing to the presence of equines (horses and mules) in these regions' communities and mountains (Hadi, 2011). In the case of equine helminth, there were significant differences in the percentages of infections in horses and donkeys of various ages, but no significant differences in the percentages of infections in males and females of horses and donkeys (Wannas, 2012). According to Zhangana et al. (2013), the prevalence rate of infection was higher in young horses under the age of 5 years than in older horses.

Treatment of Equids

Parasites should be controlled permanently to reduce the effect it on equids. Most of drugs are traditional and used in treatment of adults and foals. A single dose of ivermectin 0.2 mg/kg BW as an oral paste was shown to be more effective than a single dose of oxibendazole 10 mg/kg BW as an oral solution in treating draught horses with gastrointestinal and lung worms (Al-Saad and Abdul-Majeed, 2006). At 14 days after treatment, a mixture of ivermectin and closantel was 100% effective in eradicating eggs of *P. equorm* and *O. equi*, and 99.42% for *Strongylus* spp, as well as larvae of *Gastrophilus nasalis* (Albadrani and Aldelami, 2009). Pyantel, tetrahydropyrimidines, benzimidazoles, and macrocyclic lactones may have been used to control horse nematodes.

Antihelmintic resistance in horse cyathostomins and *Parascaris equorum* may develop as a result of improper usage of anthelmintics (Hodgkinson, 2006; Raza et al., 2019). There are a variety of medications available to treat EP, each with varying degrees of efficacy. Some pharmaceuticals, such as oxytetracycline hydrochloride, tetracycline, and anti-theilerial compounds such as parvaquone and buparvaquone, are known to be less successful for treating *T. equi* (AL-Mola and Al-Saad, 2006). When administered at two doses of 4 mg/kg body weight IM within 48 hours, imidocarb dipropionate was shown to be effective in the treatment of EP infection in horses, with treated animals recovering entirely, appearing normal and clinical signs returning to normal on the sixth day (AL-Mola and Al-Saad, 2006). In addition, a supportive therapy for EP treated with imidocarb dipropionate may include aspirin at a dosage of 10 mg/kg of body weight IM, repeated after 48 and 72 hours, and heparin at a dose of 100 IU/kg of body weight subcutaneously, repeated after 48 and 72 hours (Alsaad and Mohammad, 2011).

DISCUSSION

Parasitic diseases infect a variety of hosts and are found throughout the world, causing significant economic losses. The variation in prevalence rates might be attributable to sample size differences and environmental factors that impact both parasites and vectors. These findings could be due to the high number of ticks in Iraq and the equids' constant exposure to infected ticks. Equine piroplasmosis (EP) is a tick-borne disease that causes fever, jaundice, petechiation, depression, anemia, dyspnea, sweating, conjunctivitis, decreased appetite, colic, and sudden death in horses. It is caused by two hemoprotozoal parasites (*Theileria equi* and *Babesia caballi*) (Zhao et al., 2020). Table 1 depicts the frequency of infection (up to 100%) and the diverse group of parasites that affect it, particularly hemoparasites. Helminthes (roundworms and flatworms) infecting ruminants, horses, and birds may infect domestic and wild animals (Raue et al., 2017; Matthews and Burden, 2013; Hamzah, 2020). Many factors, both direct and indirect, might have an impact on young animals. Because several major helminth parasites that infect donkeys also infect horses, animals that co-graze may be a source of infection for both helminthes. Infection of the gastrointestinal tract is known to be acquired passively via the eating of infective larvae on pasture (Hadi, 2011). The apicomplixan parasites (*C. parvum, E. lukarti*, and *G. intestinalis*) are zoonotic gastrointestinal protozoans that are linked with diarrhea, colic, and lack of appetite. Different parasites may infect all grazing animals, and certain animals may infect all humans and animals in the same region (Altaee et al., 2014). Donkeys, on the other hand, co-graze with horses and have permission to highly transmit to others. The flukes, *Fasciola hepatica* and *Dictyocaulus arnifildi* may also infect horses. This flatworm may be passed from ruminants to equids through snails on grass. In Iraq, ticks were the most prevalent ectoparasite isolated from horses. Ticks are non-permanent, obligatory ectoparasites of vertebrates and the most common ectoparasites of vertebrates, posing a severe hazard to human and animal health (Ueti et al., 2008; Al-Moula and Rahemo, 2004; Shubber et al., 2014). Infections varied significantly according to epidemiological risk variables (gender, age, location, activity, and season). Adequate feed supply and limiting prolonged open grazing of donkeys and horses are critical. Overworking/overloading, poor husbandry practices, general negative attitudes toward this species, and limited veterinary care programs are all risk factors (Camino et al., 2019; Sray et al., 2019). Microscopical diagnosis is unreliable, particularly during chronic infection of equids with equine piroplasmosis, whereas serological surveys may be useful in detecting infections but are not specific, and using modern methods, such as molecular and nanotechnology, which are more specific, for species identification (Sray et al.,2019). Chemical medications are more prevalent in Iraq, and resistance to anthelminthic pharmaceuticals may develop. These animals are mostly utilized for sport clubs, transportation systems, raising awareness among animal owners, and providing adequate deworming and preventives to lessen the parasites' economic impact (Matthews and Burden, 2013).

CONCLUSION

The frequency of parasitic illnesses in equids in Iraq was found to be quite high in this study. Due to the huge number of different horse parasites documented in recent literature reviews, as well as the few studies completed in Iraq, further research is needed. The variability in parasite prevalence rates in these studies can be attributed to a number of factors, including the analysis techniques used, sample size, farmers' lack of use of anthelminthics, and feeding horses on pastures contaminated with infected eggs or third stage, which can cause re infection and remain in the ground, while food and pastures persistently become sources of infection. These findings stimulate the development of further diagnostic techniques for detecting all *T. equi* and *B. caballi* genotypes in other animals in order to reduce the danger of importing carrier equines into Iraq. Finally, parasitic illnesses and infestations of equines are common in Iraq and are caused by a wide range of parasites (protozoa, helminthes, ectoparasites, and parasitic flies) that endanger the health and wellbeing of the animals. In order to effectively manage the parasites, further study is required in Iraq to uncover new species, chronic infections, and infection risk factors.

ACKNOWLEDGMENT

The authors would like to express their grateful to all authors are specialists in equine parasitology.

Conflict of interest: No conflicts of interest have been declared.

REFERENCES

Abdul-Majeed, M. and M Al-Saad, K. (2006). Clinical and pathological effects of gastrointestinal and lung worms on draught horses in mosul. *Iraqi Journal of Veterinary Sciences*, 20(1), 71-80. 10.33899/ijvs.2006.45786.

Afridi, M. J. K., Abdul Hafeez, M. I. A. N., Saqib, M., Abbas, G., Javid, A. L. I., and Mansoor, M. K. 2017. Seroprevalence and risk factors for Theileria equi infection in equines from Khyber Pakhtunkhwa Province, Pakistan. *Iranian journal of parasitology*, 12(4),597. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5756310/.

Alali, F., Alhaitami, I., Jawad, R.A. and Jawad, M. 2020a. Identification of two new species of chewing lice in pigeon (Columba livia domestica) in Kerbala Province, Iraq. In *AIP Conference Proceedings*, 2290(1),020037. https://doi.org/10.1063/5.0027457.

Alali, F., Abbas, I., Jawad, M., & Hijjawi, N. 2021b. Cryptosporidium infection in humans and animals from Iraq: a review. *Acta Tropica*, 105946. https://www.sciencedirect.com/science/article/abs/pii/S0001706X2100125X

Albadrani, B. A., and Al-Iraqi, O. M. 2019. First detection of equine anaplasmosis and hemoplasmosis of horses in Mosul city, Iraq. *Adv. Anim. Vet. Sci*, *7*(2), 106-111. http://dx.doi.org/10.17582/journal.aavs/2019/7.2.106.111.

Albadrani, B., and Aldelami, M. 2009. Therapeutic efficacy of a mixture of ivermectin and closantel against gastrointestinal parasites in draft horses. *Iraqi Journal of Veterinary Sciences*, *23*(1), 37-42. 10.33899/ijvs.2009.5681.

AL-Mola, G. and Al-Saad, K. 2006. Clinical and pathological study of equine babesiosis in draught horses in mosul. *Iraqi Journal of Veterinary Sciences*, 20(1), 89-101. 10.33899/ijvs.2006.45787.

Al-Moula, I.D. and Rahemo, Z. I.2004.Taxonomic study on the species of Ticks parasitizing some Mammals in Nineva Governorate. Rafidain Journal of science, 15(4), 113-129.

Al-Rammahi, H. M., Hatem, A. A., Al-Atabi, A. C., and Al Salihi, K. A. 2020. Molecular detection and occurrence of equine theileriosis in Arabian horses in Al-Najaf province/Iraq. *Brazilian Journal of Veterinary Research and Animal Science*, *57*(3), e166996-e166996. https://doi.org/10.11606/issn.1678-4456.bjvras.2020.166996.

Al-Saad, K. M. 2009. Acute babesiosis in foals. *Journal of Animal and Veterinary Advances*, *8*(12), 2585-2589. doi=javaa.2009.2585.2589.

Alsaad, K. M. 2014. Evaluation of hemogram, acute phase response, acid base balance and blood gas analysis in newborn foals infected with babesiosis. *J Anim Plant Sci*, *24*(3), 738-742. https://www.cabdirect.org/cabdirect/abstract/20143251387.

Alsaad, K. M., Alsaad, E. A., and Al-Derawie, H. A. 2010. Clinical and diagnostic study of equine babesiosis in drought horses in some areas of Basrah Province. *Res J Anim Sci*, *4*(1), 16-22. DOI: 10.3923/rjnasci.2010.16.22.

Alsaad, K. M., and Mohammad, Y. A. 2011. The effect of aspirin and heparin as a supportive treatment for equine babesiosis treated with imidocarb dipropionate. *Assiut Veterinary Medical Journal*, 57(129),214-226. https://www.cabdirect.org/cabdirect/abstract/20113295188.

Alsaad, K. M., Hassan, S. D., and Al-Obaidi, Q. T. 2012. Detection of Babesia equi and Babesia caballi antibodies in horses and donkeys in Mosul, Iraq. *Research Opinions in Animal and Veterinary Sciences*, *2*(4), 291-294. https://www.cabdirect.org/cabdirect/abstract/20133085653.

Al-Saad, K.M. and Abdul-Majeed, M.O. 2006. Comparison of therapeutical efficacy of ivermectin and oxybendazole in treatment of draught Horses naturally infected with Gastrointestinal worms in mosul. *Iraqi Journal of Veterinary Sciences*, *20*(1)65-70. DOI: 10.33899/ijvs.2006.45785.

Altaee, I. A. A., Al-Ani, J. K., and Al-Rubaie, H. M. A. 2014. Prevalence of Giardia spp. and Cryptosporidium spp. in horses and animal handlers in some areas in Baghdad city. *Al-Anbar Journal of Veterinary Sciences*, *7*(2). https://www.iasj.net/iasj/article/107522.

Aziz, K. J., AL-Barwary, L. T. O., Mohammed, Z. A., and Naqid, I. A. 2019. Molecular identification and phylogenetic analysis of theileria equi and babesia caballi infections in equids from Erbil Province, North of Iraq. *Adv. Anim. Vet. Sci*, *7*(12), 1060-1066. DOI | http://dx.doi.org/10.17582/journal.aavs/2019/7.12.1060.1066.

Aziz, K. J., and AL-barwary, L. T. O. 2019. Prevalence rate of ixodid ticks in equids and some nearby farm animals in erbil governorate, north of Iraq. *Basrah Journal of Veterinary Research*, *18*(1),337-359. https://search.emarefa.net/detail/BIM-946696-prevalence-rate-of-ixodid-ticks-in-equids-and-some-nearby-fa.

Aziz, K. J., and AL-Barwary, L. T. O. 2020. Molecular identification of Theileria equi and Babesia caballi from ixodid ticks infesting equids in Erbil province, northern of Iraq. *Adv. Anim. Vet. Sci*, *8*(12), 1286-1293. http://dx.doi.org/10.17582/journal.aavs/2020/8.12.1286.1293.

Becker, A. C., Kraemer, A., Epe, C., and Strube, C. 2016. Sensitivity and efficiency of selected coproscopical methods—sedimentation, combined zinc sulfate sedimentation-flotation, and McMaster method. *Parasitology research*, *115*(7), 2581-2587. 10.1007/s00436-016-5003-8.

Brady, H. A. and Nichols, W. T. 2009. Drug resistance in equine parasites: an emerging global problem. *Journal of Equine Veterinary Science*, *29*(5), 285-295. https://doi.org/10.1016/j.jevs.2009.04.186.

Butty, E. 2011. Detection of Cryptosporidium and Giardia doudenalis in equines in Nineveh, Iraq. *Iraqi Journal of Veterinary Sciences*, *25*(2), 43-46. 10.33899/ijvs.2011.5649.

Camino, E., Dorrego, A., Carvajal, K. A., Buendia-Andres, A., de Juan, L., Dominguez, L., and Cruz-Lopez, F. 2019. Serological, molecular and hematological diagnosis in horses with clinical suspicion of equine piroplasmosis: Pooling strengths. *Veterinary parasitology*, *275*, 108928. 10.1016/j.vetpar.2019.108928.

Daoud, M.S., Abid, T.A. and Al-Amary, A.M. 1989. Rectal prolapse due to Gastrophilas intestinalis larvae in a horse: A case report. *Iraqi Journal of Veterinary Sciences*, *2*(1 & 2), 112-113. https://www.iasj.net/iasj/article/183674.

Dubey, J. P. and Bauer, C. 2018. A review of Eimeria infections in horses and other equids. *Veterinary parasitology*, *256*, 58-70. 10.1016/j.vetpar.2018.04.010.

Esmaeel, S. A. 2010. Clinical and hematological study of the internal parasites in native donkeys in Mosul city. *Iraqi Journal of Veterinary Sciences*, *24*(2). https://www.cabdirect.org/cabdirect/abstract/20113131957.

Estrada-Peña, A., Bouattour, A., Camicas, J. L., Guglielmone, A., Horak, I., Jongejan, F., and Walker, A. R. 2006. The known distribution and ecological preferences of the tick subgenus Boophilus (Acari: Ixodidae) in Africa and Latin America. *Experimental & applied acarology*, 38(2),219-235. https://doi.org/10.1007/s10493-006-0003-5.

Faraj, A. 2013. Survey of the ectoparasites and blood protozoa in the draught horses in Alrashdea regions_ Baghdad. *AL-Qadisiyah Journal of Veterinary Medicine Sciences*, 12(2),16-23. https://qmeds.iraqjournals.com/article_80610.html.

Faraj, A.A., Hade, B.F. and Al-Amery, A.M., 2019. Conventional and molecular study of babesia spp. of natural infection in dragging horses at some areas of Baghdad City, Iraq. *Iraqi Journal of Agricultural Sciences*, 50(3),909-15. https://doi.org/10.36103/ijas.v50i3.707.

García-Bocanegra, I., Arenas-Montes, A., Hernández, E., Adaszek, Ł., Carbonero, A., Almería, S., and Arenas, A.2013. Seroprevalence and risk factors associated with Babesia caballi and Theileria equi infection in equids. *The Veterinary Journal*, 195(2),172-178. https://doi.org/10.1016/j.tvjl.2012.06.012.

Golynski, A. A., Fernandes, K. R., Baldani, C. D., Golynski, A. L., Madeiro, A. S., Machado, R. Z., and Massard, C. L. 2008. Seroepidemiological studies on Babesia equi in horses from the State of Rio Grande do Sul determined by indirect immunoflourecence test and Elisa. *Revista brasileira de parasitologia veterinaria= Brazilian journal of veterinary parasitology: Orgao Oficial do Colegio Brasileiro de Parasitologia Veterinaria*, 17,317-321. https://pubmed.ncbi.nlm.nih.gov/20059868/.

Hadi, A. M., and Atiyah, A. H. 2014. Isolation and identification of blood parasites from equine in Baghdad. In *First scientific conference for medical and health, Baghdad, Iraq*.

Hadi, A.M. 2011. Isolation and identification of intestinal parasites from vegetables from different markets of Iraq. *Bulletin of the Iraq Natural History Museum.*11(4),17-25. https://www.iasj.net/iasj?func=article&aId=34327.

Hajeel, M.S. and Abd Alfatlawi, M.A. 2019. Sequencing-based phylogenetic-study of Babesia spp det43ected in tick tissues in Al-Diwaniyah province, Iraq. *Iraqi Journal of Veterinary Sciences*, 33(1),9-12. 10.33899/ijvs.2019.125512.1034.

Hamzah DJ. 2020.Molecular identification of Ascaridia columbae in the Local Healthy Pigeon (Columba livia domestica, Gmelin, 1780) in Karbala Province. Indian Journal of Forensic Medicine & Toxicology.;14(1),1008-112. https://doi.org/10.37506/ijfmt.v14i1.

Hasson, R. H. 2016. Ectoparasites of farm animals in Diyala province, Iraq. *Al-Anbar J. Vet. Sci*, 9(2),9-18.https://www.anbarjvs.edu.iq/ectoparasites-of-farm-animals-in-diyala-province-iraq/.

Hodgkinson, J. E. 2006. Molecular diagnosis and equine parasitology. *Veterinary parasitology*, *136*(2), 109-116. https://doi.org/10.1016/j.vetpar.2005.12.006.

Hussain, J. 2011. Prevalence of Toxoplasma gondii in native donkeys in Mosul. *Iraqi Journal of Veterinary Sciences*, *25*(2), 111-115. https://vetmedmosul.com/article_5654.html.

James, K. E., Smith, W. A., Packham, A. E., Conrad, P. A., and Pusterla, N. 2017. Toxoplasma gondii seroprevalence and association with equine protozoal myeloencephalitis: A case–control study of Californian horses. *The Veterinary Journal*, *224*, 38-43. 10.1016/j.tvjl.2017.05.008.

Kalef, D.A. 2015. The prevalence of the genus Eimeria in Draught and Al-Fourosia club horses of Baghdad Province. *Iraqi Journal of Veterinary Medicine*, *39*(1),70-74. https://doi.org/10.30539/iraqijvm.v39i1.199.

Khalid Jabar, A. Z. I. Z., and Al-Barwary, L. T. O. 2019. Epidemiological study of equine piroplasmosis (Theileria equi and Babesia caballi) by microscopic examination and competitive-ELISA in Erbil Province North-Iraq. *Iranian journal of parasitology*, *14*(3), 404. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6815869/.

Klun, I., Uzelac, A., Villena, I., Mercier, A., Bobić, B., Nikolić, A., and Djurković-Djaković, O. 2017. The first isolation and molecular characterization of Toxoplasma gondii from horses in Serbia. *Parasites & vectors*, *10*(1), 1-9. 10.1186/s13071-017-2104-x.

Kouam, M. K., Kantzoura, V., Gajadhar, A. A., Theis, J. H., Papadopoulos, E., and Theodoropoulos, G. 2010. Seroprevalence of equine piroplasms and host-related factors associated with infection in Greece. *Veterinary Parasitology*, *169*(3-4), 273-278. https://doi.org/10.1016/j.vetpar.2010.01.011.

Littlewood, J. D.2011. Equine sarcoptic mange: Re-emergence of a previously notifiable disease?. *Equine Veterinary Education*, 23(1),24-26. https://doi.org/10.1111/j.2042-3292.2010.00169.x.

Mahdi, N. K., and Ali, N. H. 2002. Cryptosporidiosis among animal handlers and their livestock in Basrah, Iraq. *East African medical journal*, *79*(10), 551-554. 10.4314/eamj.v79i10.8820.

Matthews, J. B., and Burden, F. A. 2013. Common helminth infections of donkeys and their control in temperate regions. *Equine Veterinary Education*, *25*(9), 461-467. https://doi.org/10.1111/eve.12018.

Mikaeel, F. B., and Al-Saeed, A. T. M. 2020. Serological and molecular diagnosis of Toxoplasma gondii among ewes and horses in Duhok province-Iraq. *The Iraqi Journal of Agricultural Science*, *51*(4), 1212-1219. https://doi.org/10.36103/ijas.v51i4.1100.

Mohamed, B. J. 2017. Effect of endurance exercise on sweat constituents of athletic Iraqi Arabian horses. *Iraqi Journal of Veterinary Sciences*, *31*(2), 95-100. 10.33899/ijvs.2017.145604.

Mohammad, M.K. 2015. Distribution of ixodid ticks among domestic and wild animals in central Iraq. *Bulletin of the Iraq Natural History Museum*. 13(3),23-30. https://jnhm.uobaghdad.edu.iq/index.php/BINHM/article/view/71.

Moosa, D.A., 2019. Detection of Cryptospridium sp. Oocysts in Drought Horses in Mosul, Iraq. *Rafidain Journal of Science*, *28*(3),11-16. 10.33899/rjs.2019.163148.

Moretti, A., Mangili, V., Salvatori, R., Maresca, C., Scoccia, E., Torina, A., and Pietrobelli, M. 2010. Prevalence and diagnosis of Babesia and Theileria infections in horses in Italy: a preliminary study. *The Veterinary Journal*, 184(3),346-350. https://doi.org/10.1016/j.tvjl.2009.03.021.

Mustafa, B. 2019. Detection on ectoparasites on small ruminants and their impact on the tanning industry in Sulaimani province. *Iraqi Journal of Veterinary Sciences*, 33(2),303-9. 10.33899/ijvs.2019.162995.

Onyiche, T. E., Suganuma, K., Igarashi, I., Yokoyama, N., Xuan, X., and Thekisoe, O. 2019. A review on equine piroplasmosis: epidemiology, vector ecology, risk factors, host immunity, diagnosis and control. *International journal of environmental research and public health*, *16*(10), 1736. 10.3390/ijerph16101736.

Prochno, H. C., Scorsin, L. M., De Melo, F. R., Baldani, C. D., Falbo, M. K., Aquino, L. C. T. D., and Lemos, K. R. 2014. Seroprevalence rates of antibodies against Theileria equi in team roping horses from central-western region of Paraná. *Revista Brasileira de Parasitologia Veterinária*, 23(1),85-89. https://doi.org/10.1590/S1984-29612014012.

Raue, K., Heuer, L., Böhm, C., Wolken, S., Epe, C., and Strube, C. 2017. 10-year parasitological examination results (2003 to 2012) of faecal samples from horses, ruminants, pigs, dogs, cats, rabbits and hedgehogs. *Parasitology research*, *116*(12), 3315-3330. 10.1007/s00436-017-5646-0.

Raza, A., Qamar, A.G., Hayat, K., Ashraf, S. and Williams, A.R. 2019. Anthelmintic resistance and novel control options in equine gastrointestinal nematodes. *Parasitology*, 146(4),42537. https://doi.org/10.1017 /S0031182018001786[Opens in a new window].

Sazmand, A., Bahari, A., Papi, S., and Otranto, D. 2020. Parasitic diseases of equids in Iran (1931–2020): a literature review. *Parasites & vectors*, *13*(1), 1-19. https://doi.org/10.1186/s13071-020-04472-w.

Scoles, G. A. and Ueti, M. W. 2015. Vector ecology of equine piroplasmosis. Annual review of entomology, 60, 561-580. https://doi.org/10.1146/annurev-ento-010814-021110.

Sevinc, F., Maden, M., Kumas, C., Sevinc, M., and Ekici, O. D. 2008. A comparative study on the prevalence of Theileria equi and Babesia caballi infections in horse sub-populations in Turkey. *Veterinary Parasitology*, , 156(3-4),173-117. doi.org/10.1016/j.vetpar.2008.06.006.

Shubber, H. W., Al-Hassani, N. A., and Mohammad, M. K. 2014. Ixodid ticks diversity in the middle and south of Iraq. *Int. J. Rec. Sci. Res*, 5(9),1518-23. http://www.recentscientific.com/ixodid-ticks-diversity-middle-and-south-iraq.

Sray, A.H.K., Al-Shabbani, AH.A, & Gharban, H.A.J. 2019. Serological and molecular estimation of *Theileria equi* infections in Horses of Baghdad, Al-Qadisiyah, and Wasit Provinces / Iraq. The Journal of Research on the Lepidoptera,;50 (4), 391-404. https://www.academia.edu/41392432/Serological_and_Molecular_Estimation_of_Theileria_Equi.

Suleiman, E. G., Aghwan, S. S., and Al-Iraqi, O. M. 2020. Detection of microfilaria infection in horses in Mosul city. *Iraqi Journal of Veterinary Sciences*, *26*, 23-26. https://vetmedmosul.com/article_167131.html.

Sumbria, D., Singla, L. D., Kumar, S., Sharma, A., Dahiya, R. K., and Setia, R. 2016. Spatial distribution, risk factors and haemato-biochemical alterations associated with Theileria equi infected equids of Punjab (India) diagnosed by indirect ELISA and nested PCR. *Acta Tropica*, 155,104-112. https://doi.org/10.1016/j.actatropica.2015.12.020.

Sunday Idoko, I., Tirosh-Levy, S., Leszkowicz Mazuz, M., Mohammed Adam, B., Sikiti Garba, B., Wesley Nafarnda, D., and Steinman, A. 2020. Genetic characterization of piroplasms in donkeys and horses from Nigeria. *Animals*, *10*(2), 324. doi: 10.3390/ani10020324.

Ueti, M. W., Palmer, G. H., Scoles, G. A., Kappmeyer, L. S., and Knowles, D. P. 2008. Persistently infected horses are reservoirs for intrastadial tick-borne transmission of the apicomplexan parasite Babesia equi. *Infection and Immunity*, *76*(8), 3525-3529. DOI: 10.1128/IAI.00251-08.

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. DOI: https://doi.org/10.29079/vol11iss1art183.

Zangana, I. K., Qader, N. H., Aziz, K. J., and Hassan, Z. I. 2013. Prevalence of gastrointestinal parasites in horses in Erbil province. North Iraq. *Al-Anbar Journal of Veterinary Sciences*, *6*(1). https://www.iasj.net/iasj/article/79096.

Zhao, S., Wang, H., Zhang, S., Xie, S., Li, H., Zhang, X., and Jia, L. 2020. First report of genetic diversity and risk factor analysis of equine piroplasm infection in equids in Jilin, China. *Parasites & Vectors*, *13*(1), 1-9. https://doi.org/10.1186/s13071-020-04338-1.