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Journal of Animal Science and Veterinary Medicine
Volume 5(1), pages 1-10, February 2020
Article Number: FF9130EC1
ISSN: 2536-7099
https://doi.org/10.31248/JASVM2019.175
https://integrityresjournals.org/journal/JASVM

Review

A review of zoonotic pathogens of donkeys (*Equus asinus*)

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Received 3rd December, 2019; Accepted 14th January, 2020

ABSTRACT: Donkeys belong to the equine family that are generally considered as the beast of burden and have helped mankind from way back in the ancient Greek history. They are considered resilient species especially in semi-arid areas where infrastructure is poor and other animals do not do well. They are used for various functions including farm tillage, transportation of farm products, water, firewood and recreational activities that contribute immensely to agricultural economy and availability of resources to families especially those who are poverty stricken. However, despite the significant contribution of donkeys in rural agriculture system, they have been subjected to several challenges including poor husbandry practices, overworking/overloading, limited veterinary care and general negative attitudes toward this species. Since these animals are in close contact with humans, any zoonotic disease occurrence could pose a health risk. Therefore, the purpose of this article is to review the documented zoonotic diseases affecting donkeys and describe the possible ways on how such diseases can be transmitted to other animals and humans. From this review, most studies have been carried on parasitic, bacterial and viral diseases affecting donkeys with less emphasis on other zoonoses. Hydatidosis and toxoplasma infections are the two conditions where their zoonotic potentials have been studied more compared to the rest parasitic zoonoses. Whereas for bacterial zoonoses, brucellosis, leptospirosis and salmonellosis have been researched more in equine than other potential bacterial pathogens. However, rabies and Equine encephalomyelitis viral infection have been reported more in donkeys than any other viral zoonoses. Africa, Europe and Asia are the three continents with the highest number of publications on donkey zoonoses. Therefore, proper understanding of equine pathogens with potential to cause infections in humans is necessary so that the communities who keep these animals are educated on the prevention and control measures to reduce possible human infections.

Keywords: Bacteria, donkeys, fungi, parasites, viruses, zoonoses.

INTRODUCTION

Donkeys have helped mankind for several millions of years from their utility as pack animals in many parts of the world as they contribute immensely to economic and social roles in transport, whether riding, pack transport or pulling carts (Mrema, 2004). There are approximately 90 million donkeys worldwide with China having the largest population followed by Ethiopia (FAO, 2007). In Kenya, there are over 1.8 million donkeys that are commonly found in dry areas and used for various functions including farm tillage, transportation of farm inputs and outputs, water, firewood, and for recreational purposes. These activities contribute immensely to agricultural economy and availability of water to families especially in the arid poverty stricken rural and peri-urban regions (Kamonzo et al., 2016). In many rural areas, the use of power supplied by equines and other draught animals is not falling despite increase in mechanization and motorization. This is due to the high cost of machinery and other facilities required (Sells et al., 2010). Also, the fact that donkeys are found in arid or semi-arid lands (ASALs) where infrastructure is poor (bad road network and rough terrain), and their inherent ability to thrive in such conditions, they are an important contributor of income and livelihood (Jajere et al., 2016). The use of equines in the provision of low cost transport, agricultural power and often as the sole means of generating income for their owners is expected to

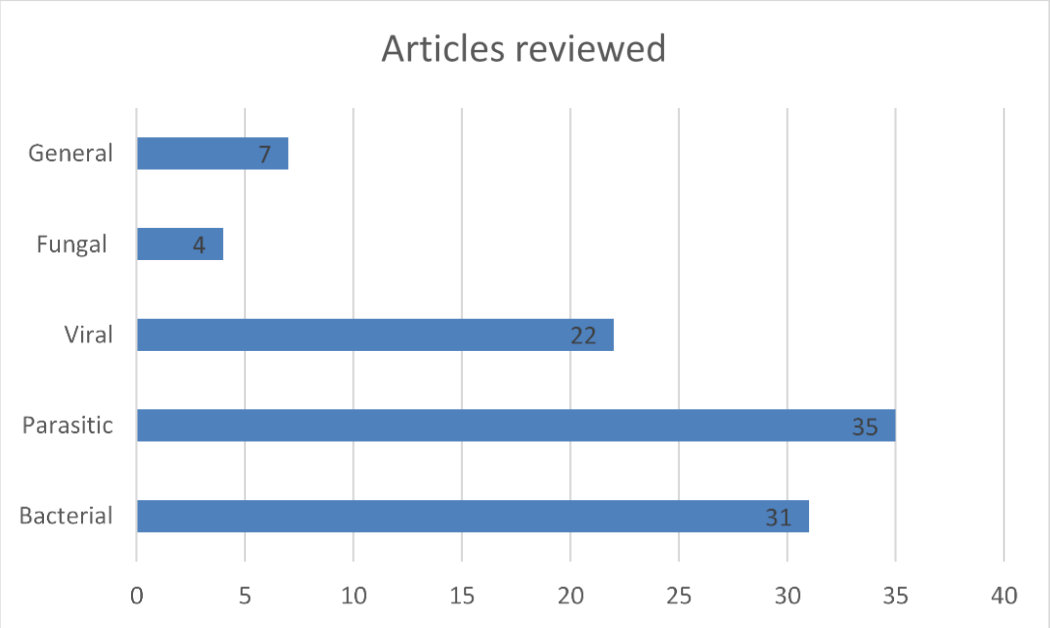

Figure 1. Number of articles reviewed.

continue (Biffa and Woldemeskel, 2006). The prolonged drought seasons attributed to global warming and poverty in ASALs areas has led to mortality of other livestock increasing donkey usage both in rural and urban settings.

However, despite the significant contribution of donkeys in rural agricultural system, they have been subjected to several challenges including poor husbandry practices, overworking/overloading, limited veterinary care and general negative attitudes toward this species by some communities (Gutema et al., 2009). Since these animals are used as draught animals, they are in close contact with humans and therefore pose a health risk. Knowledge of zoonotic diseases affecting donkeys is scanty, and is often extrapolated from knowledge of diseases of horses (Pearson and Ouassat, 2000). Therefore, the purpose of this article is to review all the documented zoonotic diseases affecting donkeys and describing the possible ways on how such diseases can be transmitted to other animals and humans.

METHODOLOGY

The review of these diseases was done between January and June, 2019. Search engines including Google, Google scholar and PubMed were used to search for publications (articles, books, power point presentation, theses, dissertation and case reports) related to zoonotic diseases in donkeys and spillover of infections to humans. Google and Google scholar were used to get as many as possible documents on donkey zoonotic diseases and PubMed for specific diseases. Publications on general information on donkey farming, management practices and welfare were excluded in this search. For the initial search donkey and zoonoses specific terms were used with any other of the following; spillover, outbreaks, humans, transmission, diseases, illness. All the identified articles were reviewed for relevance before inclusion for consideration. The language, title and the abstracts were the main aspects considered for inclusion/exclusion. A document written in English with the title and abstract describing a donkey disease of zoonotic/public health importance was considered for this study. There was no restriction to the date of publication, location and set ups. Publications with description of diseases in equines with no specific data on donkeys were also excluded. For the second stage, all the identified zoonotic diseases in stage one were searched individually to get specific information on the location, dates of study and methodology. In the first criterion, a total of 127 publications were identified and when they were subjected to the second criterion, a total of 82 publications were considered relevant, comprising of 4 theses/dissertations, 1 conference presentation, 4 fact sheets, 4 books/chapters, 1 policy document, 1 case report and 67 articles comprising of 23 review papers and 44 research papers. The articles were further grouped into bacterial zoonoses (22), parasitic zoonoses (18), viral zoonoses (19), fungal zoonoses (2) and general zoonoses (6) that describe several diseases (Figure 1). All the publications were sorted as per the continent of study (where applicable) (Table 1) however, all the papers describing general zoonoses were review articles with no specific location. All the articles were sorted as per the year of publication and there was a surge from 2013. (Figure 2). Furthermore, the zoonotic diseases were described individually in a tabular format (Table 2) and also

Table 1. Number of reviewed papers from different continents.

Type of organism	Africa	Asia	North America	South America	Europe	Australia
Bacteria	5	3	4	0	4	0
Parasite	7	2	0	1	3	0
Virus	2	1	0	0	2	0
Fungi	1	0	0	0	1	0
General	-	-	-	-	-	-
Total	15	6	4	1	10	0

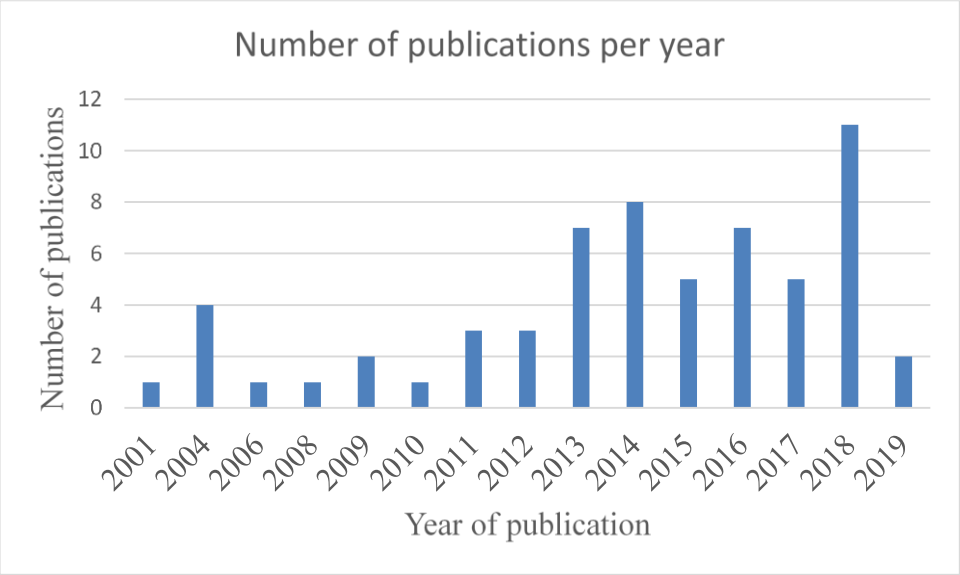

Figure 2. Number of publications on donkey zoonoses per year.

generally in the subsequent sections.

RESULTS

Bacterial zoonoses

Studies have shown that donkeys are infected with brucella bacterium and can manifest clinically as abortion in females and infertility in males (Abdalla et al., 2010). Serological survey in Nigeria revealed 14.7% brucella antibodies in horses (Ehizibolo et al., 2011) and 5.5% in donkeys (Sadiq et al., 2013) whereas in Sudan, Abdalla et al. (2010) reported prevalence of 2.12% in donkeys and this pose significant health risk to people who use and or handle donkeys in their day to day life because this is a major global zoonoses (Sadiq et al., 2013). Higher incidences of brucellosis in equines; 71.93% in horses, 63.67% in donkeys and 5.4% in mules have been reported from a serological study in Peshawar district in Pakistan (Safirullah et al., 2014). However, Tel et al. (2011) reported 6.05% seroprevalence of brucellosis in donkey using Rose Bengal Plate Test (RBPT). *Brucella abortus* biotype 1 has been isolated in a foal (Ocholi et al., 2004b) and also from hygroma fluids with inflamed joint bursa (Ocholi et al., 2004a). Donkeys have been incriminated as the reservoir hosts for brucellosis and play an important role in the maintenance and spread of the infection to both animals and humans (Abdalla et al., 2010). Rose Bengal Plate Test (RBPT), Microtitre Serum Agglutination Test (MSAT), microbial culture and Polymerase Chain Reaction are the common tests that have been used to study brucellosis disease in donkeys (Abdalla et al., 2010; Sadiq et al., 2013). The disease is transmitted to humans directly via contact with fluids or indirectly via contaminated objects from infected animals and usually associated with poor animal management practices, feeding habits, low levels of hygiene standards and socioeconomic status in communities owning and using donkeys (Safirullah et al., 2014).

Even though anthrax affects mainly herbivores, donkeys can also come down with the spore forming bacterial infection. Equines including horses and zebras have been reported to have died from anthrax infection. Horses have

Table 2. Description of zoonotic diseases affecting donkeys.

Type of organism	Disease/causative agent	Other animals affected	Distribution	Transmission to human	Reference
Bacterial	Tuberculosis/ *Mycobacterium tuberculosis, M. bovis, Mycobacterium avium ssp. paratuberculosis*	Cattle, sheep, camels, goats	Worldwide	Direct and indirect	Bryan et al., 2004
	Brucellosis/ *Brucela abortus*	Cattle, dogs, pigs, sheep, goats	America, Asia, Africa	Direct	Safirullah et al., 2014
	Salmonellosis/ *Salmonella abortus equi*	Cattle, horses, dogs, pigs	Asia, Africa, South America	Direct and indirect	Wang et al., 2018
	Leptospirosis/ *Leptospira interrogans*	Cattle, dogs, pigs	Worldwide	Direct and indirect	Grevemeyer et al., 2017
	Anthrax/ *Bacillus anthracis*	Cattle, sheep, goats, wild herbivores, camels	Worldwide	Direct and indirect	Ngetich, 2019
	Methicillin-resistant *Staphylococcus aureus*	dogs, sheep, donkeys, bats, pigs, and monkeys	Africa and Asia	Indirect	Kuroda et al., 2016
	Glanders/*Burkholderia mallei*	Horses, mules, Camels, felines, bears, wolves and dogs, Guinea pigs, hamsters	Asia, Africa, South America and Middle East	Direct and indirect	Khaki et al., 2012
Viral zoonoses	Rabies	All warm-blooded animals	worldwide	direct	Benchohra, 2016
	Eastern equine encephalomyelitis	Eastern equine encephalomyelitis, rodents, sheep, cattle, dogs, South American camelids (llamas and alpacas), pigs, deer and a captive harbor seal (Phoca vitulina)	North and South America	arthropod-borne	IOWA, 2017
	Western equine encephalomyelitis	Passerine birds, cattle, reptiles and small mammals	North America	arthropod-borne	IOWA, 2017
	Venezuelan equine encephalomyelitis	Pigs, cattle, goats, sheep, dogs, rabbits, BATS	North America	arthropod-borne	IOWA, 2017
	Equine influenza/H3N8	Horses	Elsewhere except New Zealand, Australia and Iceland	Direct and indirect	OIE Terrestrial Manual, 2013
	West Nile Viral Encephalitis	Bats, birds, passerine birds	Africa, Europe, South Asia, Oceania and North America	arthropod-borne	Mehmet et al., 2007
	Hepatitis E	Pigs, wild boar, horses, mules, Deer, cattle, cats, rabbits, camels and shellfish	Europe	direct	García-Bocanegra et al., 2019

Table 2. Cotnd.

Fungal zoonoses	Hendra virus	dogs and flying foxes	Australia	direct	Mehmet et al., 2007
	Dermatophytosis/*Microsporum racemosum*	guinea pig	Italy	Possibly direct	Nardoni et al., 2013
Parasitic zoonoses	Toxoplasmosis/ *Toxoplasma gondii*	Almost all warm-blooded animals	Worldwide	Indirect	Machacova et al., 2014
	Hydatidosis/ larvae of *Echi nococcus granul osus*	Ruminants, camels, horses	Worldwide	Indirect	Balkaya and Simsek, 2011
	Enterocytozoon/*Enterocytozoon bieneusi*	Several animals	Algeria and Spain	Indirect	Yue et al., 2017
	Trypanosomosis/*Trypanosoma evansi*	cattle, sheep, goats, pigs, camels, horses, donkeys, water buffalo, alpacas, llamas, dogs, cats and captive wild ungulates.	Africa and South America	Indirect	Cadioli et al., 2006
	Meningoencaphalitis/*Halicephalobus gingivalis*	Cattle, horses, zebras	Europe, North America and North East Asia	Possibly indirect	Onyiche et al., 2018

been reported to manifest with fever, colic, dysentery, dyspnea and bloody discharge from the natural orifices (Ngetich, 2019; Beyer and Turnbull, 2009). An anthrax outbreak investigation in Wamba area of Samburu, Kenya revealed that among the animals affected, 53 Grevy's zebra and 26 plains zebras, 5 donkeys and 2 camels succumbed to anthrax disease (Muoria et al., 2004). Anthrax infection outbreaks in humans are commonly reported following consumption of infected animal carcasses, contamination of foodstuff or coming in contact with infected animal carcasses and in cases of anthrax bio weaponry (Muoria et al., 2004; Goel, 2015; Ngetich, 2019).

Equines are believed to be resistant to Mycobacterium infection but there are some cases reported of *Mycobacterium bovis* and *Mycobacterium tuberculosis* in horses (Pavlik et al., 2004; Keck et al., 2010). *Mycobacterium avium ssp. paratuberculosis* has been suspected to infect donkeys and mules (Dierckins et al., 2004). *Mycobacterium bovis* has been isolated in a 29-year old gelding among 40 donkeys in a group in Ireland (Bryan et al., 2004). To the best of author's knowledge, this is the only documented case of *Mycobacterium bovis* infection in donkeys that can incriminate the interaction of different animal species resulting in cross infection. With the increase in the control measures of bovine Tuberculosis due to the economic significance and zoonotic potential, incidences and prevalence of mycobacterium infection in livestock has significantly reduced (Bryan et al., 2004).

Leptospirosis is caused by spirochete leptospira that is commonly found in the renal tubules of reservoir animals. Reservoir animals and watering points pose a risk of infection of other animals as they shed the bacteria in the urine (Rawlins et al., 2017). Studies involving donkey urine samples showed 18% prevalence rate of leptospirosis infection in TaqMan-based real-time quantitative polymerase chain reaction (qPCR) in Caribbean Island of St. Kitts (Grevemeyer et al., 2017). Detection of leptospires in urine of healthy donkeys incriminate them as reservoir hosts that maintain the organism with no clinical manifestation. A comparative study of leptospira infection in horses and donkeys in Iran revealed 27.88% in horses and 40% in donkeys where more mares were affected but there was no sex association in donkeys (Hajikolaei et al., 2005). Leptospira infection in equines has been associated with frequent abortions, stillbirths and recurrent uveitis (Verma et al., 2013). Diagnosis of this infection has been compromised by high cost and complexity of isolation media and the slow growth of the organism in the media therefore making the microscopic agglutination test and ELISA the two commonly employed tests for diagnosis. It is a potential health risk because animals urinate haphazardly contaminating feed, water, troughs and even environment where other animals including humans can easily come in contact and get infected (Grevemeyer et al., 2017). Similarly, natural disasters like floods and hurricane have been associated with leptospira infection in humans (Bossi et al., 2004).

Glanders is a bacterial zoonosis caused by *Burkholderia mallei* that is commonly diagnosed in

in equines (horses, donkeys and mules) even though susceptibility to it had been described in camels and wild carnivores and equines (Elschner et al., 2011; Khaki et al., 2012). It affects the respiratory and cutaneous systems of equidae and secretions from these systems can easily contaminate the environment putting other animals and even humans at risk of contracting the disease (Bossi et al., 2004). It is a common occupational hazard to veterinarians, laboratory workers and equine handlers (Elschner et al., 2011). Poor feeding and management practices, poor hygiene and overcrowding are the most considered risk factors for development of glanders disease in stables (Bossi et al., 2004). Contamination of food and water, aerosols, ingestion and in contact are the main transmission routes of this bacterial disease to other animals and humans (Duval et al., 2014). The potential use of this bacterium as a bioterrorism agent has been documented (Gilad et al., 2007). Humans are accidental hosts and no human-to-human transmission has been documented. Unfortunately, there is no vaccine available to control this disease in both animal and human populations and therefore regular screening, early detection and culling of positive cases would help to prevent/control the infection (Bossi et al., 2004; Elschner et al., 2011).

Salmonellosis has been reported to cause abortions, septicemia and polyarthritis in animals. There is limited information on the clinical manifestation of *Salmonela abortus equi* infection in horses though it has been reported in donkeys in China (Wang et al., 2018). In equines, it is usually a sequelea of Equine herpevirus type 1 infection (Swerczek, 1991). Carrier states have been described in horses and has been incriminated as the initial source of infection in a naïve herd (Niwa et al., 2016). Strict breeding measures and health policies have reduced new cases in equines in USA and Europe but it is still a challenge in Asia and African (Alam et al., 2009).

There is scanty literature on methicillin resistant *Staphylococcus aureus* (MRSA) in donkeys even though this has been isolated in horses (Kuroda et al., 2016). This is a bacterium that has been incriminated as the major source of nosocomial infections in both veterinary and human health facilities (Van Duijkeren et al., 2004). However, community acquired MRSA has been isolated in nonhospitalized humans and animals (Kuroda et al., 2016). A 4% prevalence of MRSA has been reported in horses from the USA (Boyle et al., 2017). The potential transmission of this bacterium from equids to humans has been documented (Van Duijkeren et al., 2004). There is therefore need to carry out surveillance tests on donkeys to determine the prevalence of MRSA and the possible mitigation measures.

Parasitic zoonoses

Toxoplasma gondii infection has been described to cause serious problems in donkeys. Toxoplasma parasite infects several animal species including cattle, buffaloes, sheep, goats, cats and camels (Dehkordi et al., 2013). There is scanty information on the prevalence of *Toxoplasma gondii* infection in donkeys though there are some serological tests that have attempted to determine the levels of toxoplasma antibodies in healthy donkeys (de Oliveira et al., 2013; Machacova et al., 2014). For instance, a study done in Italy on healthy donkeys from several farms revealed 8% seroprevalence in donkeys using the indirect fluorescent antibody test (Machacova et al., 2014). The parasite infects the skeletal tissues of an animal and transmission to humans is via consumption of contaminated meat or raw milk from an infected animal (Dubey, 2010). Pregnant women are believed to be the population at risk of toxoplasma infection from infected cats that can result in transovarial transmission to infect the developing fetus (Dubey, 2010).

Cystic echinococcosis is a parasitic disease affecting both humans and animals. It is caused by the larval stage of a dog tapeworm, *Echinococcus granulosus* (Berihu and Toffik, 2014). The infection caused by the larval stage is known as cystercercosis, developing as fluid filled cysts in the visceral organs of the intermediate hosts (herbivores) resulting in high economic losses due to organ condemnation (Wyckliff and Chepkirui, 2017) and also in humans resulting in high Disability Adjusted Life Years (DALYs) (Budke et al., 2006). A number of studies have been done to identify the antibodies against *Echinococcus granulosus* in donkeys and have shown significant findings. Balkaya and Simsek (2011) from their study in Turkey reported 20.4% and 33.5% seropositivity in horses and donkeys respectively.

Trypanosomosis is a parasitic disease that has been documented to cause devastating losses in livestock production systems. Tsetse flies have been incriminated as the primary biological vectors of a number of species of trypanosomes but mechanical transmission of *Trypanosoma evansi* has also been documented (Dargantes et al., 2001). *Trypanosoma vivax* and *Trypanosoma congolense* were reported to have infected donkeys in four districts in Ethiopia (Bedada and Dagnachew, 2012). In a study done in Gambia among horses and donkeys, 91% overall prevalence was recorded with specific prevalence of 31, 87, and 18% for *Trypanosoma congolense, Trypanosoma vivax, Trypanosoma brucei* respectively while 43% were mixed infections (Pinchbeck et al., 2008).

Enterocytozoon bieneusi is a parasite that can infect several animals including humans. The parasite in donkeys has been reported in Algeria, China and Spain. In China, an overall prevalence of 5.3% was reported in donkeys (Yue et al., 2017). Human infection occurs as a result of consumption of contaminated food and water and usually affect the immunocompromised individuals (Zhao et al., 2016). There is scanty information on the clinical manifestation of this parasite in both animals and humans.

There are other less significant zoonotic parasites that affect donkeys and this calls for further research studies to elucidate the epidemiological patterns and potential zoonoses. These include *Halicephalobus gingivalis* (Onyiche et al., 2018), Microsporidia and Cryptosporidium (Zhao et al., 2016), Ancylostoma and ascarids helminthes (Atawalna et al., 2015).

Viral zoonoses

Rabies is a serious zoonoses that affect all the warm-blooded animals. It is a neurotropic virus that is transmitted through the bite by a rabid animal (Lembo et al., 2010). Wild carnivores and bats are believed to be the reservoir host that maintain the virus and the primary source of infection to domestic animals and human (Banyard et al., 2013). Dogs and cats are considered the main animals that transmit the disease to other animals and humans once they are bitten by wild carnivores (Banyard et al., 2013). A rabid donkey has been reported to have bitten cows and humans in Algeria and transmitted rabies (Benchohra, 2016). Definitive diagnosis of the disease is expensive because it entails histopathology as clinical signs may be misleading (Banyard et al., 2013). Lack of collaboration between medical practitioners and their animal health counterparts and poor socioeconomic status have been cited as the possible reasons for the frequently reported outbreaks of rabies in both animals and humans (Benchohra, 2016). The burden of the disease in humans especially in Africa remains high despite the attempts to control it (Lembo et al., 2010).

Hepatitis E has been reported as an emerging disease in some countries and donkeys have been incriminated as potential reservoirs (Adlhoch et al., 2016). Hepatitis E virus has four genotypes and genotypes 3 and 4 are zoonotic and have been isolated from several domestic and wild animals (Spahr et al., 2018). In Europe, equines (0.4% horses, 1.2% donkeys and 3.6% mules) have been reported to seroconvert for this viral infection (García-Bocanegra et al., 2019). Domestic pigs, wild boar and reindeer are believed to be the main animals that can transmit the disease to humans (Rivero-Juarez et al., 2017). Contact with infected animals has been considered as a risk factor for the development of disease in humans (García-Bocanegra et al., 2019).

Equine encephalomyelitis viral infection has been described to cause significant losses in equine production (OIE Terrestrial Manual, 2013). The infection has been named depending on the location of the animals affected (CFSPH Technical Fact Sheets, 2019). It can be Venezuelan Equine encephalomyelitis (VEE), Eastern Equine encephalomyelitis (EEE) or Western Equine encephalomyelitis (WEE) (OIE Terrestrial Manual, 2013). These are arthropod borne viral diseases that cause nonspecific clinical manifestation in equines (OIE Terrestrial Manual, 2013). Venezuelan Equine encephalomyelitis (VEE) is considered to cause more pronounced clinical symptoms in humans than the other two. There is a potential virus that can be used as an agent of warfare.

Other viral infection that affect donkeys that are considered zoonotic include Hendra virus, Influenza virus and West Nile viral encephalitis (Mehmet et al., 2007). An ELISA test was carried out in Turkey to determine the West Nile virus antibodies in equines and reported 4.15% and 1.28% seroprevalence in horses and donkeys respectively (Mehmet et al., 2007).

Fungal zoonoses

There is scanty literature on fungal zoonoses affecting donkeys such as *Trichophyton mentagrophytes* and *Trichophyton verrucosum* (Abdalla et al., 2005). In Italy, a novel geophilic fungus was isolated from a herd of donkeys that showed alopecic annular, scaly areas mainly on head and neck caused by *Microsporum racemosum* (Nardoni et al., 2013). This fungus has been described to naturally infect humans but there is scarce information about the clinical presentation in animals (García-Martos et al., 1999). In Italy, 17 out of 151 donkeys kept for milk production and onotheraphy develop gradual alopecic areas around the head and the neck where skin scrapings were collected and cultured on Sabouraud Dextrose Agar (SDA) that revealed velvety colonies that is characteristic for this fungus (Nardoni et al., 2013). Another fungus, *Microsporum gypseum* has been documented to infect 0.1% human patients (Martinez et al., 2014; Rezaei-Matehkolaei et al., 2016) and 1.15% of sick dogs and cats (Nardoni et al., 2013). The documentation of fungal infections in donkeys and the close contact between donkeys and human (as beasts of burden, recreational and agritourism) pose a health risk for human especially the young, old, malnourished and immunosuppressed individuals.

DISCUSSION

From this review, it is clear that not much has been done to specifically study donkey zoonoses. With the construction of donkeys' slaughterhouses and permission to slaughter and sell donkey meat and products in African countries, zoonotic diseases should be studied and prevention or control measures put in place and public educated on the same. Most studies have been carried out to look into zoonotic parasitic, bacterial and viral diseases affecting donkeys with less emphasis on fungal zoonoses (Figure 1). Hydatidosis and toxoplasma infection are the two conditions that have been studied more compared to the rest (de Oliveira et al., 2013; Machacova et al., 2014). Whereas for bacterial zoonoses, Brucellosis, Leptospirosis and Salmonellosis have been researched more (Abdalla et al., 2010; Sadiq et al., 2013). Rabies and Equine encepha-

lomyelitis viral infection have been reported more in donkeys than any other viral infection with potential zoonoses (Lembo et al., 2010; Banyard et al., 2013; OIE Terrestrial Manual, 2013; Benchohra, 2016). Africa, Europe and Asia are the three continents with the highest number of publications on donkey zoonoses respectively (Table 1). This can be attributed to the fact that highest donkey population is found in these continents and they play an important role in the livelihoods of the communities owning and using these animals. In Africa and Asia, donkeys are used for various functions including farm tillage, transportation of farm inputs and outputs, water, firewood and recreation (Kamonzo et al., 2016). Therefore, proper understanding of diseases affecting equines with potential to cause infections in humans is necessary so that the communities who keep these animals are educated on the prevention and control measures to reduce possible human cases.

Conclusion

There are many diseases of donkeys that are potential zoonoses and therefore more research and deeper understanding about these conditions would help in controlling transmission to other donkeys and spill over to humans.

CONFLICT OF INTEREST

Authors declare that they have no conflict of interest.

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