

A Review about Prevalence of Babesia Spp in Ruminants in Iraq

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ABSTRACT

Babesiosis is a protozoan parasite disease produced by several strains of *Babesia*. It is a severe tick-borne infection that affects both wild and domestic animals, as well as people in warm temperature regions. So far, more than one hundred *Babesia* spp had discovered in mammals. This paper include the review about the prevalence of *Babesia* species in ruminants throughout Iraqi governorates and this depended on Iraqi researches that have been published in different International and local journals, and this study reported a wide variation in parasite infection rates due to a variety of factors, including host availability, the presence of parasite transmission vectors as well as hosts, the age and breed of the host, environmental conditions, and different parasite diagnosis methods, all of which contribute to variation in the prevalence infection rate in Iraq.

ARTICLE DETAILS

Published On:
03 March 2025

Available on:
<https://ijmscr.org/>

INTRODUCTION

Hemoparasitism is a prevalent ailment in animals that has a detrimental impact on the reproduction, production, performance and health parameter of the affected animals. (Abdullah et al., 2019) JAMIL et al.,2023). *Babesia* is a protozoan parasite from the genus Piroplasmida that causes a fatal illness in livestock and agricultural animals. Because the sickness has immediate economic repercussions such as decreased milk supply, loss of body weight, and animal death, it creates serious concerns for both farm animal economy and animal life (Menshawy 2020). Babesiosis is a disease transmitted by ticks which impact on a variety of domesticated and wilderness animals, as well as people in region of tropical and subtropical. So far, about one hundred *Babesia* spp found in mammals (Razmi.2022). *Babesia* spp. is causative agent of the disease's, while Ixodid ticks are its vectors. (Schnittger et al., 2012). *Babesia* spp survive and reproduce as 'piroplasms' in the red blood cells of the vertebrate animals, and in contrast with erythrocytic phases (Service, 2001). The female tick often becomes infected after swallowing *Babesia* spp in a blood meal are transmitted to another host as next generation of sporozoites found in the saliva, which includes adults, nymphs, and larvae Babesiosis' important clinical symptoms include fever, hemoglobinuria, anemia, and icterus (Service, 2001). Babesiosis is also known by a variety of other names, including Piroplasmosis, Texas fever, and Red water fever(Sahinduran, 2012).

Babesia bigemina and *B. bovis* are the primary causes of bovine babesiosis, although additional species, including *B. divergens*, *B. major*, *B. jakimovi*, *B. ovata*, and *B. occultans*, may also be involved in cow infections. (Chauvin et al., 2009). Babesiosis in sheep is caused by *B. ovis*, *B. motasi* and *B. crassa*. (Bilgic et al., 2017; Uilenberg, 2006)

History of Babesia

In 1888, Babes researched epidemics of disease with indications of hemoglobinuria over cattle in Romanian, and in cattle blood, he was first diagnosed piroplasm (Babes .1888). Firstly, he thought it was a bacterium called Hematococcus bovis, then renamed *Babesia bovis* later by Smith and Kilborne after five years verified the occurrence of an hemoprotozoan parasites in dairy bovine with Texas cow disease (babesiosis), termed *Pyrosoma bigeminum* (*Babesia bigemina*)(Bock et al., 2004). Then the initial detection of *Babesia* transmitted through transovarian via its tick vector was discovered, which was a momentous discovery (Smith and Kilborne, 1893). Babesiosis was progressively found in many regions in global and can zoonotic infection, especially within subtropical and tropical nations, as well as its economic implications (Kivaria et al., 2007). In 1956, *B. divergens* produced the initial verified human case of fatal babesiosis (Skrabalo and Deanovic. 1959). Then, the relevance of babesiosis in humans as zoonotic infection has emerged (Hunfeld et al., 2008). There are various kinds of

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Babesia that cause human illnesses across the world, especially in North America is the most common *B. microti* (Gorenflot et al., 1998) (Homer et al., 2000). They were named Pyrosoma bygeminum, and they demonstrated Ticks vector takes a significant part in the propagation of disease. This was the initial describe of a vertebrate disease spread by arthropods. Starcovici named these creatures Babesia in 1893 (Uilenberg, 2006). In 1903, Lignieres reported in cattle two types of Babesia in Argentina: *B. bovis* and *B. bigemina*. initially discovered *B. ovis* in sheep in Iran in 1936 (Delpy, 1936). In human, the initial case of babesiosis was reported in 1957 in a splenectomized Yugoslav peasant. Following the original occurrence in Europe, In 1966, a *B. microti*-related case was Identified in person has a splenectomiz from California city, USA. (Hasherni-Fesharki et al., 1981).

Taxonomy and Morphology

The Babesia genus is in the Apicomplexa phylum and the Babesiidae family. Babesia parasite that round, piriform and may be oval in shape, Featuring a polar ring, subpellicular tubules and rhoptries. conoids and Micronemes emerge in at particular stages and species (Levine, 1988). The morphometric approach, which is based on merozoite size and relation to erythrocyte radius, lacks an evident genetic foundation since *Babesia spp.* can alter in red blood cells during the asexual stage or when it infects a host that is not particular (Chauvin et al., 2009) and (Homer et al., 2000) *Babesia* merozoites, like other eukaryotic cells, have membrane organelles such as the nucleus, endoplasmic reticulum (ER), Golgi apparatus, and mitochondria. Furthermore, like other Alveolata members, they have a cellular wrapping known as the pellicle, which is made up of the cell membrane and two inner layers: a primary layer of vesicles or alveoli and a secondary layer of microtubules, both of which are included in host cell invasion and parasite motility (Lew et al. 2002). The anterior apex contains an assembly of invasion-specialized organelles known as the apical complex, which is also found in other Apicomplexans. It consists of a polar ring, micronemes, and rhoptries. Piroplasmids lack another common apical feature, the conoid (Blackman and Bannister 2001; Klinger et al. 2013). *Babesia spp.* secretory organelles can be found throughout the cytoplasm of parasite, are assumed to similar the thick granules observed in another of apicomplexans parasites, they take part in host-pathogen interactions at every erythrocyte stage, these cells also include an apicoplast, a plastid without photosynthetic function that is considered to have been acquired from algae via secondary endosymbiosis. The apicoplast is responsible for several metabolic functions, including isoprenoid and fatty acid production (Caballero et al. 2012). Because of its critical role in Babesia survival, particular plastid has piqued researchers' interest as a potential target for the creation of parasitocidal drugs (Brayton et al. 2007; Huang et al. 2015). The morphology of *Babesia spp.* is classified into big and small groups. Small

and big Babesia have lengths of 1.0 to 2.5 μm and 2.5 to 5.0 μm , respectively. Small babesias, which comprised *B. bovis*, *B. gibsoni*, *Babesia rodhaini*, *B. microti*, and large babesias, which involved *B. caballi*, *B. bigemina*, *B. Canis*, The orientation of the Babesis in the RBC according to size, since giant pyriform parasites meet at their pointy extremities at an acute angle to one another, whilst microscopic forms make an oblique angle (Ruprah NS. 1985). Over 100 Babesia species have been found, infecting various mammals and several birds (Hunfeld et al., 2008).

The morphology of distinct Babesia spp. varies depending on the hosts. In bovine and buffaloes, large form of Babesia is *B. bigemina* (4.5 μm x 2.0 μm), the parasites are often pear-shaped. The shape might be round (2-3 μm in diameter), oval, or irregular. *B. bovis* is a tiny form (2.0 μm x 1.5 μm) of Babesia. Vacuolated signet ring forms are notably abundant and somewhat bigger than *B. divergens*. (Soulsby .1986) *B. divergens* is a small form of Babesia (1.5 μm x 0.4 μm). Typically maintained in paired form, laying superficially on the erythrocytes, however thick, circular or pyriform shaps may be presents, *B. major* is a big form (3.2 μm x 1.5 μm) of Babesia. Pyriform bodies have an angle among the organisms of less than 90°. Round shapes with a diameter of 1.8 μm (Laha et al., 2015).

Babesia motasi, a big form (2.5-4.5 μm) found in ovine and caprine RBC, is pyriform in nature. *B. ovis* is a tiny (1.0-2.5 μm) type of Babesia that is often spherical and found at the RBC periphery. *Babesia foliate* is a smaller type of Babesia. RBC has a leaf-shaped structure and is more centrally positioned. *Babesia taylori* is a tiny (1.5-2.0 μm long) type of Babesia with an ovoid to spherical shape that causes many infections. Up to 16 parasites can be found in an RBC. (Laha et al., 2015).

Vector

Tick-borne hemoprotozoan infections such as babesiosis, theileriosis and anaplasmosis pose a serious threat to cattle health state and welfare in tropical and subtropical areas, such as Iraq (Bilgic et al., 2017). Their obligate blood-feeding nature allows them to spread a number of infections that can cause serious illnesses like as theileriosis, babesiosis and anaplasmosis (Kenaw et al., 2023). Babesiosis is transmitted via infected ticks that feed on host blood, the disease effective is the most commercially significant tick-borne disease in tropical region and subtropical climes. (Tavassoli et al., 2013). All Babesia species are naturally transferred from one host to another host through tick bites and Ticks can transmit Babesia via transovarian transmission and among stages transmission (transmission of Babesia from ova to larvae stage to nymph to adult Tick). Ticks are distributed worldwide, especially in tropical and subtropical regions, and 80% of cattle through world's are infected with tick-borne disease (Ghosh et al., 2007). Ticks from the genera Boophilus, Rhipicephalus, Hemaphysalis, Hyalomma, and Ixodes operate as vectors for *B. bigemina* transmission, whereas ticks from the genera Boophilus, Rhipicephalus, and

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B. bovis transmitted by Ixodes. *B. bigemina* in *B. microplus* ticks in infect animal was previously recorded (Wadhwa et al., 2008). The most common ticks were Hyalomma, followed by Hemaphysalis, Boophilus, and Rhipicephalus (Durrani and Kamal, 2008). Experimentally, transovarial and transstadial transmitted done to investigate whether goat infect by *B. ovis* are a source of parasite transmission for *R. bursa* ticks. For the transstadial transmission experiment, goats were infected with 0.1 g of *Babesia* spp. free *R. bursa* larvae (Firat et al., 2024).

Life cycle

Babesia spp. have at least two phases of reproduction: asexual and sexual, These occur in through vertebral animals and the ticks vectors, respectively, the sporozoite stage present in the salivary glands of ticks are normally transmits to the vertebral animals within 2-3 days of insect attach, Sporozoites stages transform into merozoites, which enter erythrocytes and multiply into new merozoites by binary fission. Infect red blood cell gradually break down, allowing organisms to penetrate and divided in another RBC, other merozoites grow into pre-gametocytes and cannot detected by using a light microscope. After 10 hours after ingesting the contaminated blood of the vertebrate host, the merozoites may be detected microscopically in the tick's intestines (Homer et al., 2000). The pre-gametocytes mature into gametocytes, which produce ray bodies at the front of the piroplasm. The ray bodies generate gametes that unite to form a motile zygote known as an ookinete, which penetrates the intestinal epithelial cells. The ookinete initiates meiotic division, which produces a large number of kinetes. At this point, the kinetes go via the bloodstream to various tick tissues, including ovarian cells. Infection of eggs results in transovarial transmission. Some kinetes enter cells of salivary gland, where a large multinuclear sporont is finally produced, giving birth to hundreds of microscopic sporozoites stages, inject through feeding and contribute the transmitted transstadial (Melhorn, 2016) (Jalovecka et al., 2019).

Clinical signs

Clinical indications vary depending on the animal's age and species, parasite strain, immunological condition, concurrent infection with other infections, and genetic variables in the parasite dosage. The majority of instances have been discovered in animals under the age of nine months, who are typically asymptomatic (Anon, 2008). In cattle Babesiosis, a common tick-borne infection, Infected animals frequently develop symptoms 2-3 weeks following tick infection. However, direct infusion of infected blood can reduce incubation time. With example, *B. bigemina* takes 4-6 days to incubate, but *B. bovis* requires 10-12 days (Schnittger et al., 2022). The intensity of clinical disease indications varies with the age animal, among the older animals frequently sensitive because of reduced the immunological response *B. bovis* is very virulent than *B. bigemina* or *B. divergens*. according to Hayati et al. (2020) and Surjowardojo et al.

(2023), Hemoparasites are widely recognized can destroy red blood cells, leading in anemia, anorexia, jaundice, reduced weight growth, loss of production and reproduction, increased morbidity, and even death. (Ademola and Onyiche, 2014; Opara et al., 2016). Emaciation, ataxia, loss of appetite, stop rumination, loss of body weight, progressive hemolytic anemia, jaundice (Icterus), yellowish color of mucous membranes conjunctiva and vagina in severe advanced cases, hemoglobinuria, problems with the heart rate and respiratory rate, and a decrease in milk yield are all clinical signs of babesiosis. In certain circumstances, fever with an infection results in abortion in cattle. Patients have general circulatory shock and, in certain circumstances, neurological symptoms as a result of contaminated RBCs being sequestered in cerebral capillaries (El Moghazy et al., 2014; Bhat et al. 2015; Masih et al. 2021). *Babesia*'s clinical manifestations include dark brown urine. (Yadav et al., 2004). Primary clinical signs of *B. bigemina* are fever, hemoglobinuria, and anemia (Zintl et al. 2013).

Epidemiology of Babesia spp.

Babesiosis epidemiology was influenced by a variety of parameters, including host availability, tick presence as a vector of infection transmission, parasite prevalence inside vectors, hosts, and environmental conditions. These characteristics contribute to the transmission infection. Any one of this characteristic when absent may lead to stopped the spread of diseases. In terms of babesiosis epidemiology, "endemic stability" refers to a condition in which the connection between host, parasite, vector, and environment remains such that clinical illness occurs seldom (Laha et al., 2015). *Babesia* epidemiology is influenced by a variety of factors, including host age. Infection rates are low in young animals due to intrinsic resistance, which is boosted by maternal antibodies transferred to young calves through milk. This resistance progressively declines, leaving the animal very susceptible to disease (Fadly, 2012). Also, the resistance of local breeds to babesiosis is higher than imported breeds. Due to long-term exposure to tick populations, they evolved either innate resistance or the capacity to produce a powerful immunological response to the tick (Al-Shammari et al., 2024). Host immunological state, within endemic locations, when animals young get passive immunity from their dam's colostrum and frequently experience only temporary disease with modest symptoms, the active immunity may be induced by these infections and establish a long-term carrier status. Active immunity is what makes the carrier survive and immune. These animals maintain a robust immunity while eliminating their disease either naturally or by chemotherapy (Taylor et al., 2007). *Bos taurus* is categorized into three phenotypes based on *B. bovis* susceptibility to infection, sensitive hosts, who exhibit significant clinical indications that may cause death; animals with intermediate clinical symptoms; and resistant animals, which seldom (Benavides and Sacco, 2007).

Diagnosis

Detecting active cases of babesiosis is mostly dependent on the following diagnostic methods, examine by direct microscopic of giemsa-stained thin blood smear has traditionally considered the most accurate approach for finding the parasite in an infected host, a low-cost, straightforward, generally accessible approach in all labs and, presumably, in fields. (Nayel et al., 2012), It is also a useful method for differentiating species. It is efficient in diagnosing acute infections, but less so in low parasitemia and reservoir animals. Immunological examinations, enzyme linked immunosorbent assays (ELISA) and Indirect fluorescent antibody tests (IFAT) can identify Babesia antibodies in subclinical disease and circumvent the limitations of microscopic investigation (El-Fayomy et al., 2013). These tests have limited sensitivity due to the frequency of false-positive and false-negative findings, and cross reactions make species determination problematic. In most cases, they fail to distinguish between chronic and acute infections (Mahmoud et al., 2016). Nonetheless, these approaches are simple to implement, but they require a high-quality antigen, which is difficult to produce (Mosqueda et al., 2012). Described a complement fixation (CF) assay to identify antibodies against *B. bigemina* and *B. bovis*. (Anon 2008).

Molecular diagnostics is used to identify nucleic acids, which is classified as an indirect identification. However, sensitivity and specificity are quite high (Mosqueda et al. 2012). The most sensitive and specific technology for detecting babesiosis is polymerase chain reaction (PCR) (Vannier and Krause 2009; AbouLaila et al. 2010), which is beneficial for detecting infection at an early stage. It has been found that PCR is substantially more sensitive than microscopy for detecting babesiosis. It is a crucial test for confirmation, in certain situations for regulatory testing (Sharma et al. 2016; Bal et al. 2016).

Prevalence of Babesia in ruminants

According to a database compiled from several reports, *Babesia spp.* is epidemic in Iraq and infects a wide range of ruminants. (Dakhil, 2021). Prevalence of Babesiosis in cattle, in Iraq, overall prevalence of Babesia infection was 27.27% that investigate in cattle in Erbil (Ameen et al., 2012). In Duhok and Sulaimaniya governorates the prevalence rate of bovine Babesiosis were 11.7%, 56.9% respectively (Ommer et al., 2012) In cattle the infection rate of babesiosis was 0.17% in Mosul city recorded by (Abdullah et al., 2019). Another study about prevalence of Babesiosis in cattle in Mosul city that reported higher infection was 42.33% (Suleiman & Altaee, 2017). Also infection rate of bovine babesiosis regarded in Mosul city, it was 60% reported by (Suleiman & Altaee, 2020). In Tikreet provenance the Prevalence of babesiosis in cattle was 8.8%, this study done by (Ibrahim et al., 2012). The occurrence of bovine babesiosis was 30% that has been revealed in Diyala provenance (Minnat et al., 2016). The incidence of Babesia infection in cattle was (3.1%) reported in Diyala governorate

(Hassoon, 2018). In Baghdad city the incidence of Babesiosis in cattle was (66.6%) (Saeed et al., 2017). In Babylon Province the prevalence of infection with *Babesia bigemina* was 7.75% reported by (Al-Shammari et al., 2024). The prevalence of bovine Babesiosis in Basrah governorate was (27.1%) investigated by (AL-Mayah & Abdul-Karim, 2020). In Wasit Province the infection rate of babesiosis was 6.78% (Gharban et al., 2022). In Al-Qadisiyah province the occurrence of infection rate was 47.91 % reported by (Khawla et al., 2016). The prevalence of Babesiosis in Basrah province south Iraq are regarded 27.14% (AL-Mayah & Abdul-Karim, 2020).

Prevalence of Babesia in sheep and goat, in Iraq The prevalent of *Babesia spp.* In sheep very low 0.01% in Mosul city was regarded by (Abdullah et al., 2019). Also another study indicate the total infection rate of Babesiosis in sheep in Mosul city was 43.07%. reported by (Al-lahaibi & Suleiman, 2024). In Baghdad provenance the incidence of Babesia infection in sheep was 15.55% recorded by (Arwa and Kawan, 2022). The prevalence of infection rate in sheep and goat by the Babesia spp. were 20.41% and 17.78% respectively, that indicated in Erbil province (Hassan, 2020). The occurrence of ovine babesiosis was 27.83 that has been revealed in Diyala provenance (Al-Karkhi et al., 2013). The prevalence of Babesia parasites infecting sheep in Sulaimani governorate was 25.78% recorded by (Abdullah, & Ali, 2021). In the Kurdistan region the infection rate of Babesia ovis was (1.5%) regarded by (Renneker et al., 2013). The prevalence of Babesiosis in small ruminants in Sulaimani city was 56.3% from sheep and 64% of goats. (Shadan and Aram. 2014). The study that conduct in Al-najaf provenance that observed the incidence of babesiosis in sheep was 26.9% recorded by (Al-mialy et al., 2018). The study in Duhok governorate about Prevalence of Babesiosis among goats it was 4% infected with *Babesia motasi* that observed by (Zangana & Naqid, 2011). In the central part in Iraq the prevalence rate was 2.70% with *Babesia motasi* that regarded by (Latif et al., 1987).

Prevalence of Babesia in Buffaloes, in Iraq. Study that conduct in Basrah among Buffaloes indicated infection rate of babesiosis with clinical signs reported 16% (Alautaish et al., 2023). Higher incidence of babesiosis in buffaloes regarded in Al-Najaf city was 45.74% observed by (Ateaa & Alkhaled, 2019). In Wasit governorate Babesia prevalence among buffaloes was 25.7% regarded by (Alkefari et al., 2017).

The occurrence of Babesia infection among Camels in AL-Furat Al-Awsat Governorates was 20% indicated by (Al-Hakak, 2024). The incidence of Babesiosis in camels in desert of Al-najaf provenance was 25% observed by (Al-mialy et al., 2018). The infection rate of babesiosis infect camels with to *B. caballi* was (39.47%) in south of Iraq indicated by (Jasim et al., 2015). In Diwanayah province the prevalence of Babesia spp in camels was 53% recorded by (Al-Naily & Jasim, 2018). Also another study conduct in

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Diwaniyah province about Babesia spp. occurrence in camels was 60.8% (Jasim et al., 2022).

CONCLUSION

In conclusion, the current study indicated that babesiosis highly prevalent in Iraq for many reason such as uncontrolled on Tick vectors and variable environmental conditions. The variation may be due to the species of animal, immunological status of animals and different ages, different breeds and sexes. The high infection rate in middle and south of Iraq belong to presence worm wither, humidity and marshes all these factors lead to improve the environment for increase the population of Tick vector.

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