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The Economic and Epidemiological Impact of Bovine Babesiosis: Challenges and Advances in Diagnosis and Control

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ABSTRACT

Bovine babesiosis, caused by *Babesia* species, is a tick-borne protozoan infection that importantly impacts livestock production worldwide, especially in tropical and subtropical areas. This review comprehensively investigates the epidemiology, clinical manifestation, pathogenesis, and economic implications of babesiosis in cattle. The life cycle of *Babesia* protozoans, their transmission dynamics via tick vectors, and the molecular analysis employed for detection and diagnosis are discussed. The review also addresses the clinical signs ranging from fever and anemia to severe conditions such as hemoglobinuria and organ failure, which are indicative of the disease's progression. Moreover, we study the globular distribution of *Babesia* infections, emphasizing the prevalence in regions such as South America, Asia, and Africa. The economic burden of the disease, involving treatment costs, tick control measures, and losses in meat and milk production, is outlined. Additionally, we highlight advances in chemoprophylaxis and tick control strategies aimed at the reduction of incidence and impact of babesiosis. By providing an in-depth understanding of the disease's etiology, clinical progression, and economic significance, this review aims to contribute to more effective control and management strategies for bovine babesiosis, thus safeguarding livestock health and ensuring the sustainability of cattle farming in endemic areas.

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INTRODUCTION

The Bovine possesses significant economic and social value in human society due to their production of milk, meat, hooves, bones and hides (Mahmoud et al. 2024). Ticks are a significant concern and can cause harm to livestock. They can directly affect infested cattle and buffalo and transmit dangerous infection (El Seify et al. 2015). In the coming years, one of the major challenges faced by developing countries will be a shortage of food. Tick-borne pathogens (TBPs) cause fatal infection in millions of cattle annually. This leads to decreased productivity and increased expenses for farmers worldwide due to the need for medical treatment and tick control. Based on projeections, African and Asian countries pay annual costs ranging from 3.1 to 57.2 million US dollars due to ticks and TBPs (El-Dakhly et al. 2020). *Babesia* in cattle and buffalo is the highly common blood parasite in Egypt, it has a major effect on dairy product, meat product and herd management (Mahmoud et al. 2024).

Babesia bigemina, Babesia bovis, Babesia divergens, and *Babesia* major are the four parasites that cause bovine *babesiosis*. The cattle tick *Rhipicephalus microplus* is the original carrier of Cattle Tick Fever (CTF) and the exclusive known carrier of bovine *babesiosis* (Wodaje et

al. 2019). Two types, *B. bovis* and *B. bigemina* have a significant outcome on the health and productivity of cattle and buffalo in tropic and subtropic area (Iseki et al. 2010). The spread of blood parasites is greatly influenced by the status of livestock: the host, vectors, causative agents, and the environment, which includes geographic location, climate, weather, socioeconomic areas, and sociocultural factors (Ritonga et al. 2020). Acute infection inception by *B. Bovis* and *B. bigemina* can result in terrible clinical signs, including possibly lethal hemolytic anemia (Goes et al. 2007). The hazard of zoonoses is caused by circulating parasites through tick transmission, as acute cases often convert into chronic ones and these animals keep as host to the pathogens. Numerous animals in Egypt may suffer from subclinical *babesiosis*, according to early study (Adham et al. 2009). Additionally, disregard clinical research that suggests buffaloes are highly resilient to *Babesia* infections (El-Fayomy et al. 2013).

B.bovis parasite is highly dangerous than *B. bigemina* one (Mahmoud et al. 2024). The former cause organ failure and deadly systemic shock because they are trapped in lungs, kidney, and brain micro-capillaries due to erythrocyte infection. The majority of cattle that recover from an infection with *B. bovis* continue to disseminate the infection and serve as a source to infect new animals (Bock et al. 2004). Subclinical *babesiosis* causes the afflicted cattle to become chronic carriers, which is the source of tick vectors infection and results in the infection's natural spread. Thus, latent infections are the disease's epidemiological target (Nayel et al. 2012). Controlling blood parasites is greatly aided by early identification. According to El Moghazy et al. (2014), microscopical examination using Giemsa-stained blood films have been regarded as the gold standard for diagnosing *Babesiosis* in the infected cases blood, especially in acute cases. However, in carriers, the low parasitemia is and there are few parasites in the peripheral blood. The highly sensitive and specific method of detecting *babesiosis* is polymerase chain reaction (PCR) (Mahmoud et al. 2024).

Apprehension the epidemiological picture to *babesiosis* is now essential to managing the infection and rising our capacity to identify and forecast this disease (Yousef et al. 2024). To the high-grade of the authors' knowledge, little is known about bovine *babesiosis* in the Egyptian province of Kafr El Sheikh. Thus, the surveillance of Babesia species carrier status in cows was the main focus of our investigation. The Aims of the present review were directed to contribute to more effective control and management strategies for bovine babesiosis.

Bovine Babesiosis

The livestock business is severely hampered by tick-borne diseases (TBDs). *Babesia bigemina*, *Babesia bovis, Anaplasma spp.*, and *Theileria spp.* are possible protozoal risks to worldwide cow and buffalo productivity in tick-transmitted diseases (Farooq R et al. 2020). The highest common blood parasite in cows and buffaloes in Egypt is *Babesia* (Yousef S. G. et al. 2024). *Babesia* primarily affects cows, sheep, goats, horses, cats, dogs, and humans (Liu M et al. 2021). Of the more than 100 *Babesia* kind that pervert various mammalian hosts, only 18 kinds cause the infection in domestic animals. Bovines are the particular reservoir hosts for *B. bigemina* and *B. bovis*. Water and African buffaloes are also affected by them. They were recently observed in Mexican whitetailed deer. Animals other than cattle caused the minimal epidemiological relevance (Farooq R et al. 2020). The infection is also renowned as tick fever, taxes fever, red water fever and piroplasmosis (Liu M et al. 2021).

Etiology

Worldwide, cattle tick fever (CTF) is regarded as a collection of pathogens that infect bovine (Silva et al. 2020). The intraerythrocytic parasite that causes bovine *babesiosis* (BB), one of the complicated diseases, is a member of the genus *Babesia*, which is part of the phylum Apicomplexa, family Babesiidae, and order Piroplasmida (Menshawy et al. 2020). The erythrocytes of both domestic and wild animals are invaded by this protozoan. 18s ribosomal ribonucleic acid (rRNA) gene was used by Wodaje et al. (2019) to devide *Babesia* species from ungulates and perform phylogenetic analysis. These species were identified as *Babesia. caballi, Babesia.ovis, Babesia. bovis, Babesia. bigemina,* and *Babesia. spp. B. bovis, B. bigemina, B. major, and B. divergens* are the several species that cause bovine *babesiosis*. The two major crucial species in Egypt, *Babesia. bigemina* and *Babesia. bovis,* have a major impact on the cows and the buffalo's health and production in tropical and subtropic locality (L Hemaswathy et al. 2020).

Epidemiology

Geographical Distribution

Babesiosis is recovered all over the world (Fakhar et al. 2012). Cattle *babesiosis* is most prevailing in tropical and subtropic regions, and it can also be found anywhere tick vectors are present (Jamil et al. 2023). The majority, the worldwide is *B. bigemina* and *B. bovis* with largest occurrence between latitudes 32 °N and 30 °S, where their tick reservoir, *Rhipicephalus*, is typically found. The dispersion of *B. bigemina* and *B. bovis* is similar generally, but in Africa, *Babesia bigemina* is more widespread than *Babesia bovis* due to the ability of *Rhipicephalus evertsi* and *Rhipicephalus decoloratus* to serve as carrier of this species (Mahmoud et al. 2024).

It relies on a number of variables, such as:

Age, breed and immunological statement are host factors related to disease (Jabbar et al. 2015). Due to natural selection pressure, indigenous populations have either developed an innate resistivity or an innate ability to create a strong immune reaction to the tick or tick-borne pathogens in questioning because they have lived with local ticks and associated tick-borne pathogens for a long time. this is commonly stated that there is an inverse age resistance to *babesial* pathogen, meaning that calves are less vulnerable to *babesiosis* than parents. This could be explained by the passive movement of maternal antibody through colostrum. According to Taylor et al. (2007), the intensity of clinical *babesiosis* rises with age. Animals having this resistance gradually lose it, making them more vulnerable to infection (Menshawy et al. 2020).

Compared to Bos taurus cattle, Bos indicus cattle are less prone to *babesiosis* (Fereig et al. 2017). Additionally, compared to foreign breeds, native breeds have a higher

level of *babesiosis* resistance. Because tick populations are naturally exposed for extended periods of time, they either develop an intrinsic resistance to the tick or an innate capacity to develop a strong immunological response (Siddique et al. 2020). The immunological state of the host, young animals in endemic areas typically only experience temporary infections with minimal symptoms because they passively develop immunity from the colostrum of dams. These pathogens are adequate to promote active immunity and cause long-term carriers. The carrier's persistent condition and premunity are caused by active immunity. These animals maintain a strong immunity despite losing their health issues either spontaneously or by chemotherapy (Jamil et al. 2023).

Bos taurus are categorized into three distinct phenotypes based on their susceptibility to *Babesia Bovis* pathogen: Hypersensitized animals that exhibit intense clinical symptoms that result in death, intermediate cases that exhibit mild clinical symptoms, and resistant animal, that seldom exhibit clinical symptoms. *Babesia bovis* is a highly dangerous strain of *Babesia* than *Babesia.bigemina* (Mahmoud et al. 2024). Rapid antigenic change has been shown to help many blood parasites, such as *Babesia bovis* and *Babesia bigemina*, evade human immune system (Menshawy et al. 2020). Environmental Factor: that prevalence of objective *babesiosis* varies seasonally, peaking shortly after the tick population peaks. Due to their impact on tick activity, temperature and air are the most significant climatic elements; greater temperatures increase tick activity. According to Menshawy et al. (2018), the greatest losses happen in peripheral area where the tick aggregation is very changeable based on environmental situation. Summertime is when bovine *babesiosis* infection typically reaches a high margin (Siddique et al. 2020).

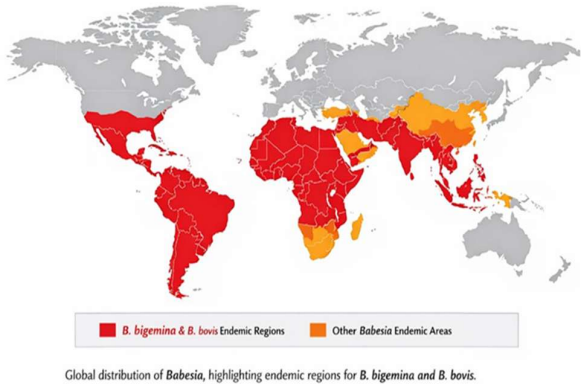

Fig.1: The distribution of *Babesia* spp. Worldwide.

Pathogenesis

Hemolysis and circulatory disruption are the two principal ways that *Babesia species* cause acute disease (Mohammed E.S et al. 2017). When sporozoites are inserted into the host after a tick biting, red blood cells (RBCs) become directly infected. Extravascular and intravascular hemolysis are caused by erythrocyte invasion. The fast-growing parasites within the red blood cells cause significant erythrocyte damage, which is accompanied by fever, hemoglobinuria, and hemoglobinemia. When the packed cell volume drops below 20%, this condition can be lethal in a matter of days and as result in anemia (Ahmed et al. 2022).

Life cycle

All *babesia* spp. have roughly similar life cycles, however there are a few minor variations since certain species experience transovarial transmission (Wodaje et al. 2019). *Babesia* causes significant pleomorphism when it multiplies in erythrocytes via binary fission. The hard tick *Boophilus microplus* infection is the first step of *babesiosis* life cycle. When ticks ingest the blood meal of cattle, they spread the protozoa *Babesia* in the host's blood. separated into three phases, such as indicated in Fig. 2.

Initially, the mother tick, or inner tick reservoir: The following is how that stage is executed inside the vector gut: Red blood cells rupture and *Babesia spp*. parasites are discharged when ticks consume an infected animal blood (Lefevre et al. 2010). where the adult phases survive while most of them die. After the ticks suck blood, the development of both male and female gametes is finished in two to four days. The process of fertilization concluded with the development of a spherical zygote, which subsequently transforms into an ookinete, a motile entity that initiates the subsequent stage of direct separation.

After ookinetes enter the mother tick and produce a huge number of sporocysts, which cause the stomach cells to explode, motile sporokinetes disseminate throughout the intrinsic fluid (haemolymph) and other bodily organs, including ovarian cells. Subsequently, sporokinetes split inner these tissues both before or and during the accumulation of tick egg masses. After the larvae hatch, a fresh round of division starts within them. The parasite's growth within the new tick generations is the subject of the second stage. The sporokinetes start it`s activity after the larvae hatching from the eggs, causing the larva tissue to split several times. The rapid development of salivary production is the first sign of the larval attachment to the animal's body.

At this point, sporozoites invade saliva and salivary gland cells. When a larva feeds on blood, sporozoites enter the red blood cells to start the animal's separation stage. It is important to note that some sporozoites do not make it to the salivary gland; instead, some remain in the larva's tissue and transform into nymphs after the larva has melted (Mandal 2012). Similar to this, the adult tick can spread the pathogens to subsequent generations via its eggs. This process, known as transovarian transmission, is repeated for multiple generations (Gray et al. 2010).

The development of the parasite within the infected animal's host is concluded as follows in the third and last stage. Tick saliva carries sporozoites into the animal's bloodstream, where they pierce the erythrocytes and change into trophozoites, that are tiny, circular or oval structures with a single nucleus. Binary fission creates schizont during asexual multiplication. Each division penetrates a fresh red blood cell, splitting inside it in the identical manner that was repeated, and concludes with the hemolysis of the impacted cells once the growing of dissension within the erythrocyte is finished and the red blood cells (RBCs) are destroyed. In this manner, the entire babesiosis life cycle persists throughout the season (Menshawy et al. 2020).

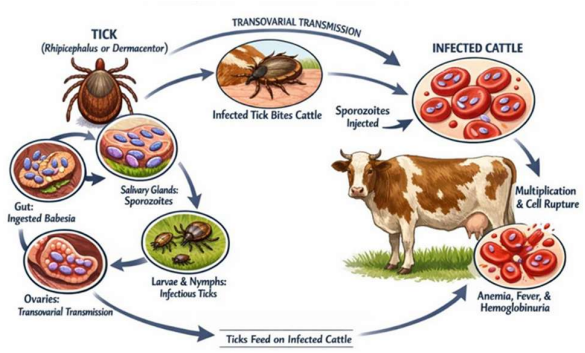

Fig. 2: The life cycle of *Babesia* spp.

Transmission

Ticks' invasion in cows and buffaloes is one of the biggest challenges facing the livestock manufacture. It primarily hazard on bovine benefits by spreading dangerous infection (Menshawy et al. 2018). Ticks carry a variety of protozoa, including *Babesia* spp., which can seriously harm cow health and negatively affect farmers' bottom lines (Hoogstraal and Kaiser. 1958). The prepatent period (6–12 days) for *Babesia bigemina* can be shortened by the dissemination of *Boophilus species*, especially males, among nearby cattle (Callow and Hoyte 1961). But 12–18 days after the tick affixes itself to the animal, the prepatent period begins (Callow 1984). However, the prepatent period usually lasts six to twelve days (Callow 1984), and *B. bovis* only spread during the larval stage (Mahoney & Mirre 1979). High temperatures reduce prepatent periods and facilitate the rapid spread of *B. bovis* by encouraging the adherence of larval ticks (Dalgliesh and Stewart 1982).

The *Babesia kind* are carried by hard ticks and is transovarially transferred from one tick stage to the follow via the egg Demessie and Derso. (2015). Ticks turn into pathogenic when they consume parasites from the afflicted animals' blood. The tick carriers of *B. bigemina* that transmit bovine *babesiosis* are *Rhipicephalus annulatus* and *Rhipicephalus microplus. Rhipicephalus geigyi, Rhipicephalus decoloratus*, and *Rhipicephalus evertsi* are further capable resevoir. *B. bovis* spreads by the ticks *Rhipicephalus annulatu* and *Rhipicephalus microplus. Rhipicephalus geigyi* is another effective vector. One-host *Rhipicephalus spp.* tick larvae are the means by which *B. bovis* is transmitted (Zaky et al. 2024). *Boophilus* ticks can carry *B. bovis* and *B. bigemina* through transovarial infection, however, only tick larval stage can transfer *Babesia. bovis*, whereas adults and nymphs can transmit *Babesia. bigemina* and *Babesia. divergens* (Esmaeil and colleagues. 2015). Before attacking the tick's eggs or salivary glands, the *babesia* parasite grows inside the tick and spreads throughout its organs. After being injected into the circulation by an infected tick biting animal, the parasites infiltrate red blood cells (RBCs) (Government and State agency bord. 2013). During the hot and humid season, ticks from the Ixodidae family are the main source of transition through both transovarial and transstadial transmission (Ozubek S et al. 2020).

In the natural world, ticks have the ability to transmit infections. *R. Microplus* and *Riphiciphelus annulatus*. These are the primary bovine vectors. *Babesiosis* can also be transmitted by *Ixodes*, *Haemaphysalis, Dermacentor,* and *Riphiciphelus* ticks (Zaky et al. 2024). Usually, the infection spreads both transovarially and transtadially. Blood transfusions, organ emulsions, and parenteral injections of tainted blood may also transmit it. Blood donors shouldn't have *babesiosis* (Menshawy et al. 2020).

Clinical signs

Spontaneous infections usually take eight to fifteen days to incubate. In acute conditions, hyperthermia (>40°C) usually lasts for a few days before other remaining clinical signs appear (OIE, 2010; Chisu et al. 2019). Clinical signs are influenced by the type, strain, and age of the parasite. *Babesiosis* typically affects adults; animals younger than nine months frequently exhibit no symptoms (Menehawy 2020). The symptoms that affected animals experienced included a significant fever, decrease of appetite, loss of rumination, respiration difficulties, and decreased milk production in nursing animals (Ahmed A.S. et al. 2022), progressive hemolytic anemia, emaciation, and varying level of icterus, ranging from paleness in moderate cases to intense yellow discoloration of the conjunctival and vaginal mucous membranes. Haemoglobinuria, elevated heart and respiration rates, and a decrease in milk production are all signs of high progressing cases. Fever can occasionally result in abortion in pregnant cattle during infections (El Moghazy et al. 2014). Reddish urine is the most distinctive clinical sign of *babesia* (Mandal. 2012). The main symptoms of *B. bovis* protozoa include hemoglobinuria, fever, and anemia. *B. bigemina* infections do not cause intravascular sequestration of infected erythrocytes, but B.bovis do (Zintl et al. 2013).

Protozoa multiply in peripheral vessels, causing intravascular hemolysis. It has been noted that the infected erythrocytes emit proteolytic enzymes. It rises as a result of enzymatic interaction with blood components. disseminated intravascular coagulation, erythrocytic fragility, and hypotensive shock. Additionally, it is hypothesized that covering RBCs with parasite antigen neutralizes the typical surface charge and promotes R.B.C. autoagglutination. The main clinical characteristics include ruminal atony, complete anorexia, decreased body weight, constipation, anemia, high temperature (105–106F), parasitemia, and hemoglobinurea. Death results from anemic anoxia (Fig. 3) (Abbas et al. 2022).

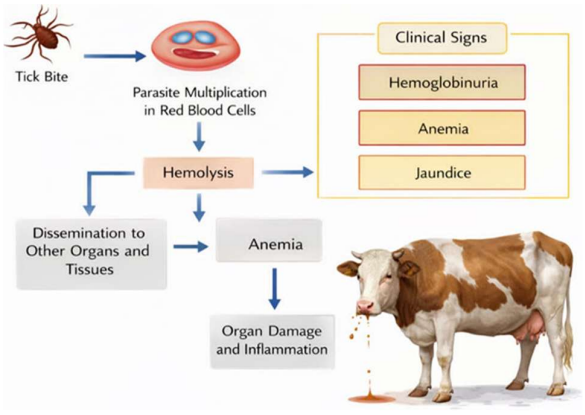

Fig. 3: The clinical signs of Babesia spp.

Diagnosis

In order to effectively manage, monitor, and control *babesial* infections, accurate diagnosis is essential (Menshawy et al. 2020). There are currently many other diagnostic approaches, such as molecular (DNA-based) assays, serological testing, and blood smear examinations, but each has drawbacks. Accurate diagnosis requires a variety of different methodologies, as is increasingly acknowledged.

A provisional diagnosing of *babesiosis* was made based on the animal's record, objective indications, and the presence of ticks on its body. Hemoglobinuria is the primary sign. Additionally, a number of laboratory tests were carried out, including ELISA, complete blood count (CBC), blood serum analysis, urine analysis, and evaluation of a blood smear and PCR is a helpful diagnostic tool (Yadav et al. 2019).

The Causative Agent Identification

A. Direct microscopic investigation

The conventional technique of detecting the causative agent in infected cases by microscopic diagnosis uses thick and thin blood smears with Giemsa or Romanowsky kind stain. It may identify parasitemia as low as 1 parasite per million red blood cells (RBCs) thanks to the thick film sensitivity. When it comes to species distinction, thin films outperform thick ones. For routine *babesiosis* diagnosis, particularly in acute cases, blood film investigating is frequently regarded as the gold standard method (Aziz et al. 2014). It is comparatively inexpensive and faster than most other techniques (Salih DA et al. 2007).

Nevertheless, the stained blood film investigation is inadequate for the precise identification and determination of *B. bigemina* and *B. bovis* during dual infections, as well as generally for diagnosing of carrier status or subclinical cases with low parasitemia (Jacobson LS et al. 2006). According to Wodaje et al. (2019), this technique is typically enough for identifying acute diseases but not for diagnosing carrier animals whose parasitemia are typically quite low.

Hematological Examinations

An automated haematological analyzer (Celltac a model no. MEK-6500k) was used to detect the red blood cell count (RBCs), hemoglobin (Hb), white blood cell count (WBCs), packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), mean corpuscular hemoglobin (MCH), polymorphs, platelets, lymphocytes, monocytes, and RDW (Ahmed A.S. et al. 2022).

C. Biochemical examinations

An automated chemistry analyzer (Aptio, Siemens, ADVIA® 2400) was used to detect the activities of total proteins, globulin, albumin, total bilirubin, direct bilirubin, alanine transaminase (ALT), aspartate transaminase (AST), gamma-glutamyl transferase (GGT), and alkaline phosphatase (ALP). Albumin values were calculated from total protein values to determine serum globulins (Ahmed A. S. et al. 2022).

D.In vitro culture

Techniques are employed to determine whether *Babesia spp*. carrier infections are present. *B. bovis* has also been culturally cloned. According to Wodaje et al. (2019), low parasitemia detectable by this method can be as low as 10-10, depending on the operator's competence and ability. This makes it a highly excitable method for the manifestation of disease with 100% specificity.

D. Animals Inoculation

An intravenous transfusion of around 500 milliliters of jugular blood into a splenectomized calf diagnosed to be *Babesia*-nagative can confirm infection in a suspected carrier animal. The calf is then monitored for the existence of infection. This approach appears to be unsuitable for routine diagnostic use and is costly and infelicitous. The presence of *B. divergens* has been verified using Mongolian gerbils (Merionesunguiculatus) (Wodaje et al. 2019).

Serology Examination

Babesia antibodies in subclinical infections can be reliably detected by serological tests such as the indirect fluorescent antibody test (IFAT) and the enzyme linked immunosorbent assay (ELISA) (Yousef, S.G et al. 2024). These tests' drawbacks include the possibility of false-positively and false-negatively results, interaction that complicate species diagnosis, and typically let down to distinguish between acute and chronic infections (Mahmoud et al. 2016), including typical specific immune responses and/or cross-reactive antibodies (Esmaeil et al. 2015).

Additionally, antibodies against *Babesia. bigemina* and *Babesia. bovis* has been identified using the complement fixation (CF) test (Menshawy et al. 2020). The most popular test for finding antibodies is in *Babesia bigemina* and *Babesia bovis* is IFAT, but because it relies on the detection of parasite antigens by serum antibodies in the examined animal blood, serological cross reactivity increases difficulty and causes species misinterpretation. Although it is simple, obtaining a great-quality antigen is hard (Mosqueda et al. 2012). Additionally, specificity and sensitivity competitory ELISA (cELISA) techniques have been established for *B. bigemina* and *B. bovis*, and their application has been confirmed in various diagnostic labs worldwide (Goff WL et al. 2008).

The disadvantage of serological testing is that antibodies can still be perceived years after a disease has recovered, but there is no distinction between acute and carrier cases. As a result, these techniques are unable to provide an accurate state of the prevalence of infection at
that peculiar time (Sharma A et al. 2013). However, in endemic regions, it is a more comprehensive picture of the prevalence of bovine *babesiosis* that can be obtained by using serological techniques in conjunction with molecular analysis to diagnose the *B. bigemina* and *B. bovis DNA*in the blood of sick animal.

Molecular diagnosis

When immunological procedures are ineffective, molecular techniques designed to identify nucleic acids have proven to be quite beneficial. Nucleic acid estimation is still regarded as an indirect method of parasite detection (Mosqueda et al. 2012). One benefit of this approach According to Skotarczak. (2008), polymerase chain reaction (PCR) is an extremely sensitive and specific

technique that can diagnose the disease in the early stages, allowing for initial diagnosing, therapeutic effort, and the avoidance of consequences. The majority of DNA-based techniques use basic polymerase chain reaction (PCR) methods to diagnose *Babesia. bigemina* and *Babesia. bovis* (Aziz et al. 2014). Well-preserved, species-specific genes make good targets for PCR tests. For *Babesia bigemina* and *Babesia bovis*, PCR test enables the designation of parasite at levels far lower than those recognized by the widely used formal parasitological methods (Sharma A et al. 2013). This is fundamental for the diagnosing of subclinical and latent infection. As a result, DNA amplification is regarded as a powerful diagnostic technique for *babesiosis* in both acute infection cases and carrier animals. *Babesia sp*. PCR findings are easily obtained, and a positive result can be obtained with as little as three parasites in one hundred µl of blood (Wodaje et al. 2019). *Babesiosis* can be diagnosed by the extremely sensitive and specific polymerase chain reaction (PCR) method (Shams et al. 2013).

In light of these, molecular diagnostics is currently the preferred technique for identifying parasites. Real-time PCR, polymerase chain reaction (PCR), loop-mediated isothermal amplification (LAMP), and other molecular techniques are highly utilized (Maharana et al. 2016). In additional to its epidemiological concern, nucleic acid-based techniques have the benefit of guaranteeing the discovery of infection during the latent phase of infection, when the parasitemia level is frequently below the perception limit of traditional technique, as well as in the judgment of the success of the particular chemotherapeutical interference (Mahmoud et al. 2024).

Egypt's bovine babesiosis situation

In Egypt and other area of the world, such as the Mediterranean Basin (Menshawy et al. 2020), bovine piroplasmids are endemic. They affect milk supply, growth rate, hides value, fertility, and fatality rate. *Babesiosis* is a major illness spread by bovine ticks in Egypt. Ticks and tick-borne diseases (TBDs) rank second among the major parasite disasters, behind trypanosomes, and inflict significant losses on the livestock sector (Desalegn et al, 2015). Additionally, *babesia* is one of the most crucial infections in Egypt due to occasionally emerge in acute forms with well-known clinical symptoms, but it also reduces the animals' ability to produce (Wodajnew et al. 2015).

Numerous research has been registered the varying rates of *babesiosis* infection in cattle of Egypt. For example, Nayel et al. (2012) recorded that the prevalence of *Babesia spp.* was 8.15% in Menofia using microscopical examination using Giemsa-stained thin blood film. Additionally, Ibrahim et al. (2013) discovered that in the provinces of Behaira and Fayoum, the prevalence of *Babesia. bovis* and *Babesia. bigemina* in cows by nPCR was 3.97 and 5.30%, respectively. According to El Moghazy et al. (2014), the Qalyobia Governorate had a blood film examination infection rate of 22.47%. Using PCR tests, Elsify et al. (2015) found that 97 and 3.18% of cattle in Egypt were invaded with *Babesia. bigemina* and *Babesia. bovis*.

According to Fereig et al. (2017), enzyme-linked immunosorbent assays using species-specific diagnostic antigens were used to determine the seroprevalence of parasitic infections in cows in Sohag and Qena province, Upper Egypt. They found that 42.2% and 33.2% of the cattle under examination had specific antibodies against *Babesia. bigemina* and *Babesia. bovis*, respectively. According to El-Bahy et al. (2018), 9.42% of Behaira residents were infected with *Babesia spp.* Using PCR, El-Dakhaly et al. (2020) found that *Babeesia bigemina* was present in cattle in the governorates of El-Fayoum, Beni-Suef, and El-Wadi El-Gadid at a rate of 19.33% (29/150).Using recombinant antigen-specific enzyme-linked immunosorbent assays (ELISA), Ibrahim et al. (2021) found that the sero-prevalence of *B. bovis* and *B. bigemina* in bovine in Menoufia governorate, Egypt, was 38.17 and 41.60% (35.88 and 37.40% for immunoglobulin M and 6.11 and 9.54% for immunoglobulin G). Using genetic techniques, Mahmoud et al. (2024) found that 18/150 (12%) cattle in the Sohag governorate were infected with *Babesia.bovis,* whereas 8 animals (5.3%) were infected with *Babesia.bigemina* and 10 cattle (6.7%). The fluctuation in prevalence rates between early report in Egypt may be explained by factors such as breeds, immune condition, climate, tick dispersion, cattle management, and sample status.

The importance of population health

Although humanlike *babesiosis* was first documented in 1957, it is nowadays recognized to be widespread throughout the world. Increased awareness of the illness and rises in real incidence are probably the causes of the additional reported cases (Yadhav et al. 2015). While some kind of *Babesia*, such *Babesia. microt*i, can affect individual health, *B.divergens* causes serious sickness in immunocompromised and splenectomized humans. *B. divergens* is a bacterium that causes transient remedial symptoms in humans. They typically develop quite quickly, and the majority of cases in the past terminated in death within a week.

Severe hemoglobinuria, hemolysis, jaundice, chills, headache, sweats, lumbar, myalgia, and stomach pain, as well as occasionally vomiting and diarrhea, are the hallmarks of the illness. Shock and renal failure are also possible. Antiparasitic medications and supportive care now have a case fatality rate of nearly 40%. Drug therapy alone may resolve mild instances (Menshawy et al. 2020). Int. J. Adv. Res. Biol. Sci. 6(1): 63-70 68 (2019) Immunocompromised people should exercise caution when traveling to areas where *babesia* is endemic, particularly during tick season, to forbid contracting *Babesia. divergens*. Wearing appropriate clothing and tick repellant can help prevent tick exposure. After being outside, clothing and skin should be checkered for ticks, and any discovery should be remote (Spickler et al. 2010).

Economic important status

Due to the discovery that 400 million cattle worldwide are infected with *Babesia* (Osman and Gaadee. 2013) and that approximately 500 million cattle are at danger worldwide (Farooq R. 2020), *Babesia* has recently become the most ubiquitous parasite. Every year, tick-borne illnesses cost cattle 18.6 billion dollars in losses and three billion pieces of hide (Terkawi et al. 2012). The annual global economic impact of tick production is estimated to be between $13 and $19 billion (Oscar and Cristian. 2018). Cattle and

buffalo advancement projects are hampered by bovine babesiosis because of their notable economic impact on meat and milk production, in addition to the expenses of medical cure and ticks' management.

It is presently regarded as the most primary endemic parasite infection that affects Egyptian bovine (Zaky et al. 2024). *Babesiosis*, especially in cattle, has a significant economic impact since, in contrast to many other parasite illnesses, it affects adults more seriously than young bovine, leads to immediate consequences such as animal death and movement restrictions due to quarantine regulations (Onoja et al. 2013). As a result, the productivity of cattle in endemic regions is still low, which hinders the development of the bovine sector and the welfare of manufacturers and their families (Mosqueda et al. 2012).

Subclinical *babesiosis* causes the afflicted livestock to become chronic carriers, serve as tick vector reservoirs for infection, and result in natural infection of the disease. In the end, the recovered animals may continue to have a microscopically undetectable subclinical infection. As a result, latent cases represent the disease's epidemiology (Menshawy et al. 2020).

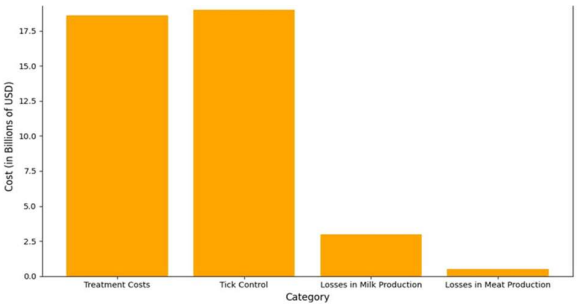

Fig. 4: The Economic impact of *Babesia*.

Prevention and Control

Chemoprophylaxis, immunization, and tick killing, or a combination of these methods, are the main strategies used to control *babesiosis* (Menshawy et al. 2020). To overcome the infection as effectively as possible and to avoid breed resistance and enzootic constancy, all three approaches must be used. Immunization, which uses either live or dead entire parasites and separated parasite antigen, is an efficient way to prevent *babesiosis* because chemoprophylaxis is not practical for a long period (Yusuf. 2017). Cattle that have been inoculated with attenuated parasites or that have recovered from the first *Babesia* contagion are immune to objection infection. Second, cattle can develop preventive immunity against both heterologous and homologous objection by being immunized with natural *Babesia* antigen excerpts or culture-derived supernatants including secreted *Babesia* antigens (Radostits et al. 2007).

Additionally, Infected animals should be sprayed with an acaricide that can forbid tick attachment, particularly in endemical regions. Cattle in high-gainsay regions may require repeated medical treatment with acaricides twice a week to eradicate the tick before the infectious sporozoite grows in the salivary gland (Urquhart et al. 1996). Eliminating the *Boophilus* tick, the *babesiosis* vector, by dipping all bovine once a week is the most amazing method for monitoring the disease (El Sawalhy et al. 2012).

No control is typically required in endemic regions where all local bovines are afflicted as calves. Calves must be exposed to the disease when they are at their most resistant in order to maintain the enzootically stable state. The calf crop may need to be vaccinated annually if the gainsay is still intermittent (El Sawalhy et al. 2012). Because fewer ticks will naturally expose animals to *babesiosis*, the likelihood of contracting the disease will decrease over time. In certain areas of the world, diseased animals should receive proper therapy as soon as possible in order to monitor *babesiosis* (Kuttler et al. 1981).

The widespread use of *anti-Babesia* protective treatments, which include administering the medication to animals at sub-lethal blood levels, can lead to the emergence of drug-resistant parasite, a problem that will demand the creation of new medications (Vial and Gorenflot. 2006). Keeping in mind that the establishment of cattle, the correct using of acaricides, and the amount of applying acaricides—more than 6 treatments annually will increase the probability of tick resistance (Zaky et al, 2024).

Treatment

Diseased animals in endemic locations should get anti-parasitic medication as soon as feasible. Treatment success depends on primal diagnosis and quick delivery of efficient medications. It has been shown that a variety of chemical compounds are efficient against bovine *babesial* infections. Several of them were highly targeted and successful (Vial and Gorenflot. 2006). However, many have been reclusive for various causes. Furthermore, in terrible cases of *babesiosis*, subsidiary therapies such as tick removal, anti-inflammatory medications, blood transfusions, iron preparations, dextrose, vitamins (B complex), laxative, and fluid replacements may be crucial (Zintl et al. 2013).

Three *babesiacides* were available for the treatment of *babesiosis* in most European countries: amicarbalideiso-thionate (Diampron®, May and Baker Ltd.), quinuroniumsulfate (Ludobal®, Bayer Ltd.), and DA (Berenil®, Hoechst Ltd.). Only the latter is available in India. At a well-supported intramuscular dosing rate of 3.5mg/kg, diaminazine effectively combats *B. bigemina* and *B. bovis*. According to Mosqueda et al. (2012), it will defend bovine from the two diseases for two and four weeks, respectively. A fourth medication, imido carbdipropionate (Imizol®; Schering-Plough), was developed in the 1970s to treat red water fever.

Due to its preventive effectiveness at double the therapeutic doses, imidocarb dipropionate swiftly emerged as the preferred manufacture in Egypt. Diminazene aceturate, better known as benenil, is also frequently used. Imidocarb is administered subcutaneously at a dose of 1.2 mg/kg for chemotherapy, whereas 3 mg/kg is protective against *B. bigemina* for a minimum of two months and *B. bovis* for four weeks. Imidocarb also eliminates *B. bigemina* and *B. bovis* from carrier cases at high doses (Abbas et al. 2022).

For treating infected horses, imidocarb may be the preferred medication (at 4mg/kg and 2mg/kg for *Babesia. equi* and *Babesia caballi*, respectively). Amicarbalide and quinuronium were later removed due to safety concerns.

Despite diminazene's continued widespread usage in the tropics to treat trypanosomosis and babesiosis, it was removed from Europe due to commercial concerns (Vial and Gorenflot 2006).

Conclusion

In this study *Rhipicephalus (Boophilus) annulatus* was the most domenant, Bovine babesiosis is a evidentiary veterinary and economic challenge in endemic regions. The disease's complex life cycle, involving tick vectors, complicates control efforts. Early detection and treatment are crucial for managing clinical symptoms, while tick control remains essential. The economic impact includes treatment costs and productivity losses, underscoring the need for effective prevention strategies. Future research should focus on improving vaccines, tick resistance management, and cost-effective treatments. A comprehensive approach combining diagnostics, control measures, and surveillance is critical for reduction the disease's impact on livestock health and agriculture.

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