Review on bovine babesiosis in Ethiopia

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Abstract: Bovine babesiosis is a tick-borne disease of cattle caused by the protozoan parasites including *Babesia bovis*, *B. bigemina* and *B. divergens*. Rhipicephalus (Boophilus) microplus, the principal vectors of B.*bovis* and B. *bigemina*. The major vector of *B. divergens* is Ixodes ricinus. There are other important vectors that can transmit these pathogens, including Haemaphysalis and other Rhipicephalus spp. Bovine babesiosis also known as red water, is the worldwide most important hemoparasitic diseases of cattle that causes significant morbidity and mortality. They are widespread in tropical and subtropical areas including Ethiopia and are vectored by one host tick Rhipicephalus species and transmission is manly transovarial. During the tick bite, sporozoites are injected into the host and directly infect red blood cells. Babesia produces acute disease by hemolysis and circulatory disturbance mechanism. The rapidly dividing parasites in the red cells produce rapid destruction of the erythrocytes with accompanying haemoglobinaemia, haemoglobinuria and fever. Early detection of blood parasites is highly beneficial active prevention and control of Babesiosis and it is achieved by three main methods: immunization, chemoprophylaxis and vector control. Imidocarb is the drug of choice for bovine babesiosis. The use of genetically resistant cattle such as *B. indicus* is proposed as sustainable approach to decrease the incidence of disease.
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Key words: Bovine babesiosis, *Babesia,* Hemoparasitic diseases and Red water.

1. Introduction

Bovine babesiosis is caused by protozoan parasites of the genus *Babesia*, order Piroplasmida, phylum Apicomplexa. Of the species affecting cattle, two – *Babesia bovis* and *B. bigemina* – are widely distributed and of major importance in Africa, Asia, Australia, and Central and South America. *Babesia divergens* is economically important in some parts of Europe. Tick species are the vectors of *Babesia*. *Rhipicephalus* (*Boophilus*) *microplus* is the principal vector of *B. bigemina* and *B. bovis* and is widespread in the tropics and subtropics. The vector of *B. divergens* is *Ixodes ricinus*. Other important vectors include *Haemaphysalis* and other species of *Rhipicephalus* (Bock *et al.,* 2008).

Babesia bigemina has the widest distribution but *B. bovis* is generally more pathogenic than *B. bigemina* or *B. divergens*. *Babesia bovis* infections are characterised by high fever, ataxia, anorexia, general circulatory shock, and sometimes also nervous signs as a result of sequestration of infected erythrocytes in cerebral capillaries. Anaemia and haemoglobinuria may appear later in the course of the disease. In acute cases, the maximum parasitaemia (percentage of infected erythrocytes) in circulating blood is less than 1%. This is in contrast to *B. bigemina* infections, where the parasitaemia often exceeds 10% and may be as high as 30%. In *B. bigemina* infections, the major signs include fever, haemoglobinuria and anaemia. Intravascular sequestration of infected erythrocytes does not occur with *B. bigemina* infections. The parasitaemia and clinical appearance of *B. divergens* infections are somewhat similar to *B. bigemina* infections (OIE. 2014).

Infected animals develop a life-long immunity against reinfection with the same species. There is also evidence of a degree of cross-protection in *B. bigemina*-immune animals against subsequent *B. bovis* infections. Calves rarely show clinical signs of disease after infection regardless of the *Babesia* spp. involved or the immune status of the dams (Bock *et al.,* 2008).

Ticks and tick-borne diseases (TBDs) affect the productivity of bovines and leads to a significant adverse impact on the livelihoods of resource-poor farming communities (Jabbar *et al*., 2015) Four main TBDs, namely anaplasmosis, babesiosis, the ileriosis and ehrlichiosis (heart water) are considered to be the most important tick-borne diseases (TBDs) of livestock in sub-Saharan Africa, resulting in extensive economic losses to farmers in endemic areas (Eygelaar *et al*., 2015). They are responsible for high morbidity and mortality resulting in decreased production of meat, milk and other livestock by-products. Generally bovine babesiosis is one of the most important diseases that seriously hinder cattle production in Ethiopia and other part of the world (Simuunza, 2009).

So the objectives of this paper are:- to review the occurrence of Bovine babesiosis, to high light the economic impact of the disease and to review the current status of the disease in Ethiopia.

2. Literature Review

2.1. Definition of Bovine babesiosis

Bovine babesiosis (BB) is a tick-borne disease of cattle caused by the protozoan parasites of the genus Babesia, order Piroplasmida, phylum Apicomplexa. The principal species of *Babesia* that cause BB are: *Babesia bovis*, Babesia *bigemina* and *Babesia divergens*. Other *Babesia* that can infect cattle includes *B. major, B. ovata, B. occultans* and *B. jakimov* (Nejash, 2016).

2.2. Epidemiology

All Babesia are transmitted by ticks with a limited host range. The principal vectors of *B. bovis* and *B. bigemina* are *Rhipicephalus* spp, ticks and these are widespread in tropical and subtropical countries. The major arthropod vector of *B. divergens* is *Ixodes ricinus*. BB is principally maintained by subclinically infected cattle that have recovered from disease. Morbidity and mortality vary greatly and are influenced by prevailing treatments employed in an area, previous exposure to a species/strain of parasite, and vaccination status. In endemic areas, cattle become infected at a young age and develop a long-term immunity. However, outbreaks can occur in these endemic areas if exposure to ticks by young animals is interrupted or immuno-naïve cattle are introduced. The introduction of *Babesia* infected ticks into previously tick-free areas may also lead to outbreaks of disease (Dominguez *et al*., 2015).

2.2.1. Agent

Babesiosis results from infection by protozoa in the genus *Babesia* (family Babesiidae, order Piroplasmida). The three species found most often in cattle are *Babesia bovis, B. bigemina* and *B. divergens*. Additional species that can infect cattle include *B. major*, *B. ovata*, *B. occultans* and *B. jakimovi* (Lemma and Demam, 2015).

Organisms that are very closely related to *B. divergens*, but do not seem to affect cattle, have recently been discovered in wildlife and humans. Whether these species should be called *B. divergens* is uncertain, but at least in some cases, they appear to be distinct organisms. Some, such as *Babesia venatorum*, have been given individual names (Bock *et al*., 2008).

2.2.2. Geographic distribution of Babesiosis

Both *Babesia* species occur in Central and South America, parts of Europe and Asia, Australia and Africa. *Babesia bigemina* has been eradicated from the United States of America. In southern Africa *Babesia bovis* is restricted to areas where *Rhipicephalus* (*B.*) *microplus* is prevalent, usually the higher rainfall areas in the eastern parts. Due to its wider vector range, *Babesia bigemina* is much more widespread and is present throughout southern Africa, except for the more arid and some high-lying parts.

Bovine babesiosis can be found wherever the tick vectors exist, but it is most common in tropical and subtropical areas. *B. bovis* and *B. bigemina* are particularly important in Asia, Africa, Central and South America, parts of southern Europe, and Australia (Bono *et al*., 2008).

2.2.3. Risk factor

2.2.3.1. Host factor

Host factors associated with disease include age, breed and immune status. *Bos indicus* breeds of cattle are more resistance to Babesiosis than *Bos taurus*. This is a result of evolutionary relationship between *Bos indicus* cattle, *Rhipicephalus* (formerly *Boophilus*) species and *Babesia*. Because of natural selection pressure, indigenous populations, having lived for a long time with local ticks and tick-borne diseases, have developed either an innate resistance or an innate ability to develop a good immuneresponse to the tick or tick-borne hemoparasitic disease in question (Chaudhry *et al*., 2010).

2.2.3.2. Environmental factor

There is a seasonal variation in the prevalence of clinical Babesiosis, the greatest incidence occurring soon after the peak of the tick population. Of the climatic factors, air temperature is the most important because of its effect on tick activity; higher temperatures increase its occurrence. Heaviest losses occur in marginal areas where the tick population is highly variable depending on the environmental conditions.

2.2.3.3. Pathogen/agent Factor

Strains vary considerably in pathogenicity; however, *B. bovis* is usually more virulent than *B. bigemina* or *B. divergens.* Many Intra-erythrocyte hemoparasites survive the host immune system through rapid antigenic variation which has been demonstrated for *B. bovis* and *B. bigemina* (Criado *et al*., 2009).

2.2.4. Host range

More than 100 known *Babesia* spp, have been identified which infect many types of mammalian host, out of these, 18 spp. cause disease in domestic animals. Babesiosis commonly infect cattle, sheep, goats, horses, pigs, dogs and cats and occasionally man. European, Sanga and Zebu breeds are all susceptible, and all develop latent infections after recovery. European breeds can retain *B. bovis* infections for life and remain infective for ticks for up to two years, while most cattle with a significant Zebu content lose the infection within two years. *Babesia bigemina* infections rarely persist for more than a year, regardless of the host, and infected cattle remain infective for ticks for only four to seven weeks (Nejash and Kula, 2016).

2.2.5. Transmission

Rhipicephalus (*B.*) *microplus* is the only known tick vector of *B. bovis* in southern Africa. Transmission is transovarial with engorging adult ticks ingesting the parasites and larval ticks of the next generation transmitting the infection. Ensuing stages are not infected.

Babesia bovis and *B. bigemina* follow similar developmental patterns in adult *Rhipicephalus* (*Boophilus*) spp. Initial development takes place in epithelial cells of the gut wall where schizogony (multiple fission) occurs with the formation of large merozoites (vermicules, sporokinetes). Successive cycles of schizogony then occur within a variety of cell types and tissues, including the oocytes. Thus, transovarial transmission occurs with further development taking place in the larval stage (Demssie and Derso, 2015).

2.3. Pathogenesis

The primary mechanism is intravascular haemolysis (leading to haemoglobinaemia and haemoglobinuria), resulting in anaemia, hypoxia and secondary inflammatory lesions in various organs, especially liver and kidneys. The secondary mechanism is electrolyte imbalances, complement activation, coagulation disorders and release of pharmacologically active substances resulting in vascular malfunction and hypotensive shock (Dominguez *et al*., 2015).

The main sequelae of the disease are: Anaemia due to haemolysis; haemoglobinaemia and haemoglobinuria, icterus. Pharmacologically active substances such as kinins and catecholamines lead to increased vascular permeability and dilatation of blood vessels resulting in oedema and hypovolaemic shock. Centrilobular liver degeneration and degeneration of kidney tubule epithelium are caused by hypoxia and possibly by immunopathologic reactions. Damage to kidney tubule epithelium impairs ion exchange, resulting in H+ retention (leading to acidosis) (EL-Ashker *et al*., 2015).

2.4. Clinical sign

The clinical signs vary with the age of the animal and the species and strain of the parasite. Most cases of babesiosis are seen in adults; animals younger than 9 months usually remain asymptomatic. Strains vary considerably in pathogenicity; however, *B. bovis* is usually more virulent than *B. bigemina* or *B. divergens* (EL-sayed, 2014).

Babesia bovis:- High fever, Ataxia and incoordination, Anorexia, Production of dark red or brown-colored urine, Signs of general circulatory shock, Sometimes nervous signs associated with sequestration of infected erythrocytes in cerebral capillaries, Anaemia and haemoglobinuria may appear later in the course of the disease and in acute cases: maximum parasitaemia (percentage of infected erythrocytes) in circulating blood is often less than 1%.

Babesia bigemina:- Fever, Haemoglobinuria and anaemia, Production of dark red or brown-colored urine, Nervous signs minimal or non-existent as intravascular sequestration of infected erythrocytes does not occur, Parasitaemia often exceeds 10% and may be as high as 30%.

Babesia divergens and Parasitaemia and clinical appearance are similar to *B. bigemina* infections

Fig. 1: Pale mucus membrane at vulva region

Fig.2: Hard ticks of the family Ixodidae Boophilus microplus

2.5. Pathological lesion

Lesions observed are those most often associated with an intravascular haemolytic condition are:- Pale or icteric mucous membranes; blood may appear thin and watery, Subcutaneous tissues, abdominal fat and omentum may appear icteric, Swollen liver with an orange-brown or paler coloration; enlarged gall bladder containing thick, granular bile, Enlarged, dark, friable spleen, Kidneys appear darker than normal with possible petechial haemorrhages, Bladder may contain dark red or brown-colored urine, Possible oedema of lungs and Petechiae or ecchymoses on surface of heart and brain (Eygelaar *et al.,* 2015).

2.5.1. Post mortem finding

2.5.2. Histopathogy

2.6. Morbidity and Mortality

Morbidity and mortality vary greatly and are influenced by prevailing treatments employed in an area, previous exposure to a species/strain of parasite and vaccination status. In endemic areas, cattle become infected at a young age and develop a long-term immunity. However, outbreaks can occur in these endemic areas if exposure to ticks by young animals is interrupted or immuno-naïve cattle are introduced (Faez *et al*., 2013).

2.7. Diagnosis

In natural infections, incubation periods usually vary from 8 to 15 days. In acute manifestations, fever (>40°C) is usually present for several days before the onset of other clinical signs: inappetence, depression, weakness and reluctance to move (Hazem *et al*., 2014). Haemoglubinuria is often present especially in *B. bigemina* infections (hence the common name "redwater"). Anaemia and icterus are especially obvious ion more protracted cases. Diarrhoea is common and pregnant cows may abort. Cerebral babesiosis, which occasionally develops in *B. bovis* infections, is manifested by hyperaesthesia, nystagmus, circling, head pressing, aggression, convulsions and paralysis; these signs may or may not accompany other signs of acute babesiosis (Jabbar *et al.,* 2015).

2.7.1. Diagnostic techniques

2.7.2. Laboratory diagnosis

Several thick and thin blood smears collected from superficial skin capillaries (e.g. tip of the ear or tip of the tail) of live animals during the acute phase of the disease (appearance of fever) on thin blood films should be air-dried, fixed in absolute methanol for 1 minute and stained with 10% Giemsa stain for 20–30 minutes. Blood films should be stained as soon as possible after preparation to ensure proper stain definition. Thick films are made by placing a small drop (approximately 50 µl) of blood on to a clean glass slide and spreading this over a small are using a circular motion eith the corner of another slide. The droplet is air-dried, heat-fixed at 80°C for 5 minutes, and stained (without fixing in methanol) in 10% Giemsa for 15 minutes. Unstained blood films should not be stored with or near formalin solutions as formalin fumes may affect staining quality; moisture also affects staining quality. If it is not possible to make fresh films from capillary blood, sterile jugular blood should be collected into an anticoagulant such as lithium heparin or ethylene diamine tetra-acetic acid (EDTA).

The sample should be kept cool, preferably at 5°C, until delivery to the laboratory. *B. bovis* is sequestered and found in higher numbers in capillary blood, *B. bigemina* and *B. divergens* parasites are uniformly distributed through the vasculature (Lemma and Demam, 2015).

2.7.3. Differential diagnosis:- includes Anaplasmosis, Trypanosomiasis, Theileriosis Bacillary haemoglobinuria, Leptospirosis, Eperythrozoonosis, Rapeseed poisoning and Chronic copper poisoning.

2.8. Economic significance

Bovine babesiosis causes most serious economic loss to the livestock industry, endangering half a billion cattle across the world (Leta and Mesele, 2014). Babesiosis, especially in cattle has great economic importance, because unlike many other parasitic diseases, leading to direct losses through death and the restriction of movement of animals by quarantine laws. The disease is also a barrier to improving productivity of local cattle by cross-breeding due to the high mortality of genetically superior but highly susceptible cattle, especially dairy cattle, imported from *Babesia* free areas. The consequence is that the quality of cattle in endemic areas remains low, therefore impeding the development of the cattle industry and the wellbeing of producers and their families (Nejash and Kula, 2016).

2.8.1. Public health significance

Although some species of *Babesia* such as *B. microti* can affect healthy people, cattle parasites seem to cause disease only in people who are immunocompromised. *Babesia divergens* causes serious disease in humans who have had splenectomies. This infection is rare; in Europe, approximately 30 cases had been reported as of 2003. It is characterized by the acute onset of severe hemolysis, hemoglobinuria jaundice, persistent high fever, chills and sweats, headache, myalgia, lumbar and abdominal pain and sometimes vomiting and diarrhea. Shock and renal failure may also be seen. *Babesia divergens* infections in humans are medical emergencies (Liu *et al*., 2014).

2.9. Treatment

Treatment of babesoisis is most likely to be successful if the disease is diagnosed early; it may fail if the animal has been weakened by anemia. A number of drugs are reported to be effective against *Babesia*, but many of them have been withdrawn due to safety or residue concerns (Mahmmod, 2014). Imidocarb are the drug of choice for bovine babesiosis, which can prevent clinical infection up bovine babesiosis, which can prevent clinical infection up to 2 months, (Liu *et al*., 2012). Sick animals should be treated as soon as possible with an antiparasitic drug. Imidocarb (Imizol) and the allied drug amicarbalide are effective babesiocides for cattle at the dose rate of 1-3 mg/kg and 5-10 mg/kg body weight respectively (Zanet *et al*., 2014). The first specific drug used against bovine Babesiosis was Trypan blue, which is a very effective compound against *B. bigemina* infections, however, it did not have any effect on *B. bovis* and it had the disadvantage of producing discoloration of animal's flesh, so it is rarely used (OIE,2009). Diminazene aceturate, which is widely used currently in the tropics as a Babesiacide, was withdrawn from Europe for marketing reasons (Simuunza, 2009). Blood transfusions and other supportive treatment. Chemoprophylaxis with one drug (imidocarb) can protect animals from clinical disease while allowing the development of immunity (Shkap, 2007).

2.10. Prevetion And Control

Active prevention and control of babesiosis is achieved by three main methods: immunization, chemoprophylaxis and vector control. Ideally, the three methods should be integrated to make the most cost effective use of each and also to exploit breed resistance and the development and maintenance of enzootic stability (Aboul *et al*., 2010).

Eradication of bovine babesiosis has been accomplished by elimination of tick vector in areas where eradication of tick is not feasible or desirable; ticks are controlled by repellents and acaricides. Reduce the exposure of cattle to tick and regular inspection of animals and premises. Cattle develop a durable, long-lasting immunity after a single infection with *B. bovis*, *B. divergens* or *B. bigemina*, a feature that has been exploited in some countries to immunize cattle against Babesiosis (Schonrn *et al*., 2011).

3. Epidemiology Of Bovine Babesiosis In Ethiopia

Ticks and tick borne diseases cause considerable losses to the livestock economy of Ethiopia, ranking third among the major parasitic disasters, after trypanosomes and endoparasitism. Major cattle tick-borne diseases in Ethiopia are anaplasmosis, babesiosis, cowdriosis and theileriosis. Babesiosis is one of the most important diseases in Ethiopia because it occurs sometimes in acute forms with serious recognized clinical manifestations yet lowering the productive performance of the affected animals (Nejash, 2016).

The study from Western Ethiopia Benishangul Gumuz Regional State, by Wodajnew *et al*. [14] reported the overall prevalence of 1.5% from which *B. bovis* was found to be 1.24% and *B. bigemina* was 0.248%. Furthermore, the reviewed study revealed that the highest prevalence was compiled during the autumn season (2.99%) followed by extremely low prevalence in the winter season (0.88%). Another study in and around Jimma town, southwest Ethiopia reported overall prevalence rate of Bovine Babesiosis as 23% by Giemsa stained blood smears out of which 33.33% was *B. bovis* and 62.96% was *B. bigemina*. Similarly the study at the same place revealed an overall prevalence rate of Bovine Babesiosis to be 12.8% [29]. The result of microscopic examination of more recent study from Southern Ethiopia in Teltele District, Borena Zone, indicated the overall prevalence of 16.9% out of which two species of Babesia comprising of *B. bovis* (9.9%) and *B. bigemina*. High prevalence of bovine babesiosis was reported regards to my beloved and respected family for their in and around Jimma town, southwest Ethiopia (Nejash and Kula, 2016).

4. Conclusion And Recommendation

Bovine babesiosis is the most important arthropod-borne disease of cattle worldwide that causes significant morbidity and mortality. The most prevalent species, *B. bovis* and *B. bigemina*, are found throughout most tropical and subtropical regions including Ethiopia. All *Babesia* are transmitted by ticks with a limited host range. The principal vectors of *B. bovis* and *B. bigemina* are Rhipicephalus spp. ticks and these are widespread in tropical and subtropical countries. Calves are virtually resistant to the Babesia. *Babesia bovis* causes more severe clinical signs as compared to *Babesia bigemina*. Bovine Babesiosis causes most serious economic loss to the livestock industry, endangering half a billion cattle across the world. The disease is also a barrier to improving productivity of local cattle by cross-breeding due to the high mortality of genetically superior but highly susceptible cattle. Currently bovine babesiosis is widespread in Ethiopia with most prevalent species being *B. bovis* and *B. bigemina*. Therefore based on the above conclusions the following recommendations can be forwarded are:- various control strategies should be adopted in order to prevent the day to day increasing losses to livestock industry and vaccines should be practiced in control and prevention of babesiosis, awareness should be given livestock owners in relation to vector control as one option of controlling bovine babesiosis, Ethiopia should develop and implement surveillance systems and action plans to prevent bovine babesiosis from spreading and epidemiological studies should be conducted on bovine babesiosis to provide the necessary incidence and prevalence data.

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