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Bovine Babesiosis and Its Current Status in Ethiopia: A Review

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Abstract
Bovine babesiosis also known as redwater, or tick fever is the worldwide most important arthropod-borne disease of cattle that causes significant morbidity and mortality. It is caused by intra-erythrocytic protozoan parasites of the genus Babesia, which is transmitted by ticks and affects a wide range of domestic and wild animals and occasionally humans. Two important Babesia species: *B. bigemina* and B bovis infect cattle. They are widespread in tropical and subtropical areas including Ethiopia and are vectored by one host tick Rhipicephalus species and transmission is manly transovarially. The objective of this paper are reviewing available literature in relation to epidemiology, diagnosis, public health importance, control and preventions of bovine babesiosis and highlighting the disease status in Ethiopia. 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. Microscopic examination is still cheapest and fastest methods used to identify Babesia parasites. But not reliable for detection of carrier animals; in these cases molecular detection methods, or serological diagnostic procedures to demonstrate specific antibodies, are required. 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. Active prevention and control of Babesiosis 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.
Keywords: Bovine babesiosis, Babesia, Ethipiopia, redwater, tick fever

1 INTRODUCTION

Ethiopia has the largest livestock population in Africa. This livestock sector has been contributing considerable portion to the economy of the country, and still promising to rally round the economic development of the country. Estimate indicates that the country is a home for about 54 million cattle, 25.5 million sheep and 24.06 million goats. From the total cattle population 98.95% are local breeds and the remaining are hybrid and exotic breeds (Leta and Mesele). In spite of having the largest livestock population in Africa, the contribution for the economic aspect of the country is still lowest and disease can be considered as major constrain (Nejash, 2016). Livestock disease is among the major factors that affect the production and productivity having negative effects on the health of the livestock. The presence of diseases caused by haemoparasites is broadly related to the presence and distribution of their vectors. Arthropod transmitted haemoparasitic disease of cattle is caused by the trypanosome, babesia, theileria and anaplasma species (Hamsho, *et al*., 2015).

Arthropod transmitted hemoparasitic diseases are economically important vector-borne diseases of tropical and subtropical parts of the world including Ethiopia (Sitotaw *et al*., 2015).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, theileriosis, and cowdriosis (heartwater) 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 (Simuunza, 2009).

Babesiosis is a tick-borne disease of cattle caused by the protozoan parasites Babesia bovis, *B. bigemina*, *B. divergens* and others. Rhipicephalus (Boophilus) spp., the principal vectors of *B. bovis* and *B. bigemina*, are widespread in tropical and subtropical countries. The major vector of *B. divergens* is Ixodes ricinus (OIE, 2010). Bovine babesiosis is the most important arthropod-borne disease of cattle worldwide that causes significant morbidity and mortality. It is the second most common blood-borne parasitic disease of mammals after the trypanosome (Hamsho *et al*., 2015). Babesiosis is a haemolytic disease and characterized by fever (40-42°C) which may be sudden in onset, anemia, icterus, hemoglobinuria, listless, anorexic, jaundice and death (Demessie and Derso, 2015). 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. *B. divergens* causes serious disease in humans who have had splenectomies (CFSPH, 2008). Active prevention and control of Babesiosis is achieved by three main methods: immunization, chemoprophylaxis and vector control (Demessie and Derso, 2015). The use of genetically resistant cattle such as *B. indicus* can also decrease the incidence of disease (Spickler *et al*., 2010).

In Ethiopia, now days no adequate emphasis has been given to livestock disease, particularly, to Bovine Babesiosis, despite of its devastating effect on cattle and other livestock's (Lemma *et al*., 2015). Bovine Babesiosis is one of the most important diseases in the country because it occurs sometimes in acute forms with serious recognized clinical manifestations yet lowering the productive performance of the affected animals (Wodajnew *et al*., 2015). Recognitions of this situation and paucity of well documented information motivated the author of this review despite disease widespread of disease in the country. Therefore the main objectives of this paper are reviewing available literature in relation to epidemiology, diagnosis, public health importance, control and preventions of bovine babesiosis. Furthermore, the paper highlights the disease current status in Ethiopia.

2 LITERATURE REVIEW

2.1 Etiology and taxonomy

Babesiosis is an infectious tick- borne disease of livestock that characterised by fever, anemia, haemoglobinuria and weakness. The disease also is known by such names as bovine babesiosis, piroplasmosis, Texas fever, redwater, tick fever, and tristeza (Sahinduran, 2012). Bovine babesiosis caused by an apicomplexan haemoprotozoan parasite under family Babesiidae, order Piroplasmida) (Sharma, *et al*., 2013).It is caused by multiple species but three species found most often in cattle are *B. bovis*, *B. bigemina* and *B. divergens*. Additional species that can infect cattle include *B. major*, *B. ovata*, *B. occultans* and *B. jakimovi* (Spickler *et al*., 2010). Two species, *B. bigemina* and *B. bovis*, have a considerable impact on cattle health and productivity in tropical and subtropical countries (El-Ashker *et al*., 2015). *Babesia* belongs to protozoan parasites of the genus Babesia, order Piroplasmida (figure 1), phylum Apicomplexa and subclass Piroplamsia and are commonly referred to as 'piroplasmas' due to the pear-like shaped merozoites which live as small parasites inside RBC of mammals (Hamsho *et al*., 2015).

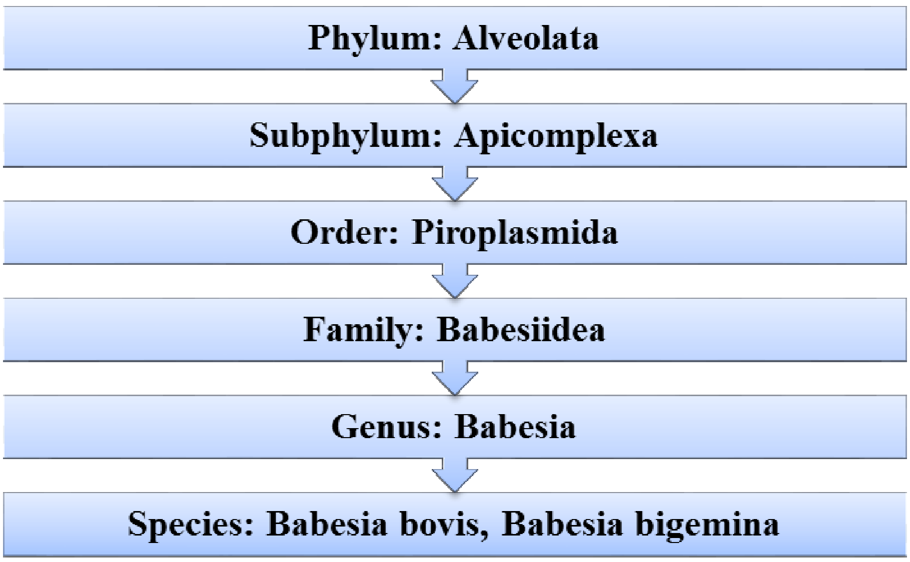

Figure 1: Taxonomy of the genus Babesia
Source: Adopted from Pohl, (2013)

2.2 Epidemiology

2.2.1 Geographical Distribution

Bovine babesiosis can be found wherever the tick vectors exist, but it is most common in tropical and subtropical areas (CFPH, 2008). *B. bovis* and *B. bigemina* are present in most areas of the world, with the greatest incidence between the latitudes of 32 °N and 30 °S, where their *Boophilus* tick vector commonly occurs (Pohl, 2013). They are particularly important in Asia, Africa, Central and South America, parts of southern Europe, and Australia. Although *B. bovis* is usually found in the same general geographic area as *B. bigemina*, slightly different groups of ticks spread these two species and some differences in their distribution can be seen. For example, *B. bigemina* is more widely distributed than *B. bovis* in Africa (Spickler *et al*., 2010). Generally both parasites, *B. bovis* and *B. bigemina*, have the same distribution, but in Africa *B. bigemina* is more widespread than *B. bovis* because of the ability of *B. decoloratus* and *R. evertsi* to also act as vectors for this species (Pohl, 2013).

B. divergens is an important parasite in parts of Europe (table 1) including the United Kingdom, Spain and northern Europe. Surveys have found evidence for this species throughout Europe, and it may also occur in North Africa. Its vector, *I. ricinus*, can survive from northern Scandinavia to the Mediterranean. However, because this tick requires 80% humidity, it can be found only in some microenvironments such as the base of vegetation in forests, rough hill scrub, and damp low-lying land. *B. major* can be found in parts of Europe, Northwest Africa and Asia, as well as China. *B. ovata* has been described in Japan, China and other parts of eastern Asia. *B. occultans* has been reported in Africa, and *B. jakimovi* occurs in Siberia (CFPH, 2008).

2.2.2 Host range

Babesiosis commonly infect cattle, sheep, goats, horses, pigs, dogs and cats and occasionally man. 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 (Hamsho *et al*., 2015). *B. bovis* and *B. bigemina* are found in cattle, which are the main reservoir hosts. They also affect water buffalo (Bubalus bubalis) and African buffalo (Syncerus caffer). B bovis and *B. bigemina* were recently discovered in white-tailed deer (Odocoileus virginianus) in Mexico. The importance of this finding is unknown, but animals other than cattle have generally been considered of little epidemiological significance as reservoir hosts (CFSPH, 2008).

2.2.3 Risk factor

2.2.3.1 Host factor

Host factors associated with disease include age, breed, and immune status (Jabbar *et al*., 2015). Bos indicus breeds of cattle are more resistance to Babesiosis than Bos Taurus. This is a result of evolutionary relationship between Bos indicus cattle, Boophilus species and Babesia (Radostits *et al*., 2007). 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. Sheep were highly susceptible to *B. ovis* than goats. It is frequently stated that there is an inverse age resistance to Babesia infection in that young animals are less susceptible to Babesiosis than older animals; the possible reason is passive transfer of maternal antibody via colostrum (Demessie and Derso, 2015).. The severityof the clinical Babesiosis increases with age so adult are more infected by Babesiosis as compared with calves (El Moghazy *et al*., 2014).

2.2.3.2 Pathogen Factor

Strains vary considerably in pathogenicity; however, *B. bovis* is usually more virulent than *B. bigemina* or *B. divergens* (CFSPH, 2008). Many Intra-erythrocyte hemoparasites survive the host immune system through rapid antigenic variation which has been demonstrated for *B. bovis* and *B. bigemina* (Radostits *et al*., 2007).

2.2.3.3 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 (Radostits *et al*., 2007). Babesiosis infection in cattle mostly reaches peak in summer (33.33%) (El Moghazy *et al*., 2014).

2.2.4 Transmissions

Babesia species is transmitted by hard ticks in which Babesia passes transovarially, via the egg, from one tick generation to the next (Demessie and Derso, 2015). Ticks become infected when they ingest parasites in the blood of infected cattle. Bovine Babesiosis is principally transmitted by means of ticks. Tick vectors of Babesia bigemina: Rhipicephalus microplus (formerly Boophilus microplus) and Rhipicephalus annulatus (formerly Boophilus annulatus); Rhipicephalus decoloratus, Rhipicephalus geigyi, and Rhipicephalus evertsi are also competent vectors. *B. bigemina* transmitted by feeding of adult and nymphal stages of one-host Rhipicephalus spp. ticks Tick vectors of Babesia bovis: Rhipicephalus microplus and Rhipicephalus annulatus; Rhipicephalus geigyi is also a competent vector *B. bovis* transmitted by feeding of larval stages of one-host Rhipicephalus spp. ticks (Yadhav *et al*., 2015). Inside the tick, Babesia zygotes multiply as "vermicules,' which invade many of the tick's organs including the ovaries; Babesia species are readily passed to the next generation of ticks in the egg. These parasites can sometimes be passed transovarially though several generations, although this varies with the species of Babesia and the species of tick (Spickler *et al*., 2010).

B. divergens can survive in tick populations for at least 4 years even if cattle are not present. When an infected tick attaches to a new host, Babesia is stimulated to undergo their final maturation. *B. bovis* parasites usually become infective within 2-3 days after larval ticks attach, and can be transmitted by larvae. In R. microplus, *B. bovis* does not persist after the larval stage. In contrast, *B. bigemina* matures in approximately 9 days after a larval tick attaches, and it is only transmitted by nymphs and adults. All three stages of I. ricinus can transmit *B. divergens*. Babesia species can also be transmitted between animals by direct inoculation of blood. Biting flies and fomites contaminated by infected blood might act as mechanical vectors, although this method of transmission is thought to be of minor importance (CFSPH, 2008).

2.2.5 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. The introduction of Babesia infected ticks into previously tick-free areas may also lead to outbreaks of disease (Yadhav *et al*., 2015). In endemic areas where tick transmission is high year round, animals tend to become infected when they are young, do not become ill, and become immune. This endemic stability can be upset and outbreaks can occur if climate changes, acaricide treatment or other factors decrease tick numbers and animals do not become infected during the critical early period. Outbreaks are also seen in areas where cold seasons interrupt tick- borne transmission for a time, as well as when susceptible animals are introduced to endemic regions or infected ticks enter new areas (Spickler *et al*., 2010).

In naive cattle, susceptibility to disease varies with the breed. *B. indicus* cattle and *B. indicus B. taurus* crosses are more resistant than *B. taurus*. Recently, variable susceptibility to *B. bovis* was also reported in some *Bos taurus* cattle: approximately 28% of a population of adult animals was susceptible to infection but resistant to clinical signs. In fully susceptible breeds, up to half or more of untreated adults and up to 10% of treated adults may die. Once hemoglobinuria develops, the prognosis is guarded. Infections with *B. bovis* are generally more likely to be fatal than infections with *B. bigemina* or *B. divergens*, and CNS signs suggest a poor prognosis (CFSPH, 2008).

Table 1: distribution of different babesia species and their vectors and host

Parasite species	Vertebrae hosts	Pathogenicity	Vectors	Distribution
B. bovis	cattle, deer	High	Ixodes,Rhipicephalus (Boophilus)	Europe,Africa, Australia, South & Central
B. bigemina	cattle, deer	moderate	Haemaphysalis, Rhipicephalus (Boophilus)	Europe,Africa, Australia, South & Central America
B. divergens	Cattle	moderate	Ixodes	Western &Central Europe
B. major	Cattle	low	Rhipicephalus (Boophilus)	Europe, Russia

Source: (Yadhav *et al*., 2015)

2.3 LIFE CYCLE

The life cycle of all Babesia species is approximately similar but slight difference exists because in some species transovarial transmission occur (Babesia spp. sensu stricto) while not in other species (Babesia microti) (Saad, *et al*., 2015). Cattle are infected by feeding ticks, which inoculates sporozoites that invade erythrocytes where they transform into trophozoites that divide by binary fission (merogony). The erythrocyte membrane breaks down and the released merozoites invade new cells resulting in an intra-erythrocytic cycle. Following a tick blood meal, gametocytes develop in the tick gut, which fuse to form diploid zygotes. Zygotes invade the digestive cells and probably basophilic cells where they under go successive round of multiplication before emerging as haploid kinetes. The kinetes migrate to many other organs including the ovaries where further division occurs. After egg hatching, the kinetes migrate to the salivary gland where they transform into multi-nucleated stages (sporogony) which later form sporozoites (Simuunza, 2009). According to Saad *et al*. (2015) Babesia species generally complete their life cycle in 3 stages.

- ✓ Gamogony (in the tick gut gametes fusion and formation)
- ✓ Sporogony (in salivary glands asexual reproduction occur)
- ✓ Merogony (in the vertebrate asexual reproduction occur)

2.4 Pathogenesis and clinical signs

Despite, being closely related and transmitted by the same Boophilus ticks, Ba. bovis and Ba. bigemina cause remarkably different diseases in cattle. In *B. bovis* infections, the disease pathology can be both due to over-production of pro-inflammatory cytokines and the direct effect of red blood cell destruction by the parasite. During an acute infection, macrophages activated by the parasite produce pro-inflammatory cytokines and parasitocidal molecules (Simuunza, 2009). Babesia produces acute disease by two principle mechanism; hemolysis and circulatory disturbance. During the tick bite, sporozoites are injected into the host and directly infect red blood cells. In the host, Babesia sporozoites develop into piroplasms inside the infected erythrocyte resulting in two or sometimes four daughter cells that leave the host cell to infect other erythrocytes. It invades erythrocyte and cause intravascular and extravascular hemolysis. The rapidly dividing parasites in the red cells produce rapid destruction of the erythrocytes with accompanying haemoglobinaemia, haemoglobinuria and fever. This may be so acute as to cause death within a few days, during which the packed cell volume falls below 20% which will lead to anemia. The parasitaemia, which is usually detectable once the clinical signs appear, may involve between 0.2% up to 45% of the red cells, depending on the species of Babesia (Demessie and Derso, 2015). 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* (CFSPH, 2008).

B. bovis is the most pathogenic of the bovine Babesia. In animals with acute *B. bigemina* infections are not as virulent as those of *B. bovis*, however the parasites may infect 40% of the red cells (Sahinduran, 2012). 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, 2010).

In animals with acute *B. bigemina* only a relatively small proportion of cases are fatal. In contrast, mortality rates over 50% are common for animals infected with *B. bovis* Infections in cattle are and characterized by fever, anorexia, listlessness, dehydration and progressive hemolysis, and may be followed by hemoglobinuria and hemoglobinemia resulting in jaundice Both *B. bigemina* and *B. bovis* have the above-named clinical signs in common, but show differences in pathogenesis and manifestation. Hence *B. bigemina* can be characterized as a peripheral babesiosis with severe anemia, whereas *B. bovis* often induces a visceral babesiosis because of thrombus formation (Pohl, 2013).

2.5 Diagnosis

Babesiosis can be diagnosed by identification of the parasites in blood or tissues, polymerase chain reaction assays (PCR), serology, or transmission experiments. Babesiosis should be suspected in cattle with fever, anemia, jaundice and hemoglobinuria (CFSPH, 2008).

2.5.1 Direct microscopic examination

Microscopic examination still cheapest and fastest methods used to identify Babesia parasites. Identification of the different stages of the parasite in mammalian or arthropod host tissues can be used for direct diagnosis purpose. Thin and thick Blood Smears Blood smear examination has been considered to be the standard technique for routine diagnosis, particularly in acute cases, but not in sub-clinical infections where the parasitemia is usually much lower (Demessie and Derso, 2015). Species differentiation is good in thin films but poor in the more sensitive thick films. This technique is usually adequate for detection of acute infections, but not for detection of carriers where the parasitaemias are mostly very low. Parasite identification and differentiation can be improved by using a fluorescent dye, such as acridine orange, instead of Giemsa (OIE, 2010). Blood film examination requires very much expertise to differentiate between *Babesia* species from one or more animal species which look similar under stained preparation (Salih *et al*., 2015).

Samples from live animals should preferably be films made from fresh blood taken from capillaries, such as those in the tip of the ear or tip of the tail, as *B. bovis* is more common in capillary blood. Babesia bigemina and *B. divergens* parasites are uniformly distributed through the vasculature. 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). Samples from dead animals should consist of thin blood films, as well as smears from cerebral cortex, kidney (freshly dead), spleen (when decomposition is evident), heart muscle, lung, and live (OIE, 2010).

2.5.2 INDIRECT DIAGNOSTIC METHODS

When parasites occur at densities below the sensitivity of direct method employed or cannot be directly demonstrated in a biological sample due to the life cycle in the host, in those cases indirect methods of diagnosis are used, which include serological tests either used for detection of antibodies or antigens. Among the various serological tests, most important once include complement fixation test (CFT), indirect fluorescent antibody technique (IFAT) and enzyme-linked immunosorbent assay (ELISA) (Salih *et al*., 2015). Blood smears are not reliable for detection of carrier animals; in these cases molecular detection methods, or serological diagnostic procedures to demonstrate specific antibodies, are required (Pohl, 2013). Serology is most often used for surveillance and export certification. Antibodies to Babesia are usually detected with an indirect fluorescent antibody (IFA) test or enzyme-linked immunosorbent assay (ELISA). Complement fixation has also been used, and agglutination assays (latex and card agglutination tests) have been described. Serological cross-reactions can complicate the differentiation of some species in serological tests (Spickler *et al*., 2010).

Polymerase chain reaction (PCR) assays can detect and differentiate *Babesia* species, and are particularly useful in carriers (CFSPH, 2008). Immunofluorescent and immunoperoxidase labeling have also been described. These parasites are found within RBCs, and all divisional stages ring (annular) stages, pear shaped (pyriform) trophozoites either singly or in pairs; and filamentous or amorphous shapes can be found simultaneously. Filamentous or amorphous forms are usually seen in animals with very high levels of parasitemia. *B. bovis* trophozoites are small (usually 1–1.5 µm x 0.5–1.0 µm), often paired and usually centrally located in RBCs. *B. divergens* resembles *B. bovis*, but the pairs are often found at the edge of the RBC. *B. bigemina* is much and can fill the RBC (Spickler *et al*., 2010).

2.6 Public health and economic significance of bovine babesiosis

2.6.1 Public health significance

Human babesiosis was first described in 1957 but is now known to have worldwide distribution. The increase in reported cases is likely due to increases in actual incidence as well as increased awareness of the disease (yadhav *et al*., 2015).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. *B. 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. *B. divergens* infections in humans are medical emergencies. They usually progress very rapidly, and most cases in the past ended in death within a week. With modern, antiparasitic drugs and supportive therapy, the case fatality rate is approximately 40%. Mild cases may resolve with drug treatment alone (CFSPH, 2008).

To prevent infection with *B. divergens*, immunocompromised individuals should be careful when visiting regions where babesiosis is endemic, especially during the tick season. Exposure to ticks should be prevented by wearing appropriate clothing (e.g., long-sleeved shirts and long pants) and tick repellents. Skin and clothing should be inspected for ticks after being outdoors, and any ticks found should be removed. There is no definitive evidence that *B. divergens* can infect immunocompetent individuals, or those who are immunosuppressed but not splenectomized. However, antibodies to Babesia were found in two of 190 French blood donors. *B. bovis* may also be zoonotic, but this is uncertain. At least some historical cases attributed to *B. bovis* were probably caused by *B. divergens* (Spickler *et al*., 2010).

2.6.2 Economic significance

Bovine Babesiosis causes most serious economic loss to the livestock industry, endangering half a billion cattle across the world (Saad, *et al*., 2015). Babesiosis, especially in cattle has great economic importance, because unlike many other parasitic diseases, it affects adults more severely than young cattle, 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 (Demessie and Derso, 2015).

2.7 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 (Demessie and Derso, 2015). 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 (Beckley, 2013). 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 (OIE, 2009)

Babesia can be prevented and controlled by using different types of vaccine e.g. live vaccine, killed vaccine and others. Most live vaccines contain specially selected strains of Babesia (mainly *B. bovis* and *B. bigemina*) and are produced in calves or in vitro in government supported production facilities as a service to the livestock industries (OIE, 2010). Live, attenuated strains of *B. bovis, B. bigemina* or *B. divergens* are used to vaccinate cattle in some countries. These vaccines have safety issues including the potential for virulence in adult animals, possible contamination with other pathogens, and hypersensitivity reactions to blood proteins. They are best used in animals less than a year of age to minimize the chance of disease. In some cases, vaccination of older cattle is necessary (e.g., if susceptible cattle are moved into an endemic area). Older animals should be monitored closely after vaccination, and treated if clinical signs develop. In some countries, animals may be vaccinated in the face of an outbreak. The use of genetically resistant cattle such as *B. indicus* can also decrease the incidence of disease. Natural endemic stability is unreliable as the sole control strategy, as it can be affected by climate, host factors and management (Spickler *et al*., 2010).

2.8 Treatment

Imidocarb are the drug of choice for bovine babesiosis, which can prevent clinical infection up to 2 months, (Saad, *et al*., 2015). Sick animals should be treated as soon as possible with an antiparasitic drug. midocarb (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 (Beckley, 2013). Treatment 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 (CFSPH, 2008). 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. Diminazene aceturate, which is widely used currently in the tropics as a Babesiacide, was withdrawn from Europe for marketing reasons (Demessie and Derso, 2015). Blood transfusions and other supportive therapy may also be necessary. Chemoprophylaxis with one drug (imidocarb) can protect animals from clinical disease while allowing the development of immunity. However, there are concerns about residues in milk and meat, and this drug is not available in all countries (CFSPH, 2008).

2.9 Status of bovine babesiosis Ethiopia

Tick-borne diseases and their vectors are wide spread in Ethiopia. They affect production in various ways, such as growth rate, milk production, fertility, the value of hides and mortality. major cattle tick-borne diseases in Ethiopia are anaplasmosis, babesiosis, cowdriosis and theileriosis (Sileshi, 1996). Ticks and tick borne diseases cause considerable losses to the livestock economy, ranking third among the major parasitic disasters after trypanosomes and endoparasitism (Desalegn *et al*., 2015). Furthermore, 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 (Wodajnew *et al*., 2015). Different researchers have reported the prevalence of bovine babesiosis from different area of Ethiopia (table 2).

The study from Western Ethiopia Benishangul Gumuz Regional State, by Wodajnew *et al*. (2015) 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 by Lemma *et al*. (2015) reported overall prevalence rate of Bovine Babesiosis as 23% by Giemsa stained blood smears out of which 33.33% is *B. bovis* and 62.96% is *B. bigemina*. Similarly the study at the same place revealed an overall prevalence rate of Bovine Babesiosis to be 12.8% Alemayehu, 2014). Furthermore, another study from Bishoftu, Central Ethiopia found prevalence of 0.6% of which equal prevalence of babesia bigemina, and babesia bovis (0.3%) was found (Sitotaw *et al*., 2014). 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* (7%) (Hamsho *et al*., 2015).

Table 2: Prevalence of bovine babesiosis from different area of Ethiopia

area	Diagnostic methods	Prevalence	Reference
Western Ethiopia	microscopic examination	1.5%	(Wodajnew *et al*., 2015)
Southern Ethiopia	microscopic examination	16.9%	(Hamsho *et al*., 2015)
South Western Ethiopia	microscopic examination	23%	(Lemma *et al*., 2015)
Central Ethiopia	microscopic examination	0.6%	(Sitotaw *et al*., 2014)

High prevalence of bovine babesiosis was reported in and around Jimma town, southwest Ethiopia (table 1) compared to other study which is 23% (Lemma *et al*., 2015). In contrast, the study from Central Ethiopia, bishoftu indicated low prevalence of bovine babesiosis (0.6%) (Sitotaw *et al*., 2014).

3 CONCLUSIONS AND RECOMMENDATIONS

Bovine babesiosis is the most important arthropod-borne disease of cattle worldwide that causes significant morbidity and mortality. The most prevalent species, Babesia 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.

- ✓ Ethiopia should develop and implement surveillance systems and action plans to prevent bovine babesiosis from spreading
- ✓ Epidemiological studies should be conducted on bovine babesiosis to provide the necessary incidence and prevalence data.
- ✓ Various control strategies should be adopted in order to prevent the day by 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.

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4 REFERENCE

Alemayehu, C. (2014). Study on bovine babesiosis and its associatted risk factors in and around Jimma town, southwest Ethiopia. DVM Thesis. Jimma University College of Agriculture and Veterinary Medicine. Jimma, Ethiopia. PP. 38

Beckley, C. S. K. (2013). Susceptibility of Indigenous Cattle Breeds to Co-Infection with Multiple Tick-Borne Pathogens, Master Theisis, University of Ghana). pp. 85

CFSPH (Center for Food Security and Public Health), 2008. Bovine babesiosis, Iowa state university, Ames, Iowa.

Demessie, Y., & Derso, S. (2015). Tick Borne Hemoparasitic Diseases of Ruminants: A Review. *Advance in Biological Research*, *9*(4), 210-224.

Desalegn, T., Fikru, A., & Kasaye, S. (2015). Survey of Tick Infestation in Domestic Ruminants of Haramaya District, Eastern Hararghe, Ethiopia. *Journal of Bacteriology & Parasitology*, *2015*.

El Moghazy, H.M., M.M. Ebied, M.G. Abdelwahab and A.A. El Sayed, 2014. Epidemiological studies on bovine Babesiosis and Theileriosis in Qalubia governorate. BenhaVeterinary Medical Journal, 27: 36-48.

El-Ashker, M., Hotzel, H., Gwida, M., El-Beskawy, M., Silaghi, C., & Tomaso, H. (2015). Molecular biological identification of Babesia, Theileria, and Anaplasma species in cattle in Egypt using PCR assays, gene sequence analysis and a novel DNA microarray. *Veterinary parasitology*, *207*(3), 329-334.

Eygelaar, D., Jori, F., Mokopasetso, M., Sibeko, K. P., Collins, N. E., Vorster, I., ... & Oosthuizen, M. C. (2015). Tick-borne haemoparasites in African buffalo (Syncerus caffer) from two wildlife areas in Northern Botswana. *Parasites & vectors*, *8*(1), 1-11. France.

Hamsho, A., Tesfamarym, G., Megersa, G., & Megersa, M. (2015). A Cross-Sectional Study of Bovine Babesiosis in Teltele District, Borena Zone, Southern Ethiopia. *Journal of Veterinary Science & Technology*, *2015*.

Jabbar, A., Abbas, T., Sandhu, Z. U. D., Saddiqi, H. A., Qamar, M. F., & Gasser, R. B. (2015). Tick-borne diseases of bovines in Pakistan: major scope for future research and improved control. *Parasit Vector*, *8*, 283.

Lemma, F., Girma, A., & Demam, D. (2015). Prevalence of Bovine Babesiosis in and Around Jimma Town South Western Ethiopia. *Advances in Biological Research*, *9*(5), 338-343.

Leta, S., & Mesele, F. (2014). Spatial analysis of cattle and shoat population in Ethiopia: growth trend, distribution and market access. SpringerPlus, 3(1), 310.

Mohammed, M. (2007). Studies on ticks and tick–borne diseases of cattle in South Darfur State, MVSc Thesis UOFK, Sudan, pp. 128

Nejash, A. (2016). Review of Important Cattle Tick and Its Control in Ethiopia. *Open Access Library Journal*. 3(3), 1-11.

OIE, 2009. Bovine Babesiosis. Aetiology,epidemiology, diagnosis and control reference, Paris,

OIE, 2010, Bovine Babesiosis. In: Manual of Diagnostic Tests and Vaccines for Terrestrial Animals. Edition. World Organisation for Animal Health, Paris. Pp 1-15

Pohl, A. E. (2013). *Epidemiology study of tick-borne diseases in cattle in Minas Gerais, Brazil* (Doctoral dissertation, lmu).

Radostits, O.M., G.C. Gay, K.W. Hinchiff and P.O. Constable, 2007. Veterinary Medicine: A text book of the disease of cattle, sheep, goat, pigs and horses. 10 th Ed London: Saunders Elsevier, pp: 1110-1489, 1527-1530.

Saad, F., Khan, K., Ali, S., & ul Akbar, N. (2015). Zoonotic significance and Prophylactic Measure against babesiosis. Int. J. Curr. Microbiol. App. Sci, 4(7), 938-953.

Sahinduran, S. (2012). Protozoan diseases in farm ruminants. In A Bird's Eye View of Veterinary Medicine. Perez Marin, C. C. (Ed). In. Tech. pp. 473-477. http://dx.doi. org/10.5772/30251.

Salih, D. A., El Hussein, A. M., & Singla, L. D. (2015). Diagnostic approaches for tick-borne haemoparasitic diseases in livestock. *Journal of Veterinary Medicine and Animal Health*, *7*(2), 45-56.

Sharma, A., Singla, L. D., Tuli, A., Kaur, P., Batth, B. K., Javed, M., & Juyal, P. D. (2013). Molecular prevalence of Babesia bigemina and Trypanosoma evansi in dairy animals from Punjab, India, by duplex PCR: a step forward to the detection and management of concurrent latent infections. *BioMed research international*, *2013*.

Sileshi, M., (1996). Epidemiology of ticks and tick-borne diseases in Ethiopia: future research needs and priorities. In: *Proceedings of a Workshop Held in Harare, Natl. Anim. Health Res. Centre, Ethiopia*, 12–13 March

Simuunza, M. C. (2009). *Differential Diagnosis of Tick-borne diseases and population genetic analysis of Babesia bovis and Babesia bigemina* (PhD Thesis, University of Glasgow).

Sitotaw, T., Regassa, F., Zeru, F., & Kahsay, A. G. (2014). Epidemiological significance of major hemoparasites of ruminants in and around Debre-Zeit, Central Ethiopia. *J Parasitol Vector Biol*, *6*, 16-22.

Sitotaw, T., Regassa, F., Zeru, F., & Kahsay, A. G. (2014). Epidemiological significance of major hemoparasites of ruminants in and around Debre-Zeit, Central Ethiopia. *J Parasitol Vector Biol*, *6*, 16-22.

Spickler, A. R., Roth, J.A., Dvorak, G. (2010). *Emerging and exotic diseases of animals*, 4th ed CFSPH Iowa State University, lowa USA. Pp: 102-105

Wodajnew, B., Disassa, H., Kabeta, T., Zenebe, T., & Kebede, G. Study on the Prevalence of Bovine Babesiosis and Its Associated Risk Factors in and Around Assosa Woreda, Benishangul Gumuz Regional State, Western Ethiopia. *Researcher*, 7(8), 33-39

Yadhav. C. P, Chandana , M.V. Sai lalith kumar, Y.N. Sujitha, M. Lavanya, Ch. Madhavilatha. (2015). An overview of Babesiosis. *Int. J. Res. Pharm, L. Sci*., 3(1): 287-295.