Int J Biol Med Res.2016;7(3):5699-5706

BioMedSciDirect Publications

Contents lists available at BioMedSciDirect Publications

International Journal of Biological & Medical Research

Journal homepage: www.biomedscidirect.com

Review Article

Bovine babesiosis and its current status in ethiopia: a review

Abdela Ahmed Nejash

School of veterinary medicine, College of agriculture and veterinary medicine, Jimma University, Jimma Ethiopia

A R T I C L E I N F O

Keywords:

Bovine babesiosis,
Babesia,
Ethipiopia,
redwater,
tickfever

A B S T R A C T

Bovine babesiosis also known as redwater, or tickfever 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. Microscopicexamination isstill cheapest and fastest methods used to identify Babesia parasites. Butnotreliable for detection of carrier animals;inthese cases molecular detectionmethods,orserologicaldiagnosticprocedurestodemonstratespecificantibodies,arerequired.AlthoughsomespeciesofBabesiasuchasB.microticanaffecthealthypeople,cattleparasitesseemtocausediseaseonlyinpeoplewhoareimmunocompromised. Early detection of blood parasites is highly beneficial active prevention and control of Babesiosisand it is achieved by three main methods: immunization, chemoprophylaxis and vector control. Imidocarb is the drug of choice for bovine babesiosis. Theuse of geneticallyresistantcattlesuchasB.indicusis proposed as sustainable approach to decrease theincidenceof disease.

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).

* Corresponding Author : **Abdela Ahmed Nejash**
Nejash.abdela@gmail.com ,Nejash.abdela@yahoo.com

Arthropodtransmittedhemoparasiticdiseasesareeconomically importantvector borne diseases of tropical and sub tropical part s of the world including Ethiopia (Sitotawet 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 (Jabbaret 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 (Eygelaaret al., 2015). They are responsible for high morbidity and mortality resulting indecreased production of meat, milk and other live stock by-products (Simuunza, 2009).

Babesiosis is a tick-borne disease of cattle caused by the protozoan parasites Babesiabovis,B. bigemina, B. divergens and others. Rhipicephalus (Boophilus) spp., the principal vectors ofB. bovis and B. bigemina, are widespread in tropical and subtropical countries. The major vector of B. divergens is Ixodesricinus(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 (Hamshoet 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). Althoughsomespecies ofBabesiasuchas B.microtican affect healthy people, cattleparasite s seem to cause disease only in people who are immunocompromised.B. divergens causes serious disease in humanswhohavehadsplenectomies (CFSPH, 2008).Active prevention and control of Babesiosis is achieved by three main methods: immunization, chemoprophylaxis and vector control (Demessie and Derso, 2015). TheuseofgeneticallyresistantcattlesuchasB.indicuscanalsodecreasetheincidenceof disease (Spickleret 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 (Wodajnewet al., 2015). The disease widespread in the countrybut there is paucity of well documented information. Recognitions of this situation and motivated the author of this review. 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

2.1Etiologyand taxonomy

Babesiosisisaninfectioustick-bornediseaseoflivestockthatcharacterisedby fever,anemia,haemoglobinuriaand weakness.Thediseasealsoisknownbysuchnamesasbovinebabesiosis,piroplasmosis,Texasfever,redwater,tickfever,andtristeza (Sahinduran, 2012).Bovine babesiosis caused by an apicomplexanhaemoprotozoan 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* (Spickleret al., 2010). Two species, B. *bigemina* and *B. bovis*, have a considerable impact on cattle health and productivity in tropical and subtropical countries (El-Ashkeret 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 (Hamshoet al., 2015).

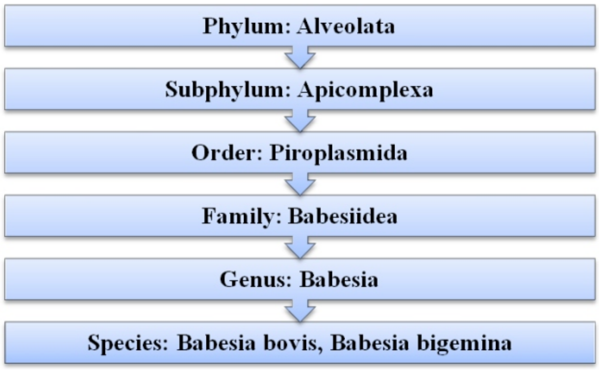

Figure : Taxonomy of the genus Babesia
Source: Adopted from Pohl, (2013)

2.2Epidemiology

2.2.1Geographical Distribution

Babesiosisisaninfectioustick bornediseaseoflivestockthat characterisedby fever,anemia,haemoglobinuriaandweakness. Thediseasealsoisknownbysuchnamesasbovinebabesiosis,piroplasmosis,Texasfever,redwater,tickfever,andtristeza (Sahinduran, 2012).Bovine babesiosis caused by an apicomplexanhaemoprotozoan 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 (Spickleret al., 2010). Two species, B. bigemina and B. bovis, have a considerable impact on cattle health and productivity in tropical and subtropical countries (El-Ashkeret 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 (Hamshoet al., 2015).

B. divergensisan importantparasiteinpartsofEurope (table 1)includingtheUnitedKingdom,SpainandnorthernEurope.SurveyshavefoundevidenceforthisspeciesthroughoutEurope,anditmayalsooccurinNorthAfrica.Itsvector,I.ricinus,cansurvivefromnorthernScandinaviatotheMediterranean.However,becausethistickrequires80%humidity,itcanbefoundonlyinsomemicroenvironmentssuchasthebaseofvegetationinforests,roughhillscrub,anddamplow-lyingland.B. majorcanbe foundin partsofEurope, Northwest AfricaandAsia,aswellas China. B.ovata has been describedinJapan,Chinaandotherpartsofeastern Asia. B.occultans has be enreported in Africa, and B.jakimovioccursin 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 (Hamshoet al., 2015). B. bovis and B. bigemina are found in cattle, which are the main reservoir hosts. They also affect water buffalo (Bubalusbubalis) and African buffalo (Synceruscaffer). B bovis and B. bigemina were recently discovered in white-tailed deer (Odocoileusvirginianus) 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 (Jabbaret al., 2015). Bosindicus breeds of cattle are more resistance toBabesiosis than Bos Taurus.This is a result of evolutionary relationship betweenBosindicus cattle, Boophilus species and Babesia (Radostitset 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 Moghazyet al., 2014).

2.2.3.2. Host factor

Strainsvaryconsiderablyinpathogenicity;how ever,B. bovisis usually more virulentthan *B. bigeminaor 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* (Radostitset 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 (Radostitset al., 2007).Babesiosis infection in cattle mostly reaches peak in summer (33.33%) (El Moghazyet 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 becomeinfectedwhentheyingestparasitesinthebloodofinfectedcattle.Bovine Babesiosis is principally transmitted by means of ticks. Tick vectors of Babesiabigemina: Rhipicephalusmicroplus (formerly Boophilusmicroplus) and Rhipicephalusannulatus (formerly Boophilusannulatus); Rhipicephalus decoloratus, Rhipicephalusgeigyi, and Rhipicephalusevertsi are also competent vectors. B. bigemina transmitted by feeding of adult and nymphal stages of one-host Rhipicephalus spp. ticks Tick vectors of Babesiabovis: Rhipicephalusmicroplus and Rhipicephalusannulatus; Rhipicephalusgeigyi is also a competent vector B. bovis transmitted by feeding of larval stages of one-host Rhipicephalus spp. ticks (Yadhavet 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 Babesiaand the species of tick (Spickleret al., 2010).

B. divergenscan survive in tick populations for at least 4 years even if cattle are not present. When an infected tick attaches to a new host, Babesiais 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*. Babesiaspecies 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. MorbidityandMortality

Morbidityandmortalityvarygreatlyandareinfluencedbyprevailing treatmentsemployedinanarea,previousexposuretoaspecies/strainofparasite,andvaccinationstatus.Inendemicareas,cattlebecomeinfectedatayoungageanddevelopalong-termimmunity. However, out breaks can occurintheseendemicareasifexposuretoticksby younganimals is interrupted or immunonaïvecattleare introduced.The introductionof Babesia infected ticks into previously tick-freeareasmayalso lead to out break sofdisease (Yadhavet al., 2015). In endemicareas where tick transmission is highy earround, animalstendto become infected when they are young, do not become ill,and become immune. This end emicstability canbe up set and out breaks can occurifclimatechanges, acaricidetreatmentoro therfactorsdecreaseticknumbersandanimalsdonotbecomeinf ected duringthecriticalearlyperiod. Out breaks area lsoseeninareas where cold season sin terrupttick-borne transmission for a time, as well as when susceptible animals are introduced to end emi cregionsor infected ticks entered wareas (Spickleret al., 2010).

Innaivecattle,susceptibilitytodiseasevarieswiththebreed.B. indicuscattleandB.indicusB.tauruscrossesaremoreresistanttha nB.taurus.Recently,variablesusceptibilitytoB. boviswasalsoreportedinsomeBostauruscattle:approximately28 %ofapopulationofadultanimalswassusceptibletoinfectionbutre sistanttoclinicalsigns.Infullysusceptiblebreeds,uptohalformore ofuntreatedadultsandupto10%oftreatedadultsmaydie.Oncehe moglobinuriadevelops,theprognosisisguarded.Infectionswith B. bovisaregenerallymore likelytobe fatalthaninfectionswithB. bigeminaorB. divergens,andCNSsignssuggestapoorprognosis (CFSPH, 2008).

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

Parasitespecies	Vertebra-ehosts	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: (Yadhavet 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. sensustricto) while not in other species (Babesiamicroti) (Saad, et al., 2015). Cattleareinfectedbyfeedingticks,whichinoculatessporozoitesth atinvadeerythrocyteswheretheytransformintotrophozoitesthat dividebybinaryfission(merogony).Theerythrocyte membrane breaks down andthe releasedmerozoitesinvade new cells resulting in an intra-erythrocytic cycle. Followin g a tick blood meal,gametocytesdevelopinthetickgut,whichfusetoformdiploid zygotes.Zygotesinvadethedigestivecellsandprobablybasophilicc ells where they under go successive round of multiplication before emergin gas haploid kinetes. The kinetesmigrate to many other organs including the ovaries where further division occurs. After egghatching,the kinetes migrate to the salivarygland where they transform intomulti-nucleated stages(sporogony)which later form sporozoites (Simuunza, 2009). According to Saadet 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, Babesiasporozoites 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 theparasite. Most cases of babesi osi saresee ninadults; animals younger than 9months usually remain a symptomatic. Strains varyconsiderably inpathogenicity;however, *B.bovisis* usually more virulent than *B. bigeminaor B. divergens*(CFSPH, 2008).

B. bovis is the most pathogenic of the bovine Babesia. In animals with acute *B. bigemina* infections are not as virul entasthose of B. *bovis,* however the parasitesmay 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. bovisInfectionsincattleare andcharacterizedbyfever, anorexia, listlessness,dehydration and progressive hemolysis, and may befollowed by hemoglobinuria and hemoglobinemi are sulting 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

Babesiosiscanbediagnosedbyidentificationoftheparasites in blood ortissues, polymerase chain reaction assays (PCR),serology,ortransmission experiments. Babes iosis should be suspected incattle 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). Bloodfilmexamination requires very much expertise to differentiate between Babes ia species from one or more animal species which look similar understained preparation (Salihet 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. Babesiabigemina 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 Diagnosticmethods

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) (Salihet al., 2015). Blood smears arenotreliable for detection ofcarrier animals;inthese cases moleculardetectionmethods,orserologicaldiagnosticproceduresto demonstratespecificantibodies,arerequired (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 (Spickleret al., 2010).

Polymerase chainreaction(PCR) assayscandetect anddifferentiateBabesiaspecies,andar eparticularlyusefulincarriers (CFSPH, 2008). Immunofluorescentand 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. bovistrophozoites 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 (Spickleret al., 2010).

2.6. Public health and economic significance of bovine babesiosis

2.6.1.Public health significance

Humanbabesiosiswasfirstdescribedin1957butisnowknowntohaveworldwidedistribution.Theincreaseinreportedcasesislikelydueto increasesinactualincidenceaswellasincreasedawarenessofthedisease (yadhavet al., 2015). Although some species of Babesi a such as B.microticanaffecthealthypeople, cattle parasites seem to caused is easeonlyinpeoplewhoareimmunocompromised.*B. divergens* causes serious disease in humans who have had splenectomies. This infection is rare;inEurope,approximately 30 cases had been reported as of 2003. It is characterized by the acuteonsetofseverehemolysis,hemoglobinuria,jaundice,persistent highfever,chillsandsweats, headache,myalgia, lumbar and abdominalpain, and sometimes vomting and diarrhea. Shockandrenalfailuremayalsobeseen.*B. divergens* infectionsinhumansaremedicalemergencies.They usually progress very rapidly, and most cases in the past end edind eath with in a week. Withmodern, antiparasitic drugs and supportive therapy, the case fatality rateis approximately 40%.Mildcasesmayresolvewithdrugtreatmentalone (CFSPH, 2008).

Topreventinfectionwith B. divergens, immunocompromisedindividuals shouldbecarefulwhenvisitingregionswherebabesiosisisendemic,especiallyduringthe tickseason.Exposure toticksshouldbepreventedbywearingappropriateclothing(e.g.,long-sleevedshirtsandlongpants)andtickrepellents. 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*(Spickleret 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 Babesiafree areas. The consequence is that the quality of cattle in endemic areas remains low, therefore impeding the development of the cattle industry and thewellbeing 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, attenuatedstrainsof B. bovis,B. bigeminaorB. divergensareusedtovaccinatecattleinsomecountries.Thesevaccineshavesafetyissuesincludingthepotentialf orvirulenceinadultanimals,possiblecontaminationwithotherpathogens,andhypersensitivityreactionstobloodproteins.Theyarebestusedinanimalslessthanayearofagetominimizethechanceofdisease.Insomecases, vaccinationofoldercattleisnecessary(e.g.,ifsusceptiblecattleare movedintoanendemicarea).Olderanimalsshouldbe monitored closely after vaccination, and treate difclinicalsignsdevelop. In some countries, animals may be vaccinated in the face of an out break. The use of genetically resistant cattle such as *B.indicus* can al so decrease the incidence of disease. Natural end emic stability is unreliable as the sole control strategy, asit can be affected by climate, host factors and management (Spickleret 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. Diminazeneaceturate, 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 (Desalegnet 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 (Wodajnewet al., 2015). Different researchers have reported the prevalence of bovine babesiosis from different area of Ethiopia (table 2).

The study from Western Ethiopia BenishangulGumuz Regional State, by Wodajnewet al. (2015) reported the overall prevalence of 1.5% from whichB. boviswas found to be 1.24%and B. bigeminawas 0.248%. Furthermore, the reviewed studyrevealed 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 babesiabigemina, and babesiabovis(0.3%) was found (Sitotawet 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%) andB. bigemina (7%) (Hamshoet 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%) (Sitotawet 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, Babesiabovis and B. bigemina, are found throughout most tropical and subtropical regions including Ethiopia. All Babesiaaretransmittedbytickswithalimitedhostrange.Theprinci palvectorsof *B. bovis* and*B. big* eminaare Rhipicephalusspp. ticks and these are wide spread in tropical and sub tropical countries. Calves are virtually resistant to the Babesia. Babesiabovis causes more severe clinical signs as compared to Babesiabigemina. 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 babesiosisto 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.

ACKNOWLEDGMENTS

Above all, I would like to praise my Almighty God, Allah, for supporting me health, wisdom and strength in my work and for his perfect protection and guidance of my life. I would like to express my sincere thanks and best regards to my beloved and respected family for their invaluable help and encouragement during my journey for their moral and financial support throughout my entire academic career. The author wholeheartedly acknowledges Jimma University College of agriculture and veterinary medicine for facility support.

4. REFERENCE

1. 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
2. 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
3. CFSPH (Center for Food Security and Public Health), 2008.Bovine babesiosis, Iowa state university, Ames, Iowa.
4. Demessie, Y., &Derso, S. (2015). Tick Borne Hemoparasitic Diseases of Ruminants: A Review. Advance in Biological Research, 9(4), 210-224.
5. 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.
6. 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.
7. 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.
8. 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.
9. 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.
10. 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.

11. 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.

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

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

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

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

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

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

18. 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 thEd London: Saunders Elsevier, pp: 1110-1489, 1527-1530.

19. 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.

20. 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.

21. 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.

22. Sharma, A., Singla, L. D., Tuli, A., Kaur, P., Batth, B. K., Javed, M., &Juyal, P. D. (2013). Molecular prevalence of Babesiabigemina and Trypanosomaevansi 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.

23. 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

24. Simuunza, M. C. (2009). Differential Diagnosis of Tick-borne diseases and population genetic analysis of Babesiabovis and Babesiabigemina (PhD Thesis, University of Glasgow).

25. 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.

26. 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.

27. 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

28. 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 AssosaWoreda, BenishangulGumuz Regional State, Western Ethiopia.Researcher, 7(8), 33-39

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