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A Review on Bovine Babesiosis

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Abstract

Babesiosis is a tick-borne disease of cattle caused by the protozoan parasites which are specific for particular species of animals. In cattle: babesia bovis (*B. bovis)* and *B. bigemina* are the common species involved in babesiosis. *Rhipicephalus (Boophilus) species*, the principal vectors of *B. bovis* and *B. bigemina* are widespread in tropical and subtropical countries. Babesiosis occur throughout the world and it can cause heavy economic losses such as mortality, reduction in meat, milk yield and indirectly through control measures of ticks. Affected animals suffered from marked rise in body temperature, loss of appetite, cessation of rumination, labored breathing, emaciation, progressive hemolytic anemia, various degrees of jaundice (Icterus). Lesions include an enlarged soft and pulpy spleen, a swollen liver, a gall bladder distended with thick granular bile, congested dark-coloured kidneys, generalized anemia and jaundice. The disease can be diagnosis based on history, clinical sign and also by identification of the agent by using direct microscopic examination, nucleic acid-based diagnostic assays, in vitro culture and animal inoculation as well as serological tests like indirect fluorescent antibody, complement fixation and Enzyme-linked immunosorbent assays tests. The most commonly used compounds for the treatment of babesiosis are diminazene diaceturate, imidocarb and amicarbalide. Active prevention and control of Babesiosis is achieved by immunization, chemoprophylaxis and vector control.

Keywords: *Babesia, Cattle, Protozoa, Vectors.*

1. Introduction

Ethiopia is known to have 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 (CSA, 2013). The country is a home for about 54 million cattle, 25.05 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, 2014).

Bovine babesiosis caused by *B. bovis* is an important disease of cattle in tropical and subtropical climates. And it is ubiquitous and widespread blood parasites in the world and consequently has considerable worldwide economic, medical and veterinary impact. The major economic impact of babesiosis is on the cattle industry and the two most important species in cattle are *B. bovis* and *B. bigemina* (Zintl *et al.*, 2013).

Domestic babesiosis is a dangerous, invasive disease of humans and animals. Probably the first described case of an epidemic caused by the babesia genus was cattle mortality (Homer *et al.*, 2000). In 1888, Victor Babes described intraerythrocytic microorganisms responsible for the death of 50 thousand cattle in Romania and classified them as Bacteria. In 1893, Kilborne and Smith described a factor of Texas cattle fever, giving them the rank of genus and name babesia as classifying them as Protozoans (Kjemtrup and Conrad, 2000). Parasites of the genus babesia infect a wide variety of wild mammals as well as man (Penzhorn, 2006).

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 next to trypanosomiasis (Hamsho *et al.*, 2015). *B. bovis* and *B. bigemina* are the common species that affect cattle. Although both species belong to the phylum apicomplexa but *B. bovis*can cause more severe disease than *B. bigemina* (De Vos and Bock, 2000).

Therefore, the objectives of this seminar paper are;

- To review available literatures on bovine babesiosis.
- To highlight the treatments, prevention and control methods of bovine babesiosis.

2. Bovine Babesiosis

2.1. Etiology

Babesiosis is caused by intraerythrocytic parasites of the genus Babesia (Hunfeld *et al*., 2008). And also the disease is known as by piroplasmosis, Texas fever, Redwater and Tick fever (Sahinduran, 2012).

Table 1: Taxonomy of the genus *Babesia.*

Phylum	Apicomplexa
Class	**Sporozoasida**
Order	**Eucoccidiorida**
Suborder	**Piroplasmorina**
Family	**Babesiidae**
Genus	**Babesia**
Species	***B.bovies, B.divergens, B. bigemina***

Source: Allsopp *et al.*,(1994).

Criado-Fornelio *et al*., (2003) used the 18s ribosomal ribonucleic acid (rRNA) gene for phylogenetic analysis and divided Babesia species from ungulates as: *B. caballi, B. bigemina, B. ovis, B. bovis* and Babesia spp. The three most common species often found 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*. *But B. ovis* and *B. motasi* are known to be pathogenic agents in sheep and goats respectively (Fakhar *et al.*, 2012).

2.2. Life cycle

The life cycle of all babesia species is approximately similar but slight difference exists because in some species transovarial transmission occur (Saad *et al.*, 2015). Babesia multiplies in erythrocytes by binary fission, resulting in considerable pleomorphism. This replication eventually gives rise to gametocytes that are ingested by the vector tick. Conjugation of gametocytes occurs in the tick gut followed by multiplication by multiple fission and migration to various tissues including the salivary glands. Further development occurs in the salivary glands before transmission. The ovaries are also invaded which leads to transovarial transmission (Gray *et al.*, 2010).

The host gets the infection when the larva sucks blood. After one molting the larva transforms into nymph which also infect as larva. Nymph transforms into adult after molting and they transmit infection in similar way (Mandal, 2012). The infective stage of babesia sporoziote enters in to the host when the tick sucks blood (Lefevre *et al.*, 2010).

2.3. Epidemiology

2.3.1. Geographical distribution

Babesiosis occurs throughout the world (Fakhar *et al.*, 2012), And also bovine babesiosis can be found wherever the tick vectors exist but it is most common in tropical and subtropical areas (CFSPH, 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 *Rhipicephalus (*formerly *Boophilus spp.)* tick vector commonly occurs. 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 *Rhipicephalus (Boophilus) decoloratus* and *Rhipicephalus evertsi* to also act as vectors for this species (Pohl, 2013).

Table 2: Major Babesia species infective to cattle, their ixodid tick vectors and geographical distribution.

Babesia species	Major ixodid vectors	Known distribution
Babesiabigemina	*Boophilusmicroplus, Boophilusdecoloratus, Boophilusannulatus, Boophilusgeigyi, Rhipicephalusevertsi*	Africa, Asia, Australia, Central, South America and Southern Europe
Babesiabovis	*Boophilusmicroplus, Boophiluannulatus, Boophilusgeigyi*	As for *B. bigemina*, but less Widespread in Africa due to *B. microplus* competition with*B. decoloratus*
Babesiadivergens	*Ixodesricinus, Ixodespersulcatus*	North-west Europe, Spain, Great Britain, Ireland
Babesia major	*Haemaphysalispunctata*	Europe, North west Africa and Asia
Babesia ovate	*Haemaphysalislongicornis*	Eastern Asia

Source: Uilenberg, (1995)

2.3.2. Risk Factors

Host factor- Host factors associated with disease include age, breed and immune status (Jabbar *et al.*, 2015). *Bosindicus* breeds of cattle are more resistance to babesiosis than *Bostaurus*. This is a result of evolutionary relationship between *Bosindicus* cattle, boophilus species and babesia (Radostits, 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 immune response to the tick or tick-borne hemoparasitic disease in question. 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. The severity of the clinical babesiosis increases with age (Taylor *et al.*, 2007).

Pathogen Factor- Strains vary considerably in pathogenicity; however, *B. bovis* is usually more virulent than *B. bigemina* and*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, 2007).

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. From the climatic factors, air and 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, 2007). Babesiosis infection in cattle mostly reaches peak in summer (El Moghazy *et al.*, 2014).

2.3.3. 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 transmitted by means of Tick vectors of *B. bigemina* are *Rhipicephalus microplus* and *Rhipicep halus annulatus*. *Rhipicephalus decoloratus*, *Rhipicephalus geigyi* and *Rhipicephalus evertsi* are also competent vectors (Table 2). Tick vectors of B. *bovis* are *Rhipicephalus microplus* and *Rhipicep halus annulatu*. *Rhipicephalus geigyiis* also a competent vector *B. bovis* transmitted by feeding of larval stages of one-host *Rhipicephalus* spp. Ticks (Yadhav et al.,2015). *B. bigemina* and *B. bovis* are transmitted transovarially by boophilus ticks but only tick larvae transmit *B. bovis*, whereas nymphs and adults transmit *B. bigemina* and *B. divergens* (Esmaeil et al., 2015).

In an infected Tick, the babesia parasite develops and spreads throughout the Tick's organs, eventually invading the salivary glands or eggs. When the infected Tick bites cattle, the parasites are injected into the bloodstream where they enter red blood cells (Government and State agencies bord, 2013).

2.4. Clinical sign

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 (OIE, 2010). The clinical signs vary with the age of the animal, the species and strain of the parasite. Most cases of babesiosis are seen in adults; animals younger than 9 months usually remain asymptomatic (Anon, 2008).

Affected animals suffered from marked rise in body temperature, loss of appetite, cessation of rumination, labored breathing, emaciation, progressive hemolytic anemia, various degrees of jaundice (Icterus) from paleness in mild case to sever yellow discoloration of conjunctival and vaginal mucous membranes in more progressive cases; haemoglobinuria, accelerated heart and respiratory rates, ocular problems and drop in milk production. In cattle, fever during infections in some cases cause abortion to pregnant cattle (El Moghazy *et al.,* 2014). Coffee colored urine is the characteristics clinical feature of babesiosis (Mandal, 2012).

In *B. bigemina* infections, the major signs include feve r, haemoglobinua and anaemia. Intravascular sequestration of infected erythrocytes does not occur with B. bigemina infections (Zintl et al., 2013).

2.5. Diagnosis

2.5.1. Identification of the agent

Direct microscopic examination-The traditional method of identifying the agent in infected animals is by microscopic examination of thick and thin films stained with Giemsa or Romanowsky type stain. The sensitivity of thick films is such that it can detect parasitaemias as low as 1 parasite in 106 red blood cells (RBCs). Species differentiation is good in thin films but poor in the 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 (Kahn, 2005).

In vitro culture-In-vitro culture methods used to demonstrate presence of carrier infections of Babesia spp. *B. bovis* has also been cloned in culture. Minimum parasitaemia detectable by this method depends on the facilities available and the skills of the operator but could be as low as 10^{-10}making it a very sensitive method for the demonstration of infection, with 100% specificity (Kahn, 2005).

Animal inoculation-Confirmation of infection in a suspected carrier animal can also be made by transfusing approximately 500 ml of jugular blood intravenously into a splenectomised calf known to be Babesia-free and monitoring the calf for the presence of infection. This method is cumbersome and expensive and obviously not suitable for routine diagnostic use. Mongolian gerbils (Merionesunguiculatus) have been used to demonstrate the presence of *B. divergens* (Zintl *et al.*, 2013).

2.5.2. Serological tests

Serological tests including indirect fluorescent antibody test (IFAT) and enzyme linked immunosorbent assay (ELISA) are capable of detecting antibodies of Babesia in sub-clinical infections. Drawbacks of these tests are the occurrence of false-positive and false-negative results involving cross- reactive antibodies and/or typical specific immune responses (Esmaeil *et al.,*2015). And also the complement fixation (CF) test has been described as a method to detect antibodies against B. bovis and B. bigemina (Anon, 2008).

IFAT is the most widely used test for the detection of antibodies to *B. bovis* and *B. bigemina* but serological cross reactions make species diagnosis difficult. It is based on the recognition of parasite antigens by serum antibodies in the blood of the tested animal. It is easy to do but requires a good quality antigen which is difficult to obtain (Mosqueda *et al*., 2012).

2.5.3. Molecular diagnosis

Molecular methods aimed to detect nucleic acids have been very useful when immunological methods do not work. Detecting nucleic acids is an indirect way of detecting the parasite so they are still considered indirect methods (Mosqueda *et al*., 2012). An advantage of this method Polymerase Chain Reaction (PCR) is more sensitive and specific technique and it allows identification of the parasite in the early stage of disease which enables ear ly diagnosis, implementation of therapy and avoidance of complications (Skotarczak, 2008).

2.6. Treatment

In endemic areas, sick animals should be treated as soon as possible with an anti-parasitic drug. The success of the treatment depends on early diagnosis and the prompt administration of effective drugs. A large number of chemical compounds have been reported to be effective against bovine babesia parasites. Some of them were very specific and effective (Vial and Gorenflot, 2006). But many have been withdrawn for several reasons. In addition, supportive therapy such as blood transfusions, anti-inflammatory drugs, tick removal, iron preparations, dextrose, vitamins (B complex), purgatives and fluid replacements, may be necessary in severe cases of babesiosis (Zintl *et al*., 2013).

The most commonly used compounds for the treatment of babesiosis are diminazene diaceturate (3-5 mg/kg), imidocarb (1-3 mg/kg) and amicarbalide (5-10 mg/kg); however, the quinuronium and acridine derivatives are also effective. For many years, the babesiacides: quinuronium sulfate, amicarbalide, diminazene aceturate and imidocarb diproprionate were used against bovine babesiosis in most of Europe; however, quinuronium sulfate and amicarbilide were withdrawn because of manufacturing safety issues and diminazene, which is widely used in the tropics as both a babesiacide and a trypanocide, was withdrawn from Europe for marketing reasons (Vial and Gorenflot, 2006).

2.7. Prevention 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 (International Laboratory for Research on Animal Diseases, 1991).

Chemoprophylaxis is not a viable long-term alternative to effective immunization, but imidocarb and diminazene have been used to protect cattle for several months against babesiosis(International Laboratory for Research on Animal Diseases, 1991). At dosage of three mg/kg, imidocarb provides protection for babesiosis for around four weeks from carrier animals (Kahn, 2005).

Vaccination has been done with varying degree of success with live and dead whole parasite and isolated parasite antigen. Several findings support the development of vaccines against Babesiosis. First; cattle which recover from a primary babesia infection or that have been immunized with attenuated parasites are resistant to challenge infection. Second, immunization of cattle with native babesia antigen extracts or culture-derived supernatants containing secreted babesia antigens elicit protective immunity against both homologous and heterologous challenge (Radostits *et al.*, 2007).

2.8. 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 but *B. divergens* causes serious disease in humans who have had splenectomies and immunoc ompromised. *B. divergens* infections in humans who a re medical emergency. They usually progress very rapidly and most cases in the past ended in death within a week. The disease is characterized by the acute onset of severe hemolysis, hemoglobinuria, jaundice, persistent high fever, chills, sweats, headache, myalgia, lumbar and abdominal pain and sometimes vomiting and diarrhea. Shock and renal failure may also be seen. 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 (Spickler *et al.*, 2010).

2.9. Economic importance

Bovine babesiosis causes most serious economic loss to the livestock industry, endangering half a billion cattle across the world (Saad *et al*., 2015). Recently Babesia becomes the most widespread parasite with consequent of heavy economic losses such as mortality, reduction in meat and milk yield and indirectly through control measures of ticks. 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 (Onoja *et al*., 2013).

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 (Mosqueda *et al.*, 2012).

2.10. Status of bovine babesiosis in 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. 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).

Table 3: Prevalence of bovine babesiosis from different area of Ethiopia

Area	Diagnostic methods	Prevalence	Reference
Western Ethiopia (Ben. Gumuz)	microscopic examination	1.5%	(Wodajnewn *et al.*, 2015)
Southern Ethiopia (Borena)	microscopic examination	16.9%	(Hamsho *et al.*, 2015)
South Western Ethiopia (Harar)	microscopic examination	23%	(Lemma *et al*., 2015)
Central Ethiopia (Bishoftu)	microscopic examination	0.6%	(Sitotaw *et al.*, 2014)

3. Conclusion and Recommendation

Babesiosis is a dangerous, invasive disease of cattles including other domestic and wild animals as well as human. Despite the diagnostic and preventive advances resulting from extensive research and a greater understanding of the disease, babesiosis continues to have significant medical and economic impact. It impair the export and import trade of live animal and animal products (Meat, milk, hide and skin) by down grading their quality and fear of the co-traders. For years, babesiosis treatment has been based on the use of very few drugs like imidocarb or diminazeneaceturate but recently, several pharmacological compounds were developed and evaluated, offering new options to control the disease. Control of tick borne diseases is crucial in improving livestock health services and animal productivity. There are different control strategies which vary from region to region as well as from area to area include tick control, vaccines (Against ticks and parasites) and drugs.

Based on the above conclusion the following recommendations are forwarded:

- Awareness should be created on mode of transmission, control and prevention methods of babesia to livestock owners.
- Economic losses from babesiosis are very high so that the respected organization should give attention to control and eradicate of the disease
- Since chemical control can result in resistance and environmental contamination, environmentally friend control mechanisms like vaccination and biological methods should be further developed.
- Ethiopia should develop and implement surveillance systems and action plans to prevent bovine babesiosis from spreading.

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Conflict of interest

None

5. References

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