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Review Article

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Review on Occurrence of Bovine Babesiosis in Ethiopia

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Abstract

Bovines can be exposed to different protozoan parasitic diseases among those diseases bovine babesiosis is one of them. Bovine babesiosis is a tick-borne disease of cattle caused by the protozoan parasites including *Babesia bovis*, *B. bigemina* and *B. divergens. Rhipicephalus (Boophilus) microplus*, the principal vectors of *B.bovis* and *B. bigemina*. The major vector of *B. divergens* is *Ixodes ricinus*. There are other important vectors that can transmit these pathogens, including *Haemaphysalis* and other *Rhipicephalus spp*. Bovine babesiosis also known as red water, is the worldwide most important hemoparasitic diseases of cattle that causes significant morbidity and mortality. They are widespread in tropical and subtropical areas including Ethiopia and are vectored by one host tick *Rhipicephalus species* and transmission is manly transovarial. During the tick bite, sporozoites are injected into the host and directly infect red blood cells. Babesia produces acute disease by hemolysis and circulatory disturbance mechanism. The rapidly dividing parasites in the red cells produce rapid destruction of the erythrocytes with accompanying haemoglobinaemia, haemoglobinuria and fever. 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. A surveillance system should be developed and implemented to prevent bovine babesiosis from spreading; epidemiological study should be conducted on bovine babesiosis to provide the necessary data.

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

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 [1]. 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 [2]. 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 [3].

Bovine babesiosis is caused by protozoan parasites of the genus *Babesia*, order Piroplasmida, phylum Apicomplexa. Of the species affecting cattle, two – *Babesia bovis* and *B. bigemina* – are widely distributed and of major importance in Africa, Asia, Australia, and Central and South America. *Babesia divergens* is economically important in some parts of Europe. Tick species are the vectors of *Babesia*. *Rhipicephalus (Boophilus)* microplus is the principal vector of B. bigemina and B. bovis and is widespread in the tropics and subtropics. The vector of *B. divergens* is *Ixodes ricinus*. Other important vectors include *Haemaphysalis* and other species of *Rhipicephalus* [4].

Babesia bigemina has the widest distribution but B. bovis is generally more pathogenic than *B. bigemina or B. divergens. Babesia bovis* infections are characterised by high fever, ataxia, anorexia, general circulatory shock, and sometimes also nervous signs as a result of sequestration of infected erythrocytes in cerebral capillaries. Anaemia and haemoglobinuria may appear later in the course of the disease. In acute cases, the maximum parasitaemia (percentage of infected erythrocytes) in circulating blood is less than 1%. This is in contrast to *B. bigemina* infections, where the parasitaemia often exceeds 10% and may be as high as 30%. In *B. bigemina* infections, the major signs include fever, haemoglobinuria and anaemia. Intravascular sequestration of infected erythrocytes does not occur with *B. bigemina* infections. The parasitaemia and clinical appearance of *B. divergens* infections are somewhat similar to *B. bigemina* infections [5].

Infected animals develop a life-long immunity against reinfection with the same species. There is also evidence of a degree of cross-protection in *B. bigemina*-immune animals against subsequent *B. bovis* infections. Calves rarely show clinical signs of disease after infection regardless of the *Babesia spp*. involved or the immune status of the dams [4].

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 [6]. Four main TBDs, namely anaplasmosis, babesiosis, the ileriosis and ehrlichiosis (heart water) are considered to be the most important tick-borne diseases (TBDs) of livestock in sub-Saharan Africa, resulting in extensive economic losses to farmers in endemic areas [7]. They are responsible for high morbidity and mortality resulting in decreased production of meat, milk and other livestock by-products.

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 [8]. 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 [9]. Generally bovine babesiosis is one of the most important diseases that seriously hinder cattle production in Ethiopia and other part of the world [10].

So the objectives of this paper are:

- ✓ To review available literatures on bovine babesiosis.
- ✓ To review the occurrence of Bovine babesiosis and its economic impact of the disease in Ethiopia.

Bovine babesiosis

Etiology

The disease Bb, synonymy also called tick fever, cattle fever, Texas fever, piroplasmosis and red water fever which is caused by the protozoan parasite of genus *babesia bovis*, *babesia bigemina* and *babesia divergens*. Other babesia parasites that can infect cattle include *babesia major*, *babesia ovate*, *babesia oculatus*, *Babesia Jakimovi*. The bovine spp which are affected by those parasites are cattle, white tailed deer, American buffalo, water buffalo, rein deer, African buffalo [11].

Taxonomic classification

Taxonomically, the babesia parasites are positioned as the following series, phylum; protozoa (apicomplexa), subphylum; sporozoa;, class; sporozoasida; order; piroplasmorida, family; babesidae and genus babesia [12].

Morphological features of the organism

The morphology of the parasite is typically pyriform but can be round, tetrad, rod shaped, elongated and cigar shaped organism. The tetrad morphology which can be seen with the giemsa staining of thin blood smear is unique to babesia and serves as distinguishing features from plasmodium falciparum, protozoan of similar morphology that causes malaria. Examination of stained blood films shows the organism to be within RBC, almost always singly or as pairs, often arranged at characteristics angle with their narrow ends opposed. Conventionally, the various spp are grouped in to the small babesia whose pyriform bodies are 1-2.5 µm and large babesia which are 2.5-5 µm long. With Romanowsky dyes the cytoplasm appears blue and the nucleus red. Under the electron microscope the parasite is seen to posses at its blunt and an electron dense apical complex which is thought to be concerned with assisting penetration of the erythrocyte [12]. There are forms of babesia which are sporozoites, trophozoites and merozoites. Sporozoites are infective forms and they are present in the saliva of infective ticks and ticks infect during their blood meal [8]. The agent does not survive outside its host and transmitted through a tick vector, therefore parameters associated with resistance to physical and chemical actions (such as temperature, disinfectants and environmental stress are not as such meaningful [12].

Table 1: Morphology of bovine babesia spp and their tick vectors.

Organism	**Morphology**	**Tick vectors**
Babesia bigemina	4.5 x 2.5 µm (large, round, pyriform and acute angle)	*Boophilus decoloratus, Boophilus anulatus*
Babesia bovis	1.5 m x 1.4 m (small, round, pyriform and acute angle)	*Ixoides spp, Boophilus anulatus, Boophilus microplus*
Babesia divergens	1.5 µm x 1.4 µm (small, round, pyriform and acute angle)	*Ixoides ricinus*
Babesia major	2.6 µm x 1.5 µm (similar with babesia bigemina but smaller)	*Haemaphysalis punctata*
Babesia jakimovi	2-4.6 µm x 1.5-2.1 µm (large, round, and pyriform)	*Ixoides ricinus*
Babesia ovate	4.5 µm x 2.5 µm (large, round, and pyriform)	*Haemaphysalis long icornis*

Source: El Sawalhy [13].

Life cycle and development of babesia

Babesia undergoes different developmental stages during their life cycle and their development is almost follow similar patterns in ticks. Babsia spp penetrates erythrocytes of vertebrate hosts and its life cycle is consists of merogony, gametogony and sporogony stages. Sporozoites penetrates the cell membrane of an erythrocytes with the aid of a specialized apical complex, once inside, it transforms into a trophozotic (feeding stage) from which two merozoites develop by process of merogony (binary fusion) or asexually, then in the passage of host blood to the mid gut of the tick vector the development of two population of ray bodies from the gamete (gametocytes) occurs the ray bodies undergo further multiplication and once division is complete a single nucleated ray bodies are haploid and assumed to be gametes emerge from the aggregate and then fuse together in pairs (syngamy) to form zygote [12]. The zygote develop into kinets that escape in to the tick haemolymph in the gut cells, schizogonyoccurs with the formation of polyploidy kinets, thus transovarian transmission occur with further development occurring in the larval stage, kinets enter the salivary gland and are transformed in to multinucleated stages (sporogony asexual reproduction and then breaks up to form sporozoites [12].

Epidemiology

All Babesia are transmitted by ticks with a limited host range. The principal vectors of *B. bovis* and *B. bigemina* are *Rhipicephalus spp*, ticks and these are widespread in tropical and subtropical countries. The major arthropod vector of *B. divergens* is *Ixodes ricinus*. *B. bovis* is principally maintained by subclinically infected cattle that have recovered from disease. Morbidity and mortality vary greatly and are influenced by prevailing treatments employed in an area, previous exposure to a species/strain of parasite, and vaccination status. In endemic areas, cattle become infected at a young age and develop a longterm 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 [14].

Geographic distribution of Babesiosis

Both Babesia species occur in Central and South America, parts of Europe and Asia, Australia and Africa. Babesia bigemina has been eradicated from the United States of America. In southern Africa *Babesia bovis* is restricted to areas where *Rhipicephalus, B.* microplus is prevalent, usually the higher rainfall areas in the eastern parts. Due to its wider vector range, *Babesia bigemina* is much more widespread and is present throughout southern Africa, except for the more arid and some high-lying parts. Bovine babesiosis can be found wherever the tick vectors exist, but it is most common in tropical and subtropical areas. *B. bovis* and *B. bigemina* are particularly important in Asia, Africa, Central and South America, parts of southern Europe, and Australia [15].

Table 2: Geographical distribution of Bovine babesia spp.

Babesia spp	**Animals affected**	**Principal Geographical distribution**	**Tick vectors**
Babesia bovis	Cattle, deer, Water buffalo, Wild ruminants	America, Europe, Australia, Middle East, Africa	*Ixodes ricinus, I. persulcatus, B. calcaratus, Rh. Bursa*
Babesia bigemina	Cattle Zebu, Water buffalo, Deer, Wild ruminants	America, Europe, Australia, Russia	*Boophilus annulatus, B. microplus, B. australis B. calcaratus, B. decoloratus, Rhipicephalus everts Rh. bursa, Rh. appendiculatus Haemaphysalis punctate*
Babesia divergens	Cattle	Europe	*I. ricinus*
Babesia major	Cattle	Europe, Russia, Middle East, North Africa	*H. punctuate*
Babesia argentina	Cattle	Central and South America, Australia	*B. microplus*

Source: Uilenberg, 1995 [16]

Risk factor

Host factor

Host factors associated with disease include age, breed and immune status. *Bosindicus* breeds of cattle are more resistance to Babesiosis than *Bostaurus*. This is a result of evolutionary relationship between *Bosindicus* cattle, *Rhipicephalus* (formerly *Boophilus) species* and Babesia. Because of natural selection pressure, indigenous populations, having lived for a long time with local ticks and tick-borne diseases, have developed either an innate resistance or an innate ability to develop a good immuneresponse to the tick or tick-borne hemoparasitic disease in question [17].

Pathogen Factor

Strains vary considerably in pathogenicity; however, B. bovis is usually more virulent than B. *bigemina* and *B. divergens* [18]. Many Intra-erythrocyte hemoparasites survive the host immune system through rapid antigenic variation which has been demonstrated for *B. bovis* and *B. bigemina* [12].

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 [12]. Babesiosis infection in cattle mostly reaches peak in summer [19].

Host range

More than 100 known *Babesia spp*, have been identified which infect many types of mammalian host, out of these, 18 spp. cause disease in domestic animals. Babesiosis commonly infect cattle, sheep, goats, horses, pigs, dogs and cats and occasionally man. European, Sanga and Zebu breeds are all susceptible, and all develop latent infections after recovery. European breeds can retain *B. bovis* infections for life and remain infective for ticks for up to two years, while most cattle with a significant Zebu content lose the infection within two years. B*abesia bigemina* infections rarely persist for more than a year, regardless of the host, and infected cattle remain infective for ticks for only four to seven weeks [20].

Transmission

Rhipicephalus (B.) microplus is the only known tick vector of *B. bovis* in southern Africa. Transmission is transovarial with engorging adult ticks ingesting the parasites and larval ticks of the next generation transmitting the infection. Ensuing stages are not infected. *Babesia bovis* and *B. bigemina* follow similar developmental patterns in adult *Rhipicephalus (Boophilus) spp.* Initial development takes place in epithelial cells of the gut wall where schizogony (multiple fission) occurs with the formation of large merozoites (vermicules, sporokinetes). Successive cycles of schizogony then occur within a variety of cell types and tissues, including the oocytes. Thus, transovarial transmission occurs with further development taking place in the larval stage [21].

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 [22]. 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 [23]. 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 [18].

Pathogenesis

The primary mechanism is intravascular haemolysis (leading to haemoglobinaemia and haemoglobinuria), resulting in anaemia, hypoxia and secondary inflammatory lesions in various organs, especially liver and kidneys. The secondary mechanism is electrolyte imbalances, complement activation, coagulation disorders and release of pharmacologically active substances resulting in vascular malfunction and hypotensive shock [14]. The main sequelae of the disease are: Anaemia due to haemolysis; haemoglobinaemia and haemoglobinuria, icterus. Pharmacologically active substances such as kinins and catecholamines lead to increased vascular permeability and dilatation of blood vessels resulting in oedema and hypovolaemic shock. Centrilobular liver degeneration and degeneration of kidney tubule epithelium are caused by hypoxia and possibly by immunopathologic reactions. Damage to kidney tubule epithelium impairs ion exchange, resulting in H+ retention (leading to acidosis) [24].

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 [25]. 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 [26].

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 [19]. Coffee colored urine is the characteristics clinical feature of babesiosis [27].

Diagnosis

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 [28].

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 10-10making it a very sensitive method for the demonstration of infection, with 100% specificity [28].

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* [29].

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 [30]. And also the complement fixation (CF) test has been described as a method to detect antibodies against *B. bovis* and *B. bigemina* [26]. 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 [31].

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 [31]. 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 [32].

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 [33]. But many have been withdrawn for several reasons. In addition, supportive therapy such as blood transfusions, antiinflammatory drugs, tick removal, iron preparations, dextrose, vitamins (B complex), purgatives and fluid replacements, may be necessary in severe cases of babesiosis [29].

The most commonly used compounds for the treatment of babesiosis are diminazene diaceturate (35 mg/kg), imidocarb (1-3 mg/kg) and amicarbalide (510 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 [34].

Prevention and control measures

Vector control Acaricide application, controlled range burning, cultivation, prolonged pasture rest uses of repellents, control of stock movement, raising, cattle, resistant to ticks, are major methods. The common acaricides are chlorinated hydrocarbons, carbamates, organophosphate, natural and synthetic pyrethrins and avermectin (dips or spray). In recent years several other measures of acaricides application has developed including pour on and spot on [35]. Parasite control Immunization of susceptible stocks, chemo prophylaxis treatment of infected animals mostly imidocarb is used and vaccination are major parasite control methods. The most common forms of immunization consist of inoculating live organism (virulent or attenuated) into susceptible calves to induce a state of pre immunization [35].

Generally, control of tick born babesiosis is based on:

- ✓ Tick control through acaricidal treatment of host
- ✓ Chemotherapy of infected host
- ✓ Test and slaughter of infected animals
- ✓ Quarantine of infected animals [9]

Economic Significance and Public Health Importance of Bovine Babesiosis

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 [22]. 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 [18].

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 [23].

Economic importance

Bovine babesiosis causes most serious economic loss to the livestock industry, endangering half a billion cattle across the world [36]. 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 [37]. 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 [31].

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 [38]. Ticks and tick borne diseases cause considerable losses to the livestock economy, ranking third among the major parasitic disasters after trypanosomes and endoparasitism [39].

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 [9]. Different researchers have reported the prevalence of bovine babesiosis from different area of Ethiopia (table 3). The study from Western Ethiopia Benishangul Gumuz Regional State, by Wodajnew et al. [9] 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. [8] 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% by Alemayehu. [40]. 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 by Sitotaw et al. [41]. 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%) by Hamsho et al. [3]

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

Area	Diagnostic methods	Prevalence	Reference
Western Ethiopia	microscopic examination	1.5%	[9]
Southern Ethiopi	microscopic examination	16.9%	[3]
South Western Ethiopia	microscopic examination	23%	[8]
Central Ethiopia	microscopic examination	0.6%	[41]

High prevalence of bovine babesiosis was reported in and around Jimma town, southwest Ethiopia compared to other study which is 23% by Lemma et al. [8]. In contrast, the study from Central Ethiopia, bishoftu indicated low prevalence of bovine babesiosis (0.6%) [41].

Conclusion and Recommendation

Bovine babesiosis is the most important arthropod-borne disease of cattle worldwide that causes significant morbidity and mortality. The most prevalent species, *B. bovis* and *B. bigemina*, are found throughout most tropical and subtropical regions including Ethiopia. All Babesia are transmitted by ticks with a limited host range. The principal vectors of *B. bovis* and *B. bigemina* are *Rhipicephalus spp*. ticks and these are widespread in tropical and subtropical countries. Calves are virtually resistant to the Babesia. *Babesia bovis* causes more severe clinical signs as compared to *Babesia bigemina*. Bovine Babesiosis causes most serious economic loss to the livestock industry, endangering half a billion cattle across the world. The disease is also a barrier to improving productivity of local cattle by crossbreeding due to the high mortality of genetically superior but highly susceptible cattle. Introduction of effective prophylactic treatment and vaccination could enables for decline of the disease. 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. Currently bovine babesiosis is widespread in Ethiopia with most prevalent species being *B. bovis* and *B. bigemina*.

Therefore based on the above conclusions the following recommendations can be forwarded are:-

- Veterinarians, private sectors and government should create awareness for clients about the disease characteristics and how they can manage their animals as well as themselves.
- Various control strategies should be adopted in order to prevent the day to day increasing losses to livestock industry and vaccines should be practiced in control and prevention of babesiosis
- Ethiopia should develop and implement surveillance systems and action plans to prevent bovine babesiosis from spreading and epidemiological studies should be conducted on bovine babesiosis to provide the necessary incidence and prevalence data.

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