REVIEW ON BOVINE BRUCELLOSIS AND ITS PUBLIC HEALTH SIGNIFICANCE IN ETHIOPIA

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Summary*:* *Bovine brucellosis* is a highly infectious, contagious, zoonotic, and economically important bacterial disease of animals, wildlife and humans worldwide caused by *Brucella abortus*. It is mainly infective for cattle, but occasionally other species of animals such as sheep, swine, dogs and horses. The disease is an endemic in most of the developing world that causes devastating losses to the livestock industry and small-scale livestock holders. It's occurrence in new areas as well as transmission from wild and domestic animals is of great significance in terms of new epidemiological direction. It is also one of the most important infectious that causes reproductive disorders in domestic animals mainly cattle. The disease transmitted mainly to animals by ingestion of contaminated feed and water, by contact with infected aborted fetus, fetal membrane and genital discharges, and by artificial insemination from infected bulls. The bacteria preferentially localized mainly in the reproductive tract of pregnant animals specifically uterus and consequently cause abortion (late abortion), retained fetal membrane and infertility, whereas orchitis and epididimitis are seen in males. In humans, bovine brucellosis typically manifests as a variety of non-specific clinical signs. The economic and public health impact of bucellosis remains of particular concern in developing countries. Among the serological tests, RBPT for screening and CFT for confirmatory are routinely used in Ethiopia. Control program for the disease include vaccination of young and mature animals and slaughter of infected animals and disposal of animals following serological test. Therefore, formulating effective control strategies are needed that includes surveillance to identify infected animals, and prevention of transmission to non-infected animals and removal of the reservoir to eliminate the source of infection is vital.

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1. INTRODUCTION

Ethiopia is a landlocked country in the Horn of Africa, covering 1.1 million square kilometers. Agriculture is the backbone of Ethiopia's economy, accounting for up to 45% of gross domestic product (GDP) and employing roughly 78% of the country's workforce (Martins, 2014). Around 80% of the populations rely on agriculture, with the majority residing in rural areas (FAO, 2017). It is the African country with the largest animal population, estimated at more than 70 million cattle, 42.9 million sheep, 52.5 million goats, 8.1 million camels, 7 million equines, and 57 million chickens (CSA, 2021). The livestock industry accounts for around 16.5% of the national GDP, contributes 15% of export earnings and 30% of agricultural employment (Leta and Mesele, 2014).

Despite having Africa's largest livestock population, the country is not benefiting from the livestock sector, which is hampered by several factors, including widespread endemic disease caused by viral, bacterial, and parasitic infestation, a lack of appropriate disease control policy, inadequate veterinary services, and government inattention. Livestock disease is one of the major roadblocks to the sector's development, as it reduces production and impedes commerce in animals and animal products (Jilo *et al*., 2016).

From those livestock diseases, zoonotic diseases like Brucellosis account for about 75% of emerging infectious disease and can be devastating to both human and animal health globally(WHO, 2017).A subset of those zoonotic infectious diseases is referred to as "neglected zoonotic disease- NZDs". These diseases are termed "neglected" as they mainly affect poor populations who live close to domestic or wild animals often in areas where health and adequate sanitary conditions are scarce. Bovine Brucellosis is among the eight illnesses designated as NZDs by the World Health

Organization along with Bovine Tuberculosis, Rabies, Anthrax, Cysticercosis, Echinococcosis, Leishmaniasis, and Human African Trypanosomiasis (WHO, 2006). Ethiopia is vulnerable to zoonotic diseases because a segment of the population lives near animals frequently in unsanitary conditions with limited access to healthcare (Habib and Alshehhi, 2021).

Bovine Brucellosis is a highly contagious, zoonotic and economically important bacterial disease of animals worldwide and it is considered by the Food and Agriculture Organization (FAO), the World Health Organization (WHO) and the Office International des Epizooties (OIE) as one of the most widespread zoonoses in the world (Ashenafi*et al*., 2016). Bovine Brucellosis usually caused by *Brucellaabortu s*and occasionally by *Brucellamelitensis* and *Brucellasuis* which are facultative intracellular, gram negative, non-spore-forming and non-capsulated, partially acid-fast coccobacilli that lack capsules, endospores or native plasmids. They survive freezing and thawing but most disinfectants active against gram-negative bacteria kill Brucella. Pasturization effectively kills Brucella in milk. The bacterium is of 0.5-0.7µ in diameter and 0.61.5µ in length. They are oxidase, catalase and urease positive. Although Brucella species are described as non-motile, they carry all the genes except the chemotactic system necessary to assemble a functional flagellum (Fretin *et al*., 2005).

The disease occurs in all age groups but most commonly in sexually mature animals. The disease is usually asymptomatic in young animals and non-pregnant females. Following infection with *B. abortus* or *B. melitensis*, pregnant adult females develop a placentitis usually resulting in abortion between the fifth and ninth month of pregnancy. Even in the absence of abortion, profuse excretion of the organism occurs in the placenta, fetal fluids and vaginal discharges. Adult male cattle may develop orchitis/epididymitis and brucellosis may be a cause of infertility in both sexes. Hygromas, usually involving leg joints, are a common manifestation of brucellosis in some tropical countries (Anonymous, 2007; Priyanka*et al*., 2019).It is one of the oldest zoonotic diseases which remain of economic and public health significance, today with major outcomes of reproductive losses in livestock and debilitating illnesses in humans (FAO, 2003).
It is one of the highest priority diseases, both in sub-Saharan Africa and other regions of the developing world. The importance of brucellosis reflects its widespread distribution and its impacts on multiple animal species, including cattle, sheep, goats, pigs and humans (Hussen and Alemu, 2020).Among the serological tests, RBPT for screening and CFT for confirmatory are routinely used in Ethiopia and other countries to detect seropositive animals. Annually with more than 50, 000 human cases of Bovine Brucellosis are reported globally. It is mainly transmitted to humans through the consumption of unpasteurized dairy products, direct contact with infected animal and their discharges. The prevalence of human brucellosis differs between areas and vary with standards of personal and environmental hygiene, animal husbandry practices and species of the causative agent and local methods of food processing (Ashenafi *et al*., 2016).
Even though, several serological surveys have showed Bovine Brucellosis is an endemic and widespread disease in urban, per-urban, highland and lowland, extensive and intensive farming, small holder farms and ranches of the country there is no documented information on how and when brucellosis was introduced and established. There is a scarcity of published literature on the status of Bovine Brucellosis in the country where large populations of cattle are reared(Dinka and Chala, 2009). Since bovine brucellosis has been widely reported in various species of animals and humans, only few reviews have addressed this disease in the context of Ethiopia. Despite being one of the most prevalent zoonoses in the country it is still neglected disease due to its lack of attention by global health systems and causing adverse impact on public health, economics, and global trade (Megersa*et al*., 2011; Anonymous, 2007). Therefore, the objective of this seminar is;

- ❖ To overview the related literatures on Bovine Brucellosis and its public health significance.

2. REVIEW ON BOVINE BRUCELLOSIS AND IT’S PUBLIC HEALTH IMPORTANCE

2.1. Historical Background

The genus Brucella was named after David Bruce, who first isolated the organism (then named Micrococcus melitensis) in 1887 from the spleen of a soldier suffering from a disease that was called Malta fever (Santos*et al*., 2005).The prevalence of brucellosis was reported in the Mediterranean region and it was historically related with war campaigns. Bovine brucellosis was first reported in the African continent in Zimbabwe (1906) followed by Kenya (1914) and South Africa (1915) (Chukwu 1985).

The epidemiology of the disease in animals as well as humans is not well understood in sub Saharan countries of African continent. Robust control of brucellosis is not implemented in Africa except in South Africa (McDermott *et al*., 2013). It is endemic among ruminants and humans in Egypt despite the presence of control programs (Hosein*et al*., 2018). The annual incidence of human brucellosis is estimated to be 5 to 12.5 million cases in Egypt (Hull and Schumaker 2018). The seroprevalence study of brucellosis in cattle revealed that the overall seroprevalence and seroprevalence at herd level was 2.4 and 45.9%, respectively, in Ethiopia. Moreover, a prevalence of 3.3% was observed in extensive farming system and 1.3% in intensive farming system. Cattle in both systems showed low level of endemicity of brucellosis (Asgedom*et al*., 2016).

2.2. Etiology

Bovine Brucellosis is primarily caused by *Brucellaabortus*, a Gram-negative,facultative intracellular, non-sporeforming and non-capsulated, partially acid-fast coccobacilli that lack capsules, endospores or native plasmids in the family Brucellaceae (class Alphaproteobacteria). The bacterium is of 0.5-0.7μ in diameter and 0.61.5μ in length. It is oxidase, catalase and urease positive, non-motile; they carry all the genes except the chemotactic system necessary to assemble a functional flagellum (Fretin*et al*., 2005). The genus encompasses 10 recognized species including three species that are of major public health and economic importance. These are *B. melitensis* which predominantly infects small rumminants, *B. abortus* which affects cattle, and *B.suis*, which affects swine. These species may also infect camelids, jacks and a variety of wildlife species. *B. melitensis*, *B. abortus*, and *B. suis* can be further sub-divided into biovars based on the unique phenotypic characteristics of different strains. Sub-species genotyping is also possible using molecular tools for analysis of genetic structure of the strains that have been isolated (Armon*et al*., 2015).

2.3. Epidemiology

The epidemiologies of the disease in livestock and humans as well as appropriate preventive measures are not well understood and such information is inadequate particularly in sub-Saharan Africa like Ethiopia. The surveillance and control of brucellosis in this region is rarely implemented outside South Africa. In dairy production, the disease is a major obstacle to the importation of high yielding breeds and represents a significant constraint to the improvement of milk production through cross breeding (Ashenafi*et al*., 2016).

2.3.1. Host Range

Brucella abortus is primarily a disease of cattle and bison but has also been reported in yak and wildlife species (eg, elk, sika deer, African buffalo, and antelope), as well as horses, camels, and South American camelids in contact with infected ruminants as indicated on Table 1(Spickler, 2023).

Table 1: Host range of Brucella species

Species	**Hosts**	**Zoonotic potential**
Brucellamelitensis	Sheep, goat	+++
Brucellaabortus	Cattle	++
Brucellasuis	Pig	++
Brucellacanis	Dog	+
Brucellaovis	Sheep	–
Brucellaneotomae	Desert wood rat	–
Brucellaceti	Cetaceans	+
Brucellapinnipedialis	Seals	+
Brucellamicroti	common voles	–

Source: (Hussen and Alemu, 2020).

2.3.2. Geographical distribution

The distribution of brucellosis in different geographies is highly dynamic, with emergence of new areas of infection and re-emergence of infection in areas where infection existed earlier. New foci of human brucellosis have emerged, particularly in central Asia, while the situation in certain countries of the Middle East is rapidly worsening (Pappas *et al*., 2006).*Brucella abortus* was once found worldwide with different level of new cases (incidence) and prevalence and remains as major source of disease in humans and domesticated animals, with rare exceptions such as Iceland. The disease has been eradicated from some countries like Canada, Australia, New Zealand, Japan and Israel have eliminated this organism from domesticated animals. Sporadic cases may be reported in travelers and immigrants in *B. abortus*-free countries (Ibrahim*et al*., 2022).The disease remains endemic in regions of Europe, Central and South America, Africa, and Asia, where its presence is associated with reduced availability of economic resources, decreased implementation of surveillance programs and control policies, and large bovine populations (Cárdenas*et al*., 2019).

2.3.3. Reservoirs

The reservoirs of the disease are domestic (dogs, cats) and wild carnivores, such as foxes and wolves, which may be important as mechanical disseminators of infection by carrying away infected material such as fetuses or fetal membranes enhances the viability of the organisms in the environment, thus increasing the chances of infecting susceptible animals. Besides they facilitate the transmission of brucellosis highly by contaminating the environment and also being the site of multiplication for the organisms in their body and excreting such agents and again the execrated organisms infect animals and humans then bring hazards on health and economy of the country. Wildlife reservoirs are exist in parts of Africa and North America such as bison and elk in which this organism is maintained. There is no evidence that any wild ungulates are infected in European countries that have eradicated B. abortus (Gall*et al*., 2001).

2.3.4. Risk factors

Agent factors: *Brucella abortus* is intracellular pathogen which is able to survive and replicate within phagocytic cells of the host. It can persist on fetal tissues and soil or vegetation for 21-81-days depending on the month, temperature, and exposure to sunlight. *B. abortus* field strain persisted up to 43-days in oil and vegetation at naturally contaminated bison birth or abortion sites. The epidemiology of the disease is affected by several factors including factors associated with disease transmission between herds, factors influencing the maintenance and spread of infection within herds. (Alemu and Markel, 2008).
Host factors: Animal population density is attributed to increase the chance of contact between susceptible and infected animals. Health status of the animals may also play a great role in acquiring and spread of the disease infection to health animals. Vaccinated and disease free animals are less susceptible than unvaccinated and immune compromised diseased animals. Caprine are at higher risk of acquiring Brucella infection than ovine. This may be due to the greater susceptibility of goats to Brucella infection. It could also be partly due to the fact that goats excrete the organism for a long period of time, unlike sheep (Ibrahim*et al*., 2022).
Environmental factors: The bacteria may remain for several months in water, aborted fetuses and fetal membranes, feces and liquid manure, wool, hay, on buildings, equipment and clothes. It is also able to withstand drying particularly in the presence of extraneous organic material and will remain viable in dust and soil. Temperature, humidity and pH influence the organism's ability to survive in the environment. Brucella is sensitive to direct sunlight, disinfectant and pasteurization (Agricultural sample survey, 2017).
Management risk factors: The transmission of the disease from one herd to another and from one area to another is always due to the movement of diseased animals from an infected herd into a non-diseased susceptible herd. Hence, lack of strict movement control of animal from one area to another, lack of proper hygienic practices and good husbandry management play a great role in the increment of brucellosis prevalence (Ibrahim*et al*., 2022).
Occupational risk: Professionals who work with animals or come into contact with infected blood are at higher risk of brucellosis. Veterinarians, dairy farmers, ranchers, slaughterhouse workers, hunters, microbiologists, farmer and also those handling artificial working in endemic areas are at risk of acquiring the diseases (Alemu and Markel, 2008).

2.3.5. Source of infection and route of transmission

Animals often acquire the disease by contact with organisms in vaginal discharges and birth products (placenta, fetus, fetal fluids) from infected animals. Introduction of pregnant, recently aborted, or recently calved animals with brucellosis from infected herds are the main source of infection for clean herds. Aborted foetuses as well as fetal membranes and uterine secretions eliminated after abortion or parturition are the most important sources of infection (Franco*et al*., 2007).

Ingestion and transmission through mucous membranes are thought to be the major routes, but organisms can also enter the body via broken skin. The mammary gland is usually colonized during a systemic infection; however, organisms can also enter from the environment via the teats. Some calves acquire *B. abortus* when they nurse, and a small percentage may be born infected. Natural mating does not seem to be a major route of transmission in cattle, but venereal transmission appears to be more efficient when *B. abortus* is deposited in the uterus, and contaminated semen could introduce this organism during artificial insemination. Other iatrogenic sources include contaminated syringes. There is no evidence that arthropods play any role in the epidemiology of brucellosis (Abubakar*et al*., 2010).

But humans acquire *B. abortus* by ingesting organisms or via contaminated mucous membranes (including the conjunctiva and respiratory tract) and abraded skin. Routes implicated in rare instances of person-to-person transmission of *brucellae* include blood transfusion, bone marrow transplantation, exposure to contaminated material while assisting at a delivery, sexual intercourse and nursing (Magableh and Bataineh, 2007).Direct contact with infected animals and consumption of contaminated dairy products may cause infection in human beings and human to human transmission is relatively uncommon (Olsen and Tatum, 2010; Krishna *et al*., 2016).

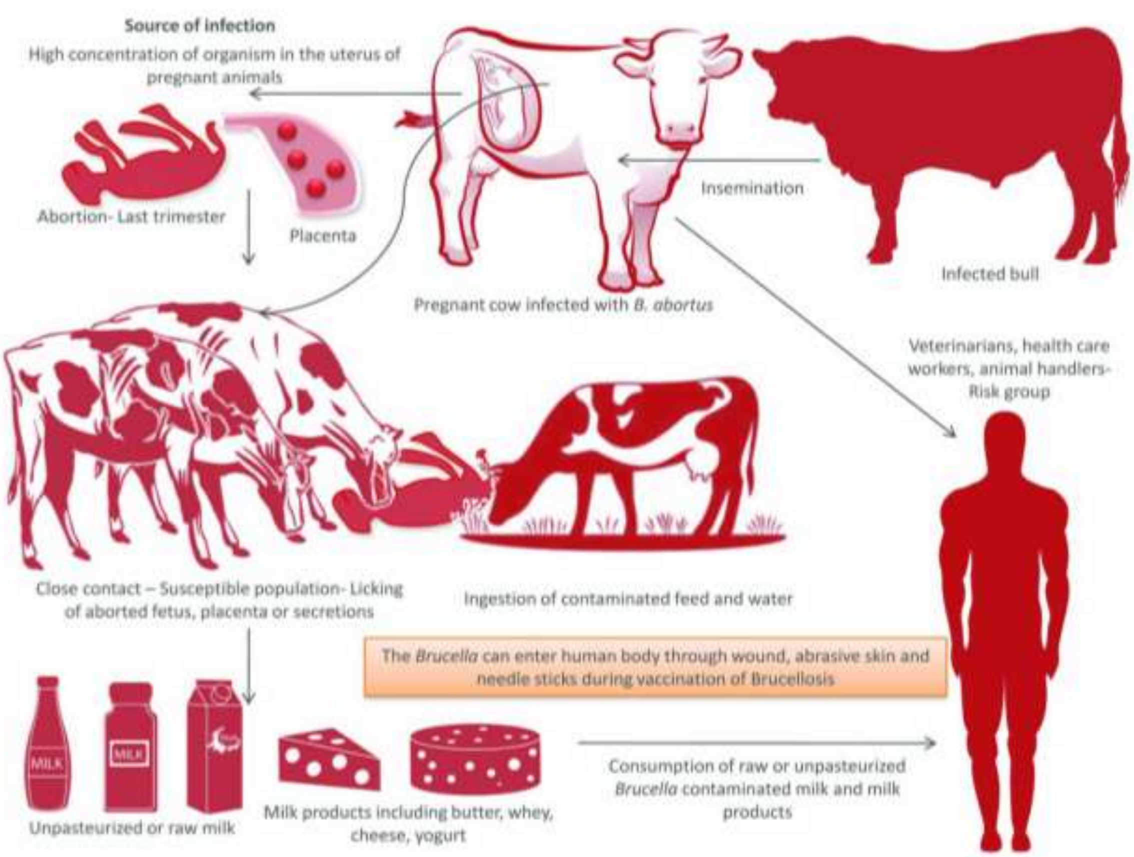

Figure 1: Transmission of *Brucella abortus* , **Source:** (Krishna *et al*., 2016)

2.4. Status of Bovine Brucellosis in Ethiopia

In Ethiopia, brucellosis is enzootic disease and bovines are highly susceptible than camels and small ruminants in pastoral and agro-pastoral areas. The highest level of prevalence is noticed in dairy cattle in the country. The disease is more prevalent in developing countries like Ethiopia and considered to be a great health problem due to lack of effective public health measures, domestic animal health programs and appropriate diagnostic facilities. Furthermore, the situation is also worsened by the resemblance of the disease with other diseases leading to misdiagnosis and under reporting. The overall studies of bovine brucellosis in Ethiopia range from 1.1% to 22.6% and 0.05% to 15.2% in indoor and outdoor management systems respectively (Hussen and Alemu, 2020).

Table 2: Status of Bovine brucellosis in different parts of Ethiopia

Study areas	Animal tested (Prevalence)	Type of test	Authors
Jimma zone	813 (0.61%)	RBPT, SAT	Tolosa*et al*., 2007
Tigray	951 (1.49%)	RBPT, SAT	Berhe*et al*., 2007
Bahr Dar	944 (4.63%)	RBPT, SAT	Hadush and Pal, 2013
Centeral Oromia	238(2.99%)	RBPT, SAT	Jergefa*et al*., 2009
AA &Suluta	501 (1.3%)	RBPT, SAT	Tesfaye*et al*., 2009
Tigray	968 (4.9%)	RBPT, SAT	Haileselassie*et al*., 2010
East Shewa	106 (11.5%)	RBPT	Dinka and Chala, 2009.
Sidama zone	627 (1.66%)	RBPT, SAT	Asmare*et al*., 2010
Jijjiga	435 (1.38%)	RBPT, SAT	Degefa*et al*., 2011
South & East Eth	623 (3.5%)	RBPT, SAT	Asmare*et al*., 2013
Alage district	804 (2.4%)	RBPT, ELIZA	Asgedom*et al*., 2016
Central highland	352 (1.2%)	RBPT	Temesgen*et al*., 2021
Debrebirhan and Ambo	415 (0.7%)	RBPT, CFT	Bashitu*et al*., 2015

2.5. Pathogenesis

Brucella survives and replicate within different host cells which explains its ability to cause infection. Pathogenesis of the organism depends upon various factors such as the species, size of the inoculum, modes of transmission and the immune status of the host. Extensive replication in placental trophoblasts is associated with abortion, and persistence in macrophages and other cell types leads to chronic infections (Muflihanah *et al*., 2013).

Brucella species cross mucous membranes, then spread to regional lymph nodes and proliferate within macrophages, (Cosford, 2018) where they evade macrophage-induced defense mechanisms. Hematogenous spread of Brucella spp to other tissues follows, with a marked tropism for the gravid uterus and placenta. Tropism for placental trophoblasts is thought to be secondary to high concentrations of erythritol, which can be metabolized by Brucella spp as a source of carbon and energy. Brucella spp can travel throughout the body, including tissues of the reticuloendothelial system (lymph nodes and spleen), mammary gland, reproductive tract, and musculoskeletal system (bone and synovial structures) and have a tendency to settle in areas of end arterial circulation (eye, kidney, meninges, and intervertebral disc). The intracellular persistence of Brucella spp facilitates evasion of the innate and adaptive host immune system and reduces exposure to antimicrobials, making treatment challenging in all host species (Davidson and Sykes, 2022).

2.6. Clinical manifestations of Brucellosis

2.6.1. Clinical manifestations in animals

The most common clinical manifestation of brucellosis in animals is abortion. In female animal, it manifests itself as abortion, neonatal weakness, retention of the placenta, endometritis and, rarely, mastitis, decreased milk yield, and decreased fertility. In male animal it causesorchitis, epididymitis and subsequent infertility. This disease has no pathognomonic lesions leathery placenta and the changes that can be observed are necrotizing placentitis, palpable testicular alterations, necrotizing orchitis and epididymitis with subsequent granuloma, necrotizing seminal vesiculitis and prostatitis. On post mortem examination, some aborted fetuses may have an excess of blood-stained fluids in the body cavities, with enlarged spleen and liver. Others appear normal. Infected fetal membranes show changes affecting part or all of the membrane. The necrotic cotyledons lose their blood-red appearance becoming thickened and dull-grey in color. In the chronic stage of the disease, the epididymis can be increased in size up to four or fivefold (Olsen and Tatum, 2016; Toby Pin-Wood cock*et al*., 2023).

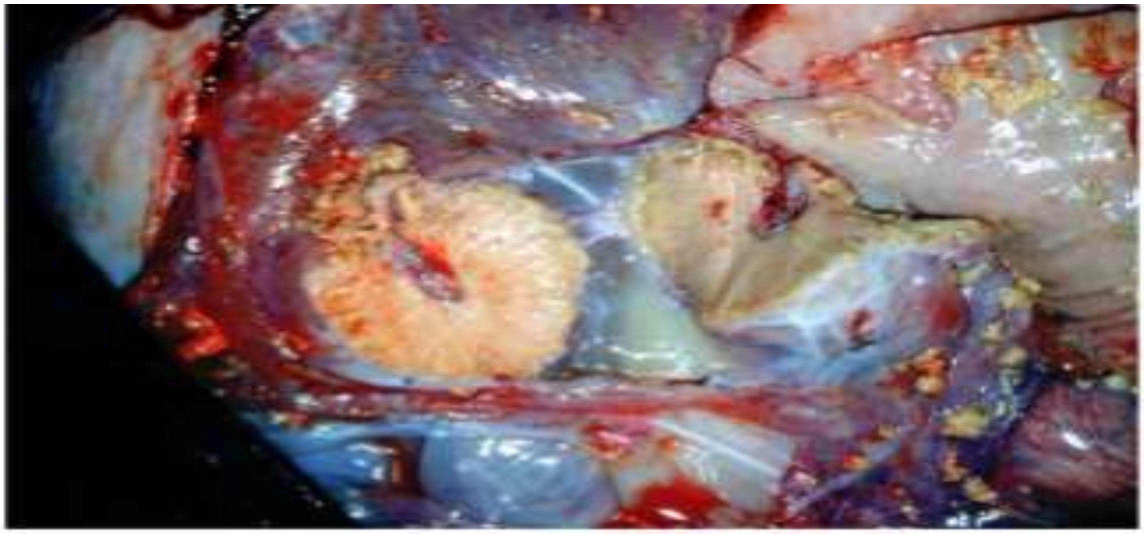

Figure 2: Uterus of cow infected with Brucella abortus

2.6.2. Clinical manifestations in humans

Brucellosis, a food borne zoonosis has caused considerable morbidity in humans in many parts of the world with major impacts on young children and elderly people. The two species, *B. melitensis* and *B. suis* have been reported to be more virulent in humans. Human brucellosis is characterized by a variable incubation period (from several days up to several months), and clinical signs include symptoms of continued, intermittent or irregular fever of variable duration, with headaches, weakness, profuse sweating, chills, depression and weight loss. Localized suppurative infections may also occur. Abortion has also happened during the early trimesters of pregnancy. In the chronic form, it may result in serious complications in which the musculoskeletal, cardiovascular and central nervous systems are affected (Mustefaand Bedore, 2019).

2.7. Diagnosis of Brucellosis

Both in humans and animals, clinically diagnosing of brucellosis is not easily achieved because of the presence of other diseases which have similar clinical signs. Even if clinical history and information about the patient give some clue in humans case, laboratory tests such as screening tests and confirmatory tests are very important tools for a correct identification of the disease in humans and for the detection and confirmation in animals; this enables to take strategic measures for controlling and prevention of brucellosis both in animals and humans accordingly (Poester*et al*., 2010).

A precise diagnosis of brucellosis is important for the control of the disease in animals and consequently in human. Clinical diagnosis is based usually on the history of reproductive failures in livestock, but it is a presumptive diagnosis that must be confirmed by laboratory methods. Brucella is intracellular pathogens in cells of the immune system and therefore it is difficult to diagnose and treat. The definitive diagnosis requires the isolation of the organism from the patient, but is restricted by the fact that Brucella spp. are slow growing intracellular pathogens, the successful culture of which from blood decreases as the disease progresses. The previous use of antibiotics also adds to the difficulty of culturing the bacillus. As such, successful diagnosis necessitates a careful selection of the best suitable culture method and validation of its performance. The sensitivity of culturing Brucella spp. from blood varies from 15% to 70% as assessed in reference to clinical evidence of infection and positive serological results depending on the study and culture method used (Alişkan, 2008).

The diagnosis of brucellosis is confirmed by isolation and identification of the causative organism. However this approach is time-consuming, and the specific tests needed to characterize the bacteria. In order to be able to screen a large number of animals, the diagnostic tests should be 'inexpensive, easy to perform, rapid, highly sensitive and fairly specific'. Several serological tests have been designed to meet these requirements. Molecular characterization techniques are also very useful tools for differentiating Brucella spp. especially follow-up testing of unusual phenotypic results of Brucella isolates. The use of molecular methods in Brucella endemic areas needs to be explored before they can be applied in these areas to diagnose brucellosis (Ashenafi*et al*., 2016).

2.8. Treatments of Brucellosis

The treatment of brucellosis in animals is not effective, and infected animals should be isolated to prevent further transmission. If feasible, infected animals should be destroyed and properly disposed of. However, multi-drug regimens could be tried. Treatment failure and relapse rates can be high and depend on the drug combination and compliance. Despite several studies on the use of antibiotics for the management of brucellosis, no conclusive evidence supporting an optimal strategy for antimicrobial therapy has been reported. The treatment for acute brucellosis recommended by the world health organization is oral doxycycline (100 mg twice a day) and oral rifampin (600 to 900 mg/d) for 6 weeks, but this regimen is not to be followed in cases complicated by spondylitis and tuberculosis due to the possibility of resistant Mycobacterium tuberculosis. Rifampin mono-therapy is the primary choice for treating brucellosis during pregnancy and a combination of sulphamethoxazole and trimethoprim is used to treat brucellosis in children (Krishna *et al*., 2016)

2.9. Control and Prevention

It depends on animal species involved, B. Species, management practices and availability and efficacy of vaccines. The options to control the disease include immunization, testing and removal, and improving management practices and movement control. The most effective prevention strategy is the elimination of infection in animals. Vaccination of animals is recommended in enzootic areas with high prevalence rates. In countries where eradication in animals through vaccination or elimination of infected animals is not feasible, prevention of human infection is primarily based on raising awareness, food safety measures, occupational hygiene and laboratory safety. Human brucellosis is best prevented by controlling the infection in animal population. Pasteurization of milk from infected animals was an important way to reduce infection in humans (Mustefa andBedore, 2019; Ukwueze*et al*., 2022).
Surveillance programis essential to reducethe infection in the animal populations and to reduce the effect of the disease on animal health and production, thus minimizing its impact on human health. An effective control of animal brucellosis requires surveillance to identify infected animal herds, prevention of transmission to non-infected animal herds, and eradication of the reservoir to eliminate the sources of infection in order to protect vulnerable animals or herds coupled with measures to prevent re-introduction of the disease (Gwida*et al*., 2010). A very important approach to the control of brucellosis that is gaining more and more recognition around the world in recent years is the one health approach to control and prevent human and animal brucellosis requires multidiscipline efforts since neither veterinarian alone nor physician alone couldn't perform all approaches of control. So it requires the participation of other discipline and farmers for effective control especially in developing countries where most people are live closer to animals (Mustefa and Bedore, 2019).

Avoiding treatment of infected animals due to the risk of bacterial persistence following treatment and potential negative impact of resurgence on international trade, food safety, and public health. Instead, infected livestock are culled. The prevention of B abortus within herds involves the use of an approved vaccine and targeted biosecurity, such as serologic screening of new stock, prevention of contact with wildlife reservoirs, infected herds or those of unknown brucellosis status, performing diagnostic investigations following abortions, proper disposal of placentas and nonviable fetuses through burial or burning, and disinfection of contaminated areas (Ukwueze*et al*., 2022).

2.10. Significance of Brucellosis

2.10.1. Public Health Significance of Bovine Brucellosis

Bovine brucellosis remains one of the most common zoonotic diseases worldwide with more than 50,000 human cases reported annually (Gwida*et al*, 2010). The public health effects of brucellosis as zoonosis has ever increased gradually, due to the expansion of international trade in animals and animal products, with increase urbanization, intensive farms and animal products, having nomadic animal husbandry (Bayleyegn, 2007). The cases of brucellosis are increasing in many developing countries due to various sanitary, socioeconomic status, and political factors (Pappas *et al*., 2006).

Transmission of brucellosis to humans occurs mainly through the consumption of unpasteurized dairy products especially raw milk, soft cheese, butter, and ice cream, through direct contact with infected animal parts, and through the inhalation of infected aerosolized particles. However, consumption of hard cheese, yogurt, and sour milk are less hazardous, since both propionic and lactic fermentation takes place. Bacterial load in animal muscle tissues is low, but consumption of undercooked traditional delicacies such as liver and spleen has been implicated in human infection (Radostits *et al*., 2000).

A natural reservoir of the agent and the source of infection in humans are infected domestic animals, mainly cattle, sheep, goats and swine. Also, dogs, especially shepherd dogs, and wild animals: hares, wild rabbits, roe deer and foxes may play some role as reservoirs and spreaders of the germs. Among humans, the highest exposure is observed among: veterinary doctors, veterinary technicians, insemination service employees, zoo technicians, farmers working on multi-herd farms (production cooperatives), e.g. cattlemen, also private farmers, employees of meat processing enterprises and the fodder processing company(Elżbieta and Jerzy, 2013). It was estimated that release of an aerosolized form of Brucella under optimal circumstances for dispersion would cause 82,500 cases of brucellosis and 413 fatalities. Cases of laboratory-acquired brucellosis are the perfect examples of airborne spreading of the disease. Most common symptoms of brucellosis include undulant fever in which the temperature can vary from $37^{C}0$ in the morning to 400^{C} in the afternoon; night sweats with peculiar odor, chills and weakness, insomnia, anorexia, headache, arthralgia, constipation, sexual impotence, nervousness and depression. Human brucellosis is also known for complications and involvement of internal organs and its symptoms can be very diverse depending on the site of infection and include encephalitis, meningitis, spondylitis, arthritis, endocarditis, orchitis, and prostatitis. Spontaneous abortions, mostly in the first and second trimesters of pregnancy, are seen in pregnant women infected with Brucella (Ashenafi*et al*., 2016).

2.10.2. Economic significance of Bovine Brucellosis

Bovine Brucellosis is consistently ranked among the most economically important zoonoses globally (Rubach*et al*., 2013).The economic impact of brucellosis varies by geography and livestock production system and could be rightly referred to as multiple burdens with significant economic implications on humans, livestock and wildlife. In middle-income countries like Ethiopia, the brucellosis is much more variable as they tend to report the greatest number of outbreaks and animal losses with its attendant economic cost. The disease is endemic and neglected, with large disease and livelihood burdens in animals and people, and almost no effective control. Not surprisingly, most of these countries have less public investment in veterinary and health services, weaker surveillance and operational capacity. Endemicity of brucellosis in low-income countries of sub-Saharan Africa and South Asia has multiple economic implications across agriculture and public health, and broader implications on economic and social development sectors (Ukwueze*et al*., 2022).

Estimating the economic impact of brucellosis includes, cost of illness in livestock (medication treatment cost, loss of production), cost of prevention (vaccination, livestock sector treatment, herd slaughter, market loss due to risk of infected meat and milk, mortality, morbidity, lower production, loss of exports increased bio- security),opportunity costs (loss of animal genetic resources, loss of opportunities occasioned by spending on disease prevention and cure), and cost of illness in human (cost of drugs, patient out of pocket treatment expenses, and loss of work or income due to illness). Brucella infection in pregnant cows can cause abortion or premature calving. Furthermore, brucella infection can lead to temporary sterility, death from acute metritis and decreased milk production. (Georgios*et al*.,2005).

The disease causes heavy economic losses in livestock producers. The economic losses arises from abortion, reduced milk production, losses of calves due to abortion and still birth, culling of infected cows, hindering animal export trade of a nation, losses of man-hours, medical costs and government costs incurred for research and eradication program. Although estimates of the costs associated with brucellosis infections remain limited to specific countries, all data suggest that worldwide economic losses due to brucellosis are extensive not only in animal production, but also in public health (cost of treatment and productivity loss) (Georgios*et al*.,2005).

2.11. Control of Brucellosis Through One Health Approach.

Ethiopia is one of the sub-Saharan African countries, with the largest animal and second largest human population. Livestock are the major sources of income and security for a significant segment of the population, and the system of animal production is by and large of an extensive type. Brucellosis creates a serious economic problem for the intensive and extensive livestock production systems. Losses in animal production due to this disease can be of major importance primarily because of 20% decreased milk production in aborting cows. The common sequel of infertility increases the period between lactations. The average inter calving period of an infected herd prolonged by several months (Gemechu, 2017).

Currentlya very important approach to control zoonotic diseases like brucellosis which gaining more and more recognition around the world in recent years is the One Health approach to control and prevent human and animal brucellosis requires multidiscipline efforts since neither veterinarian alone nor physician alone couldn't perform all approaches of control. So it requires participation of other discipline and farmers for effective control especial in developing countries where most people are live closer to animals. In the One Health framework veterinary, medical, environmental and allied professionals and experts collaborate together with the aim of identifying possible risk factors for this infection and design a suitable approach to combatting the infection. Unfortunately, in many underdeveloped and developing countries, this kind of collaboration is non-existent or weak which gives room for brucellosis to thrive unchecked especially in rural populations. y to control it. In Ethiopia at regional levels, no strategy is in place to control brucellosis (Beruktayetand Mersha, 2016).

3. CONCLUSION AND RECOMMENDATION

Bovine Brucellosis is a much known livestock and zoonotic diseases worldwide and has a high prevalence rate in different parts of developing countries like Ethiopia. It affects both animals and humans, has a very high economic and public health impact. Its impact on public health is very well related to the infected animal species from which human transmission occurs. Bovine brucellosis is asymptomatic in young and pregnant animals. The disease is transmitted from infected animals to human beings through several routes and it is a special hazard to occupational groups like veterinarian, abattoir worker and artificial insemination. It causes considerable losses in animals as a result of abortion and a reduction in milk yield. Existence of the disease in a population is detected by identification and isolation on culture, serological tests and PCR based molecular tests. The worldwide economic losses due to brucellosis are extensive not only in animal production but also in human health, but surveillance and control measures are not instituted adequately. Based on the above conclusion the following recommendations are forwarded.

- ✓ Efforts should be made by the government and the other concerned parties to raise awareness of the disease and its impact on public health.
- ✓ Regular surveillance is necessary as it is one of the important steps in preventive and control measures.
- ✓ Extensive research on the epidemiology and public health impacts of bovine brucellosis should be undertaken continuously.
- ✓ Vaccination of the animals in endemic area should be strengthened by veterinary and Para veterinary services.
- ✓ The government, public health officers and veterinarians have to work together to reduce the economic and zoonotic impact of the disease.

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