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Review of Cattle Brucellosis in Ethiopia

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Abstract: Brucellosis is an infectious bacterial zoonotic disease caused by member of the genus Brucella. The disease affects both animals and human beings resulting in a serious economic loss in animal production sector and deterioration of public health. Cattle brucellosis has significant economic and zoonotic implication for the rural communities in Ethiopia in consequence of their traditional life styles, feeding habits and disease patterns. Hence, knowledge of brucellosis occurrence in traditional livestock husbandry practice has considerable importance in reducing the economic and public health impacts of the disease. The possible sources of infections include all infected tissues, aborted fetus, vaginal discharges, cultures and potentially contaminated materials. The nature aspects of the pathogenesis of the diseases lie on the presence of the bacteria in the cells and employing various methods to survive in the phagocytic cells. The disease can be transmitted from infected host to susceptible animals in direct and indirect contacts. But the most common mode of transmission is sexual contact. Various methods are employed for the diagnosis of brucellosis including microscopic examination, culture methods, serological and molecular biology. Public health importance of brucellosis is much related to the infected animal species from which human transmission occurs. The economic importance of brucellosis depends up on the species of animal affected. It can cause considerable losses in cattle as a result of abortion and reduction in milk yield. The most rational approach for control of *B. abortus* infection is by vaccinating young female animals. To deal with diseases like brucellosis, the public in general and high risk groups in particular should be made aware of the zoonotic and economic importance of brucellosis through veterinary extension education.

Key words: Brucellosis · Ethiopia · Complement Fixation Test · Rose Bengal Test · Sero- Prevalence · Public Health Significance

INTRODUCTION

Ethiopia has one of the largest livestock resources in Africa, with a total cattle population of 47.6 million [1]. Livestock contributes more than 30% of the agricultural gross domestic product and 19% in export earnings. Oxen provide draught power to cultivate grain crops in rural agriculture, which is the backbone of the economy. The comparatively huge livestock resources of the country and the economic return gained from this subsector do not coincide, because of prevalent infectious diseases, among other factors. Bovine brucellosis is one of these infectious diseases and has been reported from several parts of the country [2].

Brucellosis is one of the oldest and most widespread zoonotic diseases, affecting food production in the tropics and subtropics [3]. It is an economically important disease of livestock causing reproductive wastage through infertility, delayed heat, loss of calves, reduced meat and milk production, culling and economic losses from international trade bans [3].

Bovine brucellosis is mainly caused by *Brucella abortus*; to a lesser extent by *B. melitensis* and occasionally by *B. suis*. Clinically, it is characterized by abortion and retained fetal membrane (RFM) in cows and orchitis and epididymitis in bulls [4]. Sources of infection include aborted fetuses, fetal membranes, vaginal discharges and milk from infected cows. The most common route of transmission in cattle is through direct contact with an aborting cow and the aborted fetus or by indirect contact with contaminated fomites. Ingestion of contaminated pasture, feed, fodder and water may also play a secondary role [5].

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Although the disease has been eradicated from most of the developed countries, it is still a major public and animal health problem in many developing countries, where livestock are a major source of food and income [6]. The incidence of human brucellosis is correlated with the level of incidence in domestic animals [5]. Human cases occur after ingesting raw milk and milk products and coming into close contact with infected animals. Human brucellosis can be a very debilitating disease, although the case fatality rate is generally low [6].

Objectives:

- To review cattle brucellosis in Ethiopia
- To review the zoonotic importance of brucellosis
- To summarize the prevalence of brucellosis in cattle population in Ethiopia

Epidemiology

The Causative Agent: *Brucella abortus* is the causative organism for bovine brucellosis. *Brucella abortus* is mainly infective for cattle, but occasionally other species of animals such as sheep, swine, dogs and horses may be infected. Cattle can be also become infected by *B.suis* and *B.melitensis* when they share pasture or facilities with infected pigs, goats, or sheep. The infections in cattle caused by heterologous species of Brucella are usually more transient than that caused by *B. abortus* [7].

Occurrence and Prevalence: The endemic of bovine brucellosis in Ethiopia has been gradually established over the last two decades by various researchers [8-13]. Using past reports and investigations, a summary of bovine brucellosis seroprevalence was produced in Ethiopia, thereby bringing the disease into a sharper focus [14]. A survey of 226 animals in Gobe ranch showed 16.81% of the animals to be infected with brucellosis [8]. A study carried out in the Abernosa Ranch showed that, out of the 963 animals that had been tested for brucellosis 137 (14.2%) were infected [15]. A study around Sidamo Region of Ethiopia found 11.6% reactors in cattle [9]. A seroprevalence rate of 38.7% (57/147) was found at Bako Research Center, Western Ethiopia [12]. A crude seroprevalence rate of 16.9% was found in and around Bahir Dar and Abay[12]. Thus, the disease appears to be widespread in both indigenous and exotic crosses of cattle in the country.

Source of Infection and Transmission: Brucellosis occurs worldwide in domestic and game animals and it is one of the major drug neglected disease [16]. It creates a serious economic problem for the intensive and extensive animal production system of the tropics. Its occurrence is increasing in developing countries in an aggravating manner, which depends on the policy of many developing countries of importing exotic high production breeds without having the required veterinary infrastructure and the appropriate level of development of socioeconomic situation of the animal holder [17]. Furthermore, the increasing towards intensification of animal production favors the spread and transmission of the infection [16]. Susceptibility to infection depends on age, breed and pregnancy status. Younger animals are relatively resistant. Sexually mature animals are much more susceptible to infection, regardless of gender [18]. The main sources of infection for cattle are fetuses, fetal fluids and vaginal discharges. Transmission through gastrointestinal tract is also common following ingestion of contaminated pasture, feed, fodder or water. Moreover, cows customarily lick fetuses and new born calves; all of which may contain a large number of organisms and constitute a very important source of infection [5].

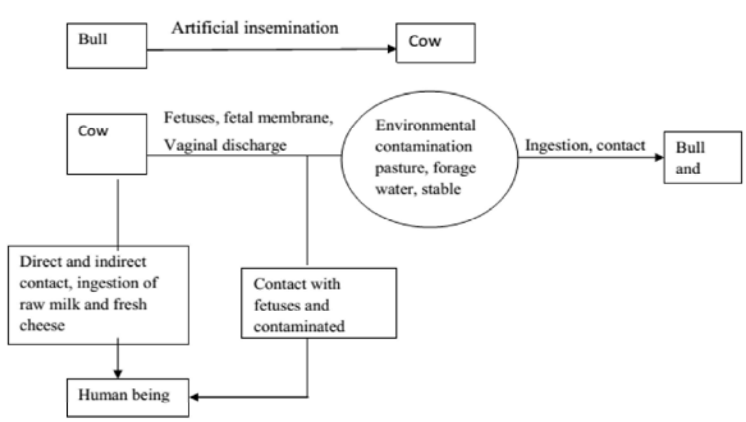

Fig. 1: Mode of transmission of bovine brucellosis (*B. abortus*).
Source: [4].

Characteristics of the Animal and Herd: Younger animals are more resistant to infection and frequently clear infections, although latent infections do occur. Only 2.6% of animals infected at birth remain infected as adults. Sexually mature animals are much more susceptible to infection, regardless of gender. Most animals infected as adults remain infected for life. Herd size and animal density are directly related to prevalence of disease and difficulty in controlling infection in a population. Calving practices also play a major role in the spread of brucellosis. Separate calving pens allow for minimizing exposure of uninfected animals. Whether a herd raises its own replacement animals or purchases replacement animals affects the potential for introduction in to the heard [19].

Possible Risk Factors

Animal Risk Factors: Susceptibility of cattle to *B.abortus* infection is influenced by the age, sex and reproductive status of the individual animal. Sexually mature pregnant cattle are more susceptible to infection with the organism than sexually immature cattle of either sex. Susceptibility increases as stage of gestation increases [20].

Pathogen Risk Factors: *Brucella abortus* is a facultative intracellular organism capable of multiplication and survival within the host phagosome. The organisms are phagocytized by polymorpho nuclear leucocytes in which some survive and multiply. The organism is able to survive with in macrophages because; it has the ability to survive phagolysosome. The bacterium possesses an unconventional non- endotoxin lipopolysacharide which confers resistance to antimicrobial attacks and modulates the host immune response. These properties make lipopolysacharide an important virulence factor for brucella survival and replication [20].

Occupational Risk Factors: Laboratory workers handling Brucella cultures are at high risk of acquiring brucellosis through accidents, aerosolizing and/or inadequate laboratory procedures. In addition to this, abattoir workers, farmers and veterinarians are at high risk of acquiring the infection [21].

Management Risk Factors: The spread of the disease from one herd to the other and from one area to another is almost always due to the movement of an infected animal from infected herd in to a non-infected susceptible herd [20].

Public Health Significance: The most pathogenic and invasive species for human are, *B.melitensis*, B. *abortus* and *B. canis*. Human Brucellosis caused by *B. melitensis* is the most severe one followed by B. *suis,* B. *abortus* and *B. canis* in their decreasing order. An outbreak of brucellosis would be difficult to detect because the initial symptoms are easily confused with those of influenza [22].

Impact of Brucellosis on Cattle Production: In infected cattle populations brucellosis is might lead to a lower calving rate due to temporary infertility and/or abortion, resulting in a decreased milk production cows, increased replacement costs as well as lowered sale value of infected cows. General economic losses, however, go far beyond the financial losses suffered by cattle producers alone. Not only cattle but also other species might be affected by brucellosis, including humans [23].

Economic Losses of Brucellosis:

- Losses due to abortion in the affected animal population
- Diminished milk production, Brucella mastitis and contamination of milk
- Cull and condemnation of infected animals due to breeding failure
- Endangering animal export trade of a nation
- Human brucellosis causing reduced work capacity through sickness of the affected people
- Government costs on research and eradication schemes;
- Losses of financial investments

Pathogenesis: *B. abortus* has predilection in the pregnant uterus, udder, testicle and accessory male sex glands, lymph nodes, joint capsule and bursa. After initial invasion of the body, localization occurs initially in the lymph nodes. *B.abortus* phagocytized by macrophages and neutrophils in an effort by the host to eliminate the organism. However, once inside phagocyte, B. *abortus* is able to survive and replicate. The phagocyte migrates via the lymphatic system to the draining lymph nodes where brucella infection causes cell lysis' and eventual lymph node hemorrhage following exposure [24]. Because of vascular injury some of the bacteria enter to the blood stream and subsequent bacteremia occurs, which disseminates the pathogen throughout the body. If the infected animals are pregnant, B. *abortus* will colonize and replicate in high number in the chorionic trophoblast of the developing fetus. The resulting tissue necrosis of the fetal membrane follows transmission of bacteria to the fetus. The net effect of chorionic and fetal colonization is abortion during the last trimester of pregnancy [20]. Sexually immature and other non pregnant cattle can become infected but lose their hormonal antibody. In adult non pregnant cow, localization occurs in udder and uterus, if it becomes gravid, infected bacteremic phases originated in the udder. Infected udders are clinically normal but they are important as a source of infection for calves and humans drinking the milk. Erythritol that produced by the fetus stimulates the growth of B. *abortus* and stimulates localization of infection in the placenta and fetal fluids. Invasion of the gravid uterus results severe ulcerative endometritis. In acute infection of pregnant cows, up to 85% of the bacteria are in cotyledons, placental membranes and allantoic fluid. In fetus naturally and experimentally infected with B. *abortus*, the tissues changes include lymphoid hyperplasia in multiple lymph nodes, lymphoid depletion in thymic cortex, adrenal cortical hyperplasia and disseminated inflammatory foci composed mainly of large mononuclear leucocytes. Abortion in cattle usually occurs in the last three months of pregnancy [24].

Clinical Signs

Clinical Signs in Animals: In highly susceptible non-vaccinated pregnant cow, abortion occurs after the 5 months of pregnancy; in bull orchitis and epididymitis are cardinal signs [25].

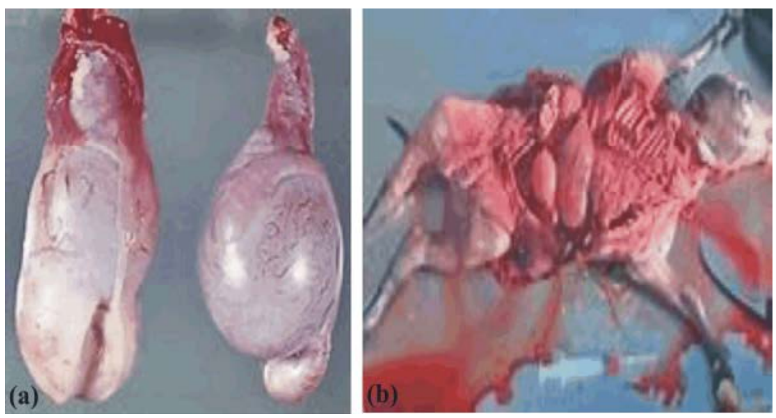

Fig. 2: Epididymitis in Bulls (a) and abortion in a cow (b) Source: [24].

Symptoms of Human Brucellosis: The most common symptoms of brucellosis include undulant fever in which the temperature can vary from 37.8°C in the morning to 40°C in the afternoon; night sweets with peculiar odder and weakness. Common symptoms also include insomnia, anorexia, headache, constipation, sexual impotence, nervousness, encephalitis, spondylitis, arthritis, endocarditis, orchitis and depression. Spontaneous abortion mostly in the first and second trimesters of pregnancy, are seen in pregnant women infected with Brucella. Lack of appropriate therapy during the acute phases may result in localization of Brucella in various tissues and organs and lead to sub acute or chronic disease which is very hard to treat [26].

Diagnosis: The diagnosis of brucellosis always requires laboratory confirmation. It is made possible by direct demonstration of the causal organism using staining, immunofluorescent antibody, culture and directly demonstration of antibodies using serological techniques [27].

Microscopic Examination and Culture Methods: Specimen of fetal stomach, lung, liver, placenta, cotyledon and vaginal discharges are stained with Gram stain and modified Ziehl Nelson stains. Brucella appears as small red-colored, coccobacili in clumps. Blood or bone marrow samples can be taken cultured in 5-10% blood agar is used. To check up bacterial and fungal contamination; Brucella selective media are often used. The selective media are nutritive media, blood agar based with 5% sero negative equine or bovine serum. On primary isolation it usually requires the addition of 5-10% carbon dioxide and takes 3-5 days incubation at 37°C for visible colonies to appear [28].

Animal Inoculation: Lab animals such as guinea pigs are intramuscularly inoculated 0.5-1ml of suspected tissue homogenate and sacrificed at three and six weeks post inoculation and serum is taken along with spleen and other abnormal tissue for serology and bacteriological examination [27].

Serological Examination: Body fluids such as serum, uterine discharge, vaginal mucus and milk or semen plasma from suspected cattle may contain different quantities of antibodies of the IgM, IgG1, IgG2 and IgA types directed against Brucella [28].

Milk Ring Test: It is cheap, easy, simple and quick to perform. It detects lacteal anti-Brucella IgM and fat globules from milk and form red ring in positive case. However, it tests false positive when milk that contains colostrums, milk at the end of the lactation period, milk from cows suffering from abnormal disorder or mastitis. Milk that contain low concentration of lacteal IgM, IgA or lack the fat clustering factors, tests false negative. Because lacteal antibodies rapidly decline after abortion or parturition, the reliability of milk ring test using 1ml milk to detect Brucella antibodies in individual cattle or intact milk is strongly reduced [29]. Although the milk ring test performed with 8ml milk, it improved the detection of brucellosis in tank milk. It may test false positive when races of colostrums are present in tank milk [30].

Rose Bengal Plate Test (RBPT): It is a spot agglutination technique. It does need special laboratory facilities and is simple and easy to perform. It used to screen sera for Brucella antibodies. The test detects specific antibodies of the IgM and IgG type. Although the low PH (3.6) of the antigen enhances the specificity of the test and temperature of the antigen and the ambient temperature at which the reaction takes place may influence the sensitivity and specificity of the test [31].

Complement Fixation Test (CFT): The CFT test is highly specific but it requires highly trained personnel as well as suitable laboratory facilities. It measures more antibodies of the IgG1 type than antibodies of the IgM type [29].

The CFT is widely used and accepted as a confirmatory test although it is complex to perform, requiring good laboratory facilities and adequately trained staff to accurately titrate and maintain the reagents. There are numerous variations of the CFT in use, but this test is most conveniently carried out in a microtiter format. Either warm or cold fixation may be used for the incubation of serum, antigen and complement: either 37°C for 30 minutes or 4°C for 14–18 hours. A number of factors affect the choice of the method: anti- complementary activity in serum samples of poor quality is more evident with cold fixation, while fixation at 37°C increases the frequency and intensity of prozones and a number of dilutions must be tested for each sample [32].

ELISA test: It is a test which offers excellent sensitivity and specificity with a minimum of equipment and sources in kit form. Is more suitable than the complement fixation test for use in smaller laboratories and now it is used for the diagnosis of wide range of animal and human diseases [25].

Differential Diagnosis: There are many potential causes of abortion in cattle. Endemic infectious causes of abortion include viral diseases such as infectious bovine rhinotracheitis and mucosal disease; and infections with other organisms such as Trichomonas foetus, Neospora caninum, Campylobacter foetus, Listeria monocytogenes, Sarcosporidia, various Leptospira species and fungi. Exotic viral disease causing abortions include Rift Valley fever [33].

Postmortem Findings

Gross Findings: In cows, the main sites of infection are the endometrium of the uterus and the foetal placenta. The uterus appears normal externally but the endometrium is invariably infected. The inter cotyledonary areas of the placenta are generally thickened with yellow gelatinized fluid and may be ulcerated, appear like leather and have mucoid or fibrino-purulent deposits on the surface. Placental cotyledons are hyperemic and may have areas of yellow–grey necrosis and be covered with a sticky brown exudates [34].

The uterus of infected cows are characterized by brownish Fluid, with exudate consistent with a necrotizing placentitis and the uterus can also show fibrinous necrotic exudates and multifocal haemorrhages [35].

The foetus is usually swollen, with blood-tinged fluid found subcutaneously and in the body cavities; the umbilical cord may be thickened and swollen. The most important lesion is a catarrhal or fibrinous pneumonia [33].

Other lesions include fibrinous pleuritis and peritonitis, bronchopneumonia and splenitis [36]. Fibrinous pericarditis has been described as a significant fetal lesion in brucellosis [34].

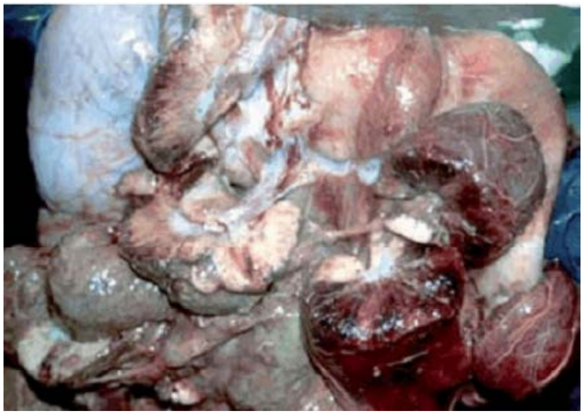

Fig. 3: Uterus from a *Brucella abortus*-infected cow immediately after abortion.
Several necrotic and hemorrhagic placentomes, characterizing a severe and diffuse fibrinous–necrotizing and hemorrhagic acute placentitis. Source: [33].

Fig. 4: *Brucella abortus*-infected aborted fetus with an acute diffuse severe fibrinous pleuritis
Source: [33].

In Bulls, *B. abortus* causes infection and swelling of the testicles that may not be obvious, but increasing pressure results in necrotic foci that grow and coalesce and may lead to total testicular necrosis with sequestration by inflammatory thickening of the tunica. *B. abortus* may also infect the accessory sex glands. Brucellae in cattle may localize in the carpal and other bursae, where hygromas containing large numbers of bacteria may be found [33].

Microscopic Findings: In Cows, when examined microscopically, the membranes and cotyledons contain many mononuclear cells with some neutrophils and the chorionic epithelial cells are packed with the bacteria. An abnormally firm attachment of the chorionic villi of the placenta results from necrosis and enlargement of the maternal villi and the presence of inflammatory exudates [33].

Necrotic neutrophilic placentitis with perivascular infiltrates is the most frequent microscopic change in experimentally infected cows and inflammation is associated with large numbers of *B. abortus* cells inside macrophages and trophoblasts [34].

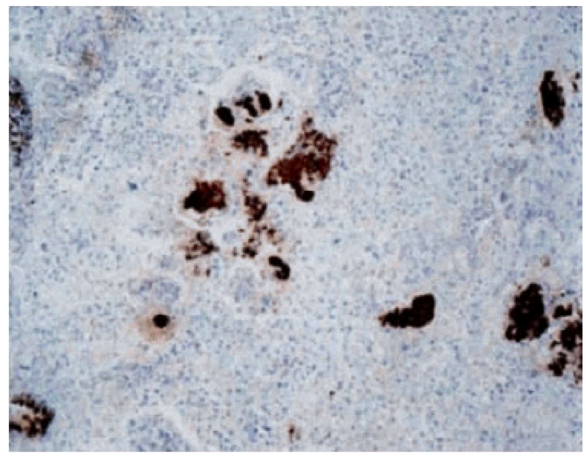

Fig. 5: Bovine placenta from a *Brucella abortus*-infected cow.
Immunolabelling of several colonies of B. abortus with a multifocal distribution. Streptavidin–biotin–peroxidase complex.
Source: [33].

Microscopic examination of the foetal lungs shows scattered foci of bronchitis and bronchopneumonia [33].

Treatment: Brucellosis is one of the drug neglected disease and treatment of brucellosis in domestic animals is not indicated, but if necessary the treatment often given are sulphadiazine, streptomycin, chlortetracycline and chloramphenicol. Humans are usually treated with antibiotics such as, doxycycline and rifampicine [37].

The combination doxycycline and an aminoglycoside (gentamicin, streptomycin, or netlimicin) for 4 weeks followed by the combination of doxycycline and rifampcin for 4 to 8 weekdays is the most effective regimen [38].The doxycycline /aminoglycoside combination is more effective than the doxycycline/rifampin combination in that rifampin reduces levels of doxcycline in plasma [39].

Within 4 to 14 days after the initiation of therapy, patients become afebrile and constitutional symptoms disappear. The enlarged liver and spleen return to their normal size within 2 to 4 weeks. An acute, intense flare-up of symptoms may follow the start of treatment, especially with that of tetracyclines. This reaction is transient and does not necessitate the discontinuation of therapy [37].

Prevention and Control

In Animals: Prevention and control of brucellosis can be adopted realistically through understanding of local and regional variations in animal husbandry practices, social-customs, infrastructures and epidemiological patterns of the disease. The common approaches used to control brucellosis include, quarentine of imported stocks, hygienic disposal of aborted fetuses, fetal membrane and discharges with subsequent disinfection of contaminated area. Animals which are in advanced pregnancy should be kept in isolation until parturition [40]. Moreover replacement stock should be purchased from herd free of brucellosis and decide for or against immunization of negative animals. Eradication by test and slaughter of positive reactor is also possible [25].

In Humans: The most rational approach for preventing human brucellosis is control and eradication of the infection in animal reservoirs. In addition, there is a need to educate the farmers to take care in handling and disposing of aborted fetus, fetal membrane and discharges as well as not to drink unpasteurized milk and abattoir workers in transmission of infection especially via skin abrasion [5]. The drug recommended is rifampcin at dosage of 600-900 mg daily combined with doxicycline at 200 mg daily. Both drugs are given in the morning as a single dose and relapse is unusual after a course of treatment continued for at least 5 weeks [41].

Suggested Prevention and Control Strategies for Livestock Brucellosis in Ethiopia: As the source of human brucellosis is direct or indirect exposure to infected animals or their products, prevention must focus on various strategies that will mitigate infection risks. To our knowledge, there has been no national programme proposed for prevention and control of brucellosis in Ethiopia. Similarly at regional levels, no strategy is in place to control brucellosis. This is largely a result of lack of facilities and budget to run such a program. Moreover, many responsible bodies may not recognize the significance of brucellosis given the contradictory and sometimes low prevalence data. However, at this time, it is crucial to define geographical extent of the problem and then allocate resources and funds to initiate prevention and control strategies in this country [42].

Immunity

Humoral Immune Response: Naturally infected animals and those vaccinated as adults with strain 19 remain positive to the serum and other agglutination tests for long periods. The serum of infected cattle contains high levels of IgG1, IgG2, IgM and IgA isotypes of antibody [43]. Similar isotypes at different relative concentrations occur in milk, although most of the IgA is present in secretory form. The first isotype produced after an initial heavy infection or strain 19 immunization is IgM and is soon followed by IgG antibody. IgG1 immunoglobulin is the most abundant in serum and exceeds the concentration of IgG2. The magnitude and duration of the antibody response following immunization is directly related to the age at immunization and the number of organisms administered. Following immunization with a standard dose of strain 19 during calf hood, IgG antibody concentrations usually decline to diagnostically insignificant levels over 3-6 months. Residual antibody if present, is usually predominantly of the IgM class. Following exposure to virulent *B. abortus*, antibody may appear in 4-10 weeks or longer, depending on the size and route of entry of the inoculums and the stage of pregnancy of the animal. Antibodies of IgG, IgM, IgG1 and IgG_2 isotypes can all react in the tube agglutination test, but those of the IgM class are by far the most efficient [44, 45].

Cellular Immune Response: Brucella species are facultative intracellular pathogens. They are readily phagocytised by macrophages and polymorph nuclear leukocytes and, in the case of virulent strains, are capable of surviving within these cells and phagocytosis is promoted by antibody. However, since virulent Brucella can survive within normal macrophages for long periods, recovery from infection is likely to be dependent upon the acquisition of increased bactericidal activity by phagocytic cells. Macrophage activation occurs when T-lymphocytes of the appropriate subset are stimulated to release lymphokines (interleukins) [45, 46].

The release of these activating factors is dependent upon recognition of the appropriate antigen by the T- lymphocyte and is subject to regulation through the major histocompatibility complex. Live organisms capable of establishing persistent intracellular infection and certain types of antigen, with or without adjuvant, are the most effective inducers of cell-mediated immunity. The role of cytotoxic cells, including cytotoxic T-lymphocytes, natural killer (NK) and killer (K) cells, in the cell-mediated immune response to Brucella has not been elucidated.

Further studies are also needed to determine the basic processes underlying the development of protective immunity to Brucella in the natural host species [47, 48].

Vaccines

***Brucella abortus* S 19 Vaccine:** The most widely used vaccine for the prevention of brucellosis in cattle is the *Brucella abortus* S19 vaccine, which remains the reference vaccine to which any other vaccines are compared. It is used as a live vaccine and is normally given to female calves aged between 3 and 6 months as a single subcutaneous dose of 5–8 × 10^{10} viable organisms. A reduced dose of from 3 × 10^8 to 3 × 10^9 organisms can be administered subcutaneously to adult cattle, but some animals will develop persistent antibody titers and may abort and excrete the vaccine strain in the milk. Alternatively, it can be administered to cattle of any age as either one or two doses of 5 × 10^9 viable organisms, given by the conjunctival route; this produces protection without a persistent antibody response and reduces the risks of abortion and excretion in milk when vaccinating adult cattle [33].

Brucella abortus S19 vaccine induces good immunity to moderate challenge by virulent organisms. The vaccine must be prepared from USDA-derived seed and each batch must be checked for purity (absence of extraneous microorganisms), viability (live bacteria per dose) and smoothness (determination of dissociation phase). Seed lots for S19 vaccine production should be regularly tested for residual virulence and immunogenicity in mice [33].

***Brucella abortus* S RB51 Vaccine:** Since 1996, *B. abortus* strain RB51 has become the official vaccine for prevention of brucellosis in cattle in several countries. It has been reported that full doses of RB51 when administered intravenously in cattle induce severe placentitis and placental infection in most vaccinated cattle and that there is excretion in milk in a relevant number of vaccinated animals. Field experience also indicates that it can induce abortion in some cases if applied to pregnant cattle. Due to these observations, vaccination of pregnant cattle should be avoided. One way to reduce the side effects of RB51 is to reduce the dose. When using the reduced dose of this vaccine (1 × 10^9 colony-forming units [CFU]), on late pregnant cattle, no abortions or placentitis lesions are produced in subcutaneously vaccinated cattle, but the vaccine strain can be shed by a significant proportion of vaccinated animals. However, this reduced dose does not protect against *B. abortus* when used as a calf hood vaccination, but does protect when used as an adult vaccine [33].

It should be emphasized that RB51, as well as S19, can infect humans and cause undulant fever if not treated. There have been limited studies with RB51 in humans but it appears that the risk of developing undulant fever after exposure is low. The diagnosis of the infection produced by RB51 requires special tests not available in most hospitals. Physicians making decisions on prophylactic treatment for accidental exposure to RB51 should be informed that this vaccine strain is highly resistant to rifampicin, one of the antibiotics of choice for treating human brucellosis [33].

The Status of Brucellosis in Ethiopia: Ethiopia located in Eastern Africa, is predominantly an agrarian country with over 85% of its population engaged in agricultural activity. The country has diverse agro ecological zones, which have contributed to the evolution of different agricultural production systems. Animal husbandry forms an integral part of agricultural production in almost all ecological zones of the country [49].

Both husbandry systems as well as environmental conditions greatly influence the spread of brucella infection [50]. Ethiopia has several institutionally owned commercial dairy farms, mostly situated in and around Addis Ababa and in some regional towns. These farms have been the focus of most of Brucella surveys, potentially producing a bias in reported findings. These prevalence reports have been systematically reviewed as intensive and extensive management systems of various regions in Ethiopia.

Table 1: Prevalence of brucellosis in cattle in intensive management systems

S. No	Author	Year	Site	Prevalence%
1	Alem and Solomon	2002	Borena zone	50
2	Meyer	1980	IARWE	39
3	Tariku	1994	NEE	22
4	Bekele *et al.*	2000	SEE	11-15
5	Molla	1989	Arsi area	8.2
6	Haileselassie *et al.*	2010	Tigray region	7.7

Prevalence in Extensive Management System: According to the available data, Brucella sero prevalence with in extensive cattle rearing system is lower than that of intensive systems. As reported, In Jimma zone, the overall individual animal prevalence and herd prevalence are 0.77 and 2.9% respectively [51]. Recent reports from North West, Tigray region [52]. And Sothern Sidama zone [53], recorded an overall prevalence of 1.2 and 1.66% following screening 848 and 1627 cattle from extensive system respectively.

Table 2: Summary on the Prevalence of Brucellosis in Ethiopia

S. No	Author	Year	Site	Breed	Prevalence%
1	Gebretsadik	2005	Tigray	Cross	3.19
2	Mussie	2005	Bahirdar	Cross	0.26
3	Kassahun	2004	Bahirdar	Cross	2.5
4	Tadele	2004	Sidama zone	Local	1.7
5	Tadele	2004	Sidama zone	Cross	0.8
6	Mekonnen	2002	NEW	Local	0.2
7	Mekonnen	2002	NEW	Cross	22

(Source:Teshager *et al*., 2014).

The incidence of animal and human brucellosis in the last two decades has increased as rapidly as urbanization and improved transportation has concentrated herds that were traditionally small and dispersed. In many developing countries the problem is compounded by an absence of national surveillance programs, diagnostic facilities or reliable data [54].

In Ethiopia, in the past, information concerning the prevalence of brucellosis was lacking. In recent years, however, increasing demand to milk and milk products necessitated great attention to be given to dairy farms by both public and private sectors [55].

In Ethiopia, a number of works have been done on sero-prevalence of brucellosis in different parts of the country. However, the economic impact of the disease on animal productivity and production is not yet assessed. So far, only one study has been made at Caffa State farm, Wollo, from 1987 to 1993. The same paper indicated that there was an annual loss estimated to be 88,941.96 Ethiopian birr due to reduced milk production and abortions in the farm on 193 study animals [56]. Serological investigation on the prevalence of brucellosis in Ethiopia has been carried out in different part of the country for the last 24 years. Pioneer survey was done and a positive reaction of 39% out of 1010 cattle owned by the then Institute of Agricultural Research (IAR) was reported[57]. The survey conducted on prevalence of bovine brucellosis in four different farms around Addis Ababa showed that 18. 4% were positive reactors out of 178 tested animals[58]. The other survey conducted on sero-epidemiological prevalence of bovine brucellosis in Arsi region on 2178 animals showed that 7.62% were positive reactors [59]. In a study on bovine brucellosis in selected sites in Sidamo region indicated that out of 734 tested animals 15.8% were found to be positive reactors[53]. Generally speaking, the disease seems to be more prevalent in large improved herd than smaller indigenous herd [60]. The prevalence is also high in ranch animals [51, 52, 61]. The fact that infected ranches are breeding centers definitely favors the spread of brucellosis [51]. In addition, the distribution of F1 heifers from the ranches would most likely exacerbate the situation in other production systems. These production units will therefore continue to spread brucellosis to other areas until effective measures are instituted which might change the situation [52, 51]. However, there is no information available so far on the measures taken to combat brucellosis in Ethiopia. In Ethiopia, reliable data on human Brucellosis is lacking.

Wuchale Jida District of Selalle Zone is one of the districts in Ethiopia where dairy production using high yielding breeds of cattle has been started earlier. Its temperate climate in the highlands fairly favours the introduction and development of crossbred dairy cattle. Although Wuchale Jida District is known for its dairy production, the status of bovine brucellosis is not well known. Thus, it is necessary to assess the situation of brucellosis in smallholder farms in the district as it is the major source of milk for Addis Ababa, the Capital of Ethiopia [61].

CONCLUSION

Brucellosis is worldwide and has high prevalence in different areas of Ethiopia. Brucellosis 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. The disease transmits from infected animals to human beings through several routes. It is special hazard to occupational groups. It causes considerable losses in cattle as a result of abortion and reduction in milk yield. Even though the disease is prevalent in Ethiopia, few reports in human are available. This may be due to absence of appropriate diagnostic facilities.

Based on the above conclusion the following recommendations are forwarded;

- ✓ Public education on the transmission and source of infection of the disease need to be under taken.
- ✓ The necessary precautions should be taken to reduce occupational risks.
- ✓ Pasteurization of milk should be widely practiced to prevent human infection.
- ✓ Isolation of aborted animals and proper disposal of aborted fetuses and fetal membranes, preferably, by incineration.
- ✓ The isolation of calving animals' in separate calving pens.

- ✓ Replacement stock should be purchased from herd known to be free of brucellosis.
- ✓ Strict movement control of animal from one area to another in order to prevent the spread and transmission of the disease from infected cattle to the non-infected ones.

REFERENCES

1. Central Statistical Agency (CSA), 2008. Agricultural sample survey 2007/08: report on livestock and livestock characteristics (private peasant holdings). Addis Ababa Statistical bulletin, 2(417): 20.
2. Asfaw, Y., B. Molla, K.H. Zessin and A. Tegegne, 1998. A cross- sectional study of bovine brucellosis and test performance in intra- and peri- urban production systems in and around Addis Ababa, Ethiopia. Bulletin of Animal Health and Production in Africa, 46: 217-224.
3. Mangen, M.J., J. Otte, D. Pfeiffer and P. Chilonda, 2002. Bovine brucellosis in sub- Saharan Africa: Sero- Prevalence and impact on meat and milk off take Potential, 8: 108-120.
4. Acha, N. and B. Szyfres, 2001. Zoonoses and communicable diseases common to man and animals. Scientific and technical publication, 1(580): 109-111.
5. Food and Agriculture Organization of the United Nations (FAO), 2003. Guidelines for coordinated human and animal brucellosis surveillance. Animal production and Health Protection, 156: 45.
6. PAHO\ WHO., 2001. Zoonoses and Communicable Diseases Common to Man and Animals. 3rd edition. VI. Bacteriosis and Mycosis. Scientific and Technical Publications, No 580. Pan American Health Organization Pan American Sanitary Bureau, Regional Office of the World Health Organization. Washington D. C. USA. pp: 57-58.
7. Bayleyegn, M., 1989. Sero-epidemiological survey of bovine brucellosis in Arsi Region. DVM Thesis: Faculty of Veterinary Medicine (FVM), Addis Ababa University (AAU). Debrezeit Ethiopia.
8. Endrias, Z., 1989. Seroprevalence study of bovine brucellosis in selected sites of Sidamo region. DVM Thesis: Faculty of Veterinary Medicine (FVM), Addis Ababa University (AAU). Debrezeit, Ethiopia.
9. Tekelaye, B., O.B. Kasali, M. Mugrewa, R.G. sholtens and Y. Tamirat, 1989. The prevalence of brucellosis in indigenous cattle in central Ethiopia. Bulletin of Animal Health and Production in Africa; 37: 97-98.
10. Muktar, R., 1993. Reproductive wastage in cattle due to bovine brucellosis. Proceedings of the fourth national livestock improvement conference, 13-15th November 1991. Institute of Agricultural Research, pp: 270-272.
11. Abeje, S., 1994. Sero-epidemiological Study of Bovine Brucellosis in and Around Bahir Dar. DVM Thesis, FVM, AAU.
12. Tariku, S., 1994. The impact of brucellosis on productivity in an improved dairy herd of chaffa state farm, Ethiopia Berlin: Freie Universitat, Fachbereich veterinaiarmedizin, M.Sc. Thesis.
13. Yilikal, A., 1998. The epidemiology of bovine brucellosis in intra - and peri- urban dairy production systems in and around Addis Ababa. Freie University of Berlin, Faculty of Veterinary Medicine, Master's Thesis.
14. Taye, Y., 1991. Sero-prevalence study of bovine brucellosis at Abernosa. DVM Thesis, FVM, AAU. Debrezeit. Ethiopia.
15. Nicolettie, P., 1980. The epidemiology of bovine brucellosis. In: Brady, C.A. and Conelius, C.A. (eds.): Advance in Veterinary Science and Comparative Medicine. New York, Academic Press lnc., pp: 69-98.
16. Seifert, H.S.H., 1990. Human hygiensiche und wirtschaftliche Bedeutung der Brucellose in der Tier haltung des sahel. Gottinger Beirt. Land. Forst wirt. Trop. Subtrop, 51: 187-192.
17. Hirsh, D.C. and Y.C. Zee, 1999. Veterinary Microbiology. Black Well Science Publishing, USA, pp: 196-226.
18. Zee, Y.C. and C.H. Dwight, 2003. Bovine Brucellosis. 2nd ed. London: Black GG Science, pp: 196-202.
19. Radostits, E.D., C.C. Gay and K.W. Inchcliff, 2006. Veterinary Medicine Textbook of the disease of Cattle, Sheep, Pigs, Goats and Horses, 9th ed., Newyork: W.B. Sunders Company Ltd., pp: 867-882.
20. Colibaliy, N.D. and K.R. Yamego, 2000. Prevalence and control of Zoonotic disease: collaboration between public health workers and veterinarians in Burkina Faso. Acta Tropica, 76: 53-57.
21. Chain, E., M.E. Tolmasky and E. Garcia, 2005. Whole genome analyses of speciation events in pathogenic Brucella. Infection and Immunity, 73: 8353-8361.
22. Nuru, S. and P. Schnurrenberg, 1995. The present status of Bovine Brucellosis in Nigeria: It's prevalence, significance and areas of research need. Bull. Office international Des Epizootics international Epizootics, 83(11-12): 1113-1123.

23. Scholz, H.C., Z. Hubalek, L. Sedlacek, G. Vergnaud, H. Tomaso, S. Al Dahouk, F. Melzer, P. kampfer, H. Neubaver, A. Cloeckaert, M. Maquart, M.S. Zygmunt, A.M. Whatmore, E. Falsen, P. Bahn, C. Gollner, M. Pfeffer, B. Huber, H.J. Busse and K. Nockler, 2008. Brucella microti sp. Nov., isolated from the common vole Microtis arvalis. Int. J. Syst. Evol. Microbial., 58: 375-382.
24. Walker, R.L., 1999. Brucella. In: Dwight C. Hirsh and Yuang Chung Zee (ED.): Veterinary Microbiology and Microbial Disease, London, Black Well Science, pp: 999-1000.
25. Mantur, B.G. and S.S. Mangalgi, 2007. Evaluation of conventional Castaneda and lysis centrifugation blood culture techniques for diagnosis of human brucellosis. J. clin. Microbial., 42: 4327-4328.
26. Quinn, P.J., M.E. Carter, W.J.C. Donnely, F.C. Lonard and D. Maquire, 2002. Brucella Species in Veterinary Microbiology and Microbial Disease, Londen, Black Well Science ltd, pp: 999-1000.
27. Georgios, P., A. Nikolas, B.Mile and T. Epaminondas, 2005. Brucellosis in England J. Med., 352: 25-36.
28. OIE, 2000. Ovine Epididimytis (B. ovis) Manual of standard for Diagnostic Test and Vaccines. 3rd ed. OIE, Paris, France, pp: 467-474.
29. Nielson, O., R. Steward, K. Nielson, L. Measurs and P. Duigan, 2001. Serologic survey of Brucella Species, antibodies in some animals of North America. J. Wild life Dis., 37: 89-100.
30. OIE. 2009. Bovine Brucellosis; version adopted by the world Assembly of delegates of the OIE, pp: 639-640.
31. Australian Veterinary Emergency Plan (AUSVETPLAN), 2005. Bovine Brucellosis Prevalence in and around Australia. 3rd ed. Journal of Applied Microbiology, 11: 8-9.
32. Xavler, M.N., T.A. Palxao, E.P. Poester, A.P. Lage and R.L. Santos, 2009. Pathology, immunohistochemistry and bacteriology of tissues and milk of cows and fetuses experimentally infected with Brucella abortus. J. Comp. Pathol., 140: 147-157.
33. Poester, F.P., L.E. Samartino and R.L. Santos, 2013. Pathogenesis and Pathobiology of brucellosis in livestock: Rev.sci.tech.off.int.Epiz, 32(1): 105-115.
34. Hong, C.B., J.M. Donahue, R.C. Giles, K.B. Poonacha, P.A. Tuttle and N.E. Cheville, 1991. Brucella abortus-associated meningitis in aborted bovine fetuses. Veterinary Pathology, 28: 492-496.
35. Luzzi, G.A., R. Brindle, P.N. Sockett, J. Solera, P. Klenerman and D.A. Warrel, 1993. Brucellosis. Imported and laboratory acquired cases, an over view of treatment trials. Trans. R.soc. Trop. Med. Hyg., 87: 138-141.
36. Solera, J., 1995. Doxycycline- rifampin versus doxycylcine-streptomycin in treatment of human
a. State farm, Ethiopia. Fachburg Veterinaemedizin, Frei Universitate, Berlin, Msc Thesis.
37. Corbel, M.J., 1997. Recent advances in brucellosis. J Med Microbiol, 46: 101.
38. Bishop, G.C., P.P. Busman and S.D. Herr, 1994. Brucellosis: 1st edition. Oxford University Press, pp: 1053-1066.
39. WHO, 1997. Emerging and Communicable Disease surveillance and control. The development of new brucellosis. Report of the WHO meetings, Geneva, December, pp: 41-47.
40. Yohannes, M., H. Degefu, T. Tolosa, K. Belihu, R. Cutler and S. Cutler, 2013. distiribution of brucellosis in different regions in Ethiopia. African Journal of Microbiology Research, 7: 1150-1157.
41. Radostits, O.M., C.C. Gay, C.D. Blood and K.W. Hinchcliff, 2000. Veterinary Medicine, Text book of the Disease of Cattle, Sheep, Pigs, Goats and Horses. 9th edition. NEW YORK: W.B. Saunders Company Itd, pp: 867-882.
42. WHO, 1986. Joint FAO\WHO Committee on brucellosis. 6th Report.Geneva: WHO.
43. WHO, 1997. Emerging and Communicable Disease surveillance and control. The development of new brucellosis. Report of the WHO meetings, Geneva, December, pp: 41-47.
44. Tegegne, A. and T.W. Crawford, 2000. Draft animal power use in Ethiopia.DVM Thesis, FVM, AAU. Debrezeit. Ethiopia.
45. Alem, W. and G. Solomon, 2002. A retrospective Sero - epidemiology study of Bovine Brucellosis in different production systems in Ethiopia. ln: processing of 16th Annual Conference pp: 53-57. June 5-6, Addis Ababa, Ethiopia.
46. Meyer, C.E., 1980. Report on Veterinary activities. Institute of Agricultural Research, Ethiopia. FAO Report No. AG: DP/ETH/78/004. FAO (Food and Agriculture Organization of the United Nations), Rome, Haly, pp: 24.
47. Tariku, S., 1994. The impact of brucellosis on productivity in an improved dairy herd of chaffa state farm, Ethiopia Berlin: Freie Universitat, Fachbereich veterinaiarmedizin, M.Sc. Thesis.

48. Bekele, A., B. Molla, Y. Asfaw and L. Yirgu, 2000. Bovine Brucellosis, Sero-epidemiological study in selected farms and ranches in South Eastern Ethiopia. Bulletin of Animal Health and Production in Africa, 48: 13-17.
49. Molla, B., 1989. Sero epidemiological survey of bovine brucellosis in Arsi Region. DVM thesis, Faculty of Veterinary Medicine, Addis Ababa University, Debrezeit, Ethiopia.
50. Haileselassie, M., K. Shewit and K. Moses, 2010. Serological survey of bovine brucellosis in barka and arado breeds (Bos indicus) of Western Tigray, Ethiopia. Preventive Veterinary Medicine, 94(1-2): 28-35.
51. Gebretsadik, B., 2005. Sero - epidemiological study of bovine brucellosis in Tigray region, North Ethiopia, Msc Thesis, FVM, AAU, Debrezeit, Ethiopia.
52. Mussie, H., 2005. Sero - Prevalence study of brucellosis in cattle and human in Bahir Dar milk shed. Msc Thesis, FVM, AAU, Debrezeit, Ethiopia.
53. Tadele, T., 2004. Sero-prevalence study of bovine brucellosis and its public health significance in jimma zone, Western Ethiopia.DVM Thesis, FVM, AAU. Debrezeit. Ethiopia.
54. Mekonnen, G., 2002. Sero - epidemiological investigation of bovine brucellosis in North Eastern Ethiopia. A report submitted to Agricultural Bureau of Amhara National Regional State Bahir Dar, Ethiopia.
55. Teshager, D., A. Mulie, S. Tesfaye and M. Yimer, 2014. Seroprevalence of Bovine brucellosis in Central Ethiopia. Global research Journal of Public Health and Epidemiology, 1(7): 54-64.
56. Shiferaw, A., 1987. The prevalence of bovine brucellosis under different management systemsaround Shoa based on serological test. FVM, AAU, Debre Zeit, DVM Thesis.
57. Sintaro, T., 1994. The impact of brucellosis on productivity in an improved dairy herd of Chaffastate farm, Ethiopia. Fachburg Veterinaemedizin, Frei Universitate, Berlin, Msc Thesis.
58. Gebre-mariam, K., 1985. The prevalence of bovine brucellosis in four different farms. FVM, AAU, Debrezeit, Ethiopia.
59. Zewdu, E., 1989. Sero-prevalence study of bovine brucellosis in selected sites of Sidamo region. FVM, AAU, Debre Zeit, DVM Thesis.
60. Wondimu, A., 1989. The Epidemiology and economics of bovine brucellosis in the centralhighland of Ethiopia. VEERU, Reading University, Master’s Thesis.
61. Hadigo, K., 1987. A survey of bovine brucellosis around Bahirdar. FVM, AAU, Debre Zeit, Ethiopia.