Academic Journal of Animal Diseases 11(1): 01-11, 2022
ISSN 2079-200X

DOI: 10.5829/idosi.ajad.2022.01.11

Review on Status of Small Ruminant Brucellosis and its Public Health Importance in Ethiopia

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Abstract: First among the many factors which limit the economic returns from small ruminants is disease. One infectious disease which particularly impedes international trade is brucellosis. Brucellosis in small ruminants is mainly caused by *Brucella melitensis* and *Brucella ovis* and in sporadic cases by *Brucella abortus*. This disease is mainly characterized by abortion with the development of yellowish, sticky layers on the placenta in females. In male animals, it causes orchitis and epididymitis and arthritis in both sexes. Species of *Brucella* are obligate parasites, requiring an animal host for maintenance. They are small, non - motile, non - sporulating, non-toxigenic, aerobic, facultative intracellular, gram-negative coco-bacilli parasites. Sexually mature and pregnant animals are more prone to *Brucella* infection. The primary route of dissemination of *Brucella* is the placenta, fetal fluids and vaginal discharges expelled by infected animal after abortion or full-term parturition. *Brucella* species can enter mammalian hosts through skin abrasions or cuts, the conjunctiva, the respiratory tract, the gastrointestinal tract and through reproductive tracts. In active cases brucellosis of small ruminants can be diagnosed by isolation and identification of the responsible micro-organisms using bacteriological tests. *Brucella* can also be detected using molecular tests. But in chronic infection the disease is diagnosed by different immunological and serological tests. Brucellosis is readily transmissible to humans, causing acute febrile illness undulant fever – which may progress to a more chronic form and can also produce serious complications affecting the musculoskeletal, cardiovascular and central nervous systems. Humans get infected mainly by drinking unpasteurized milk and/or exposure to aborted fetuses, placentas or infected animals and by an occupational risk. Brucellosis presents a significant impediment to the economic potential of the large population of small ruminants such as reproductive and productive wastage and trade ban. Small-ruminant brucellosis has been shown to occur worldwide. Status of small ruminant brucellosis in Ethiopia is not well reviewed and organized. A review conducted on small ruminant brucellosis indicates that the prevalence of the disease is high in lowlands as compared with middle and highlands. Since brucellosis has no effective treatment vaccination, test and slaughter, hygiene and awareness creation are the best alternative strategies.

Key words: Brucellosis · Ethiopia · Small Ruminant · Public Health

INTRODUCTION

Goats and sheep are important domestic animals highly adaptable to broad range of environmental conditions. In tropical livestock production systems in Africa [1] they account around 21% of the global small ruminant population. Small ruminants fulfill a number of economic and social functions. According to statistics from the Central Statistical Agency [2], Ethiopia has over 39.89 million head of sheep and 50.5 million goats. Twenty-five percent of the sheep and 73% of the national goat population inhabit the lowlands (mostly pastoral areas) [3]. These small ruminants and their milk/meat products represent an important export commodity, which significantly contributes to the national economy. Moreover, low cost of production, requirement of little land and higher prolificacy made them attractive asset for development. Investment in sheep and goats avoid losses due to high inflation rates that are found in unstable economies of many underdeveloped countries like

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Ethiopia. This is because sheep and goats provide rapid cash turn over. There is also a growing export market for sheep and goats' meat in the Middle Eastern Gulf states and some African countries. At optimum off take rates, Ethiopia can export 700, 000 sheep and 2 million goats annually and at the same time supply 1, 078, 000 sheep and 1, 128, 000 goats for the domestic market [4].

In spite of the presence of huge small ruminant population, Ethiopia failed to optimally utilize this resource as a sector. This is because of small ruminant production is constrained by the compound effect of diseases, poor feeding and management and low genetic endowment. Among those factors which limit the economic returns from small ruminants' production diseases stand in the frontline. One of such disease that hampers the productivity of small ruminants and impedes international trade is brucellosis, the major ones particularly in the pastoral areas [5].

Brucellosis is an infectious bacterial disease caused by members of the genus Brucella. It is disease of worldwide importance and affects a number of animal species. Brucellosis in small ruminants is mainly caused by *Brucella melitensis (B. melitensis*) and *B. ovis* in and sporadic case by *B. abortus*. This disease is mainly characterized by abortion with the development of yellowish, sticky layers on the placenta in females. In male animals, it causes orchitis and epididymitis, as well as inflammation of the joints and bursa. The consequences of brucellosis in small ruminants are: infertility, a high mortality rate in lambs and kids, mastitis, reduced milk production [6, 7].

The presence of small ruminant brucellosis in Ethiopia is well established [8-13] similar to other reports elsewhere it imposes tremendous economic loss due to reproductive wastages such as infertility, abortion, stillbirth and the likes.

On the other hand, brucellosis is a zoonotic infectious disease affecting humans with an estimated half a million human cases reported annually from the world [10]. Human brucellosis is an ancient disease that has had different names throughout time based on the main clinical symptom (fever) and the geographical location: Malta fever, Mediterranean fever, Undulant fever, Gibraltar fever, Rock fever and Neapolitan fever, among others [14]. Cattle, goats, pigs, sheep, horses and dogs play a significant role in the transmission of this disease to man and the pastoralist communities who have daily contact with their animals and use their products in their dietary habits are being infected by brucellosis and in addition to these veterinarians, abattoir workers and laboratory technicians are vulnerable of the diseases [7, 14]. In Ethiopia most of livestock owners have no awareness about zoonotic importance of brucellosis and its mode of transmission and they drink raw milk and handle retained placenta with bare hand [15].

In general, the epidemiology of small ruminant brucellosis and its awareness various from one area to another so control measures appropriate in one area is not necessarily of value in another. Hence, it is essential to have adequate knowledge of the epidemiology and awareness of the disease before contemplating control programs. Therefore, the objective of this review was to through the lights on the status of small ruminant brucellosis and its public health importance in Ethiopia.

Small Ruminant Brucellosis: Brucellosis is a zoonotic disease caused by facultative, intracellular bacteria of the genus Brucella that can survive and multiply within phagocytic cells of the host. Brucellosis of small ruminants is an infectious disease of goat and sheep characterized by mass abortion in females, epididymitis and orchitis in males in first out breaks and becomes chronic and latent after the first outbreak of the disease.

Etiology: Brucellosis is an infectious bacterial disease caused by microorganisms of the genus Brucella, a coccobacillus, gram negative, facultative intracellular pathogen, which affecting a number of animal species. In small ruminants, brucellosis is mainly caused by *B. melitens* and *B. ovis* and in sporadic cases *B. abortus*. *B. melitensis* is most commonly infects sheep and goats while *B. ovis* primarily affects sheep. *B. melitensis* is most common source of human brucellosis [16, 17]. *B. melitens*, *B. abortus* and *B. ovis* are small, non - motile, non-sporulating, nontoxigenic, aerobic, facultative intracellular, gram-negative coccobacilli or short rods 0.6 to 1.5 ìm long by 0.5 to 0.7 ìm in width and usually have individual arrangement and less frequently are found in pairs, short chains, or small groups [18]. Brucella species are fastidious bacteria that need rich culture medium to support adequate growth. The growth occurs on Brucella agar, MacConkey Agar, Trypticase Soy agar, Sheep Blood agar and Standard Nutrient agar at 25-42°C. Colonies on translucid media are transparent, convex and have an entire edge [19, 20].

Epidemiology

Geographic Distribution: Small-ruminant brucellosis has been shown to occur worldwide and is principally found in: Mediterranean countries, The Middle East, Africa,

India, China, Mexico and Parts of Latin America and sub-Saharan African countries particularly East Africa. Small-ruminant brucellosis is common in tropical area where animal production is commonly practiced, especially pastoral area [6, 17].

Host Risk Factors

Age Factor: The prevalence of the disease is most frequently occurred in adult sheep and goats than younger one. Sexually mature and pregnant animals are more prone to Brucella infection and brucellosis than sexually immature animals of either sex [9, 12, 21]. Brucellosis of small ruminants affects sexually matured animals; with the predilection sites being the reproductive tracts of the males and females, especially the pregnant uterus. This is due to the presence of sex hormones and erythritol, which stimulate the growth and multiplication of Brucella organisms and tend to increase in concentration with age and sexual maturity [21].

Species and Breed's Factor: Goats are at higher risk of acquiring Brucella infection than sheep. 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. This reduces the potential for diseases spread among sheep flocks [9, 12, 21].

Sex: Male animals are less susceptible to Brucella infection than females, due to presence of low concentration of erythritol in male relative to female animals [9, 21].

Flock Size: Brucellosis is considered as disease of flock importance. The prevalence of small ruminant brucellosis is high in large flock size than small size flock [22].

Environmental Factor: Brucella may retain infectivity for several months in water, aborted fetuses and fetal membranes, feces and liquid manure, wool, hay, on buildings, equipment and clothes. Brucella is also able to withstand drying particularly in the presence of extraneous organic material and will remain viable in dust and soil [23].

Management Risk Factor: The spread of the disease from one herd to another and from one area to another is always due to the movement of infected animals from an infected flock into a non-infected susceptible flock. 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 the prevalence of brucellosis [24]. Mixing different species of animals (sheep/goat/cattle) together has also a great factor to increase incidence of brucellosis [12].

Occupations at Higher Risk: People who work with animals or come into contact with infected blood are at higher risk of brucellosis. Examples include: veterinarians, ranchers, slaughterhouse workers, microbiologists and farmer in endemic areas are at risk [4, 7, 14].

Transmission: Generally, transmission of small ruminant brucellosis occurs in the sheep and goats by materials excreted from the female genital tract forming the main supply of organisms for transmission to other animals and man. Therefore, in most circumstances, the primary route of dissemination of *Brucella* is the placenta, fetal fluids and vaginal discharges expelled by infected ewes after abortion or full-term parturition. Very large numbers of organisms are shed at the time of parturition or abortion [25]. In goats, excretion of the organisms from the vagina is prolonged and copious (2 to 3 months generally). In sheep excretion is generally less prolonged, usually ceasing within 3 weeks after abortion or full-term parturition [21]. Shedding of *Brucella* is also common in udder secretions and semen and *Brucella* may be isolated from various tissues, such as lymph nodes from the head and those associated with reproduction and sometimes from arthritic lesions [17].

Brucellosis can transmit between animals through direct or indirect contact with diseased animals and their discharges. Ingestion of food and water contaminated with Brucella containing uterus discharge, aborted fetus and placenta are the way of getting brucellosis into flocks. The disease can also acquire through venereal transmission between adult and in kids and lambs by milk sucking and by invitro transmission [6]. In human 70-90% cause of Brucella infection occurs via the skin and mucus membrane by direct contact [26]. Human can also acquire brucellosis by consumption of raw milk from infected animal as described in figure 1 below.

The infection is commonly transmitted from one ram to the other by perpetual contact. Transmission may also occur through the ewe when an infected ram deposits his semen and another ram mates her shortly thereafter. The infection is not very common in ewes and when it occurs it is contracted by sexual contact. *B. ovis* does not persist very long in ewes and is generally eliminated

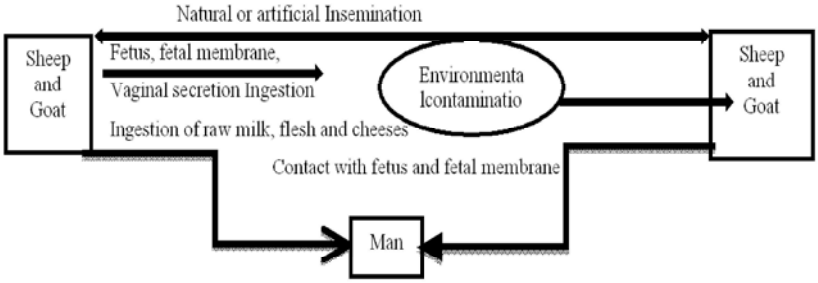

Fig. 1: Mode of transmission of small ruminants' brucellosis
Source: [25]

before the next lambing period [25]. Only a small proportion of lambs and kids are infected'' *in vitro*" and the majority of *B. melitensis* latent infections are probably acquired through colostrum or milk. Small ruminants infected when they are young sometimes become persistent carriers. They can remain undetectable by diagnostic tests, including serology, until they give birth or abort [17].

Pathogenesis: *B. melitens* can enter mammalian hosts through skin abrasions or cuts, the conjunctiva, the respiratory tract, the gastrointestinal tract and through reproductive tracts. In the alimentary tract the epithelium covering the ileal-payers' patches are preferred site for entry [27]. In the gastrointestinal tract, the organisms are phagocytosed by lympho-epithelial cells of gut associated lymphoid tissue, from which they gain access to the sub-mucosa and localized to the reticuloendothelial system and genital [21]. Organisms are rapidly ingested by polymorpho-nuclear leukocytes, which generally fail to kill them and are also phagocytosed by macrophages. Bacteria transported in macrophages, which travel to lymphoid tissue draining the infection site, may eventually localized in lymph nodes, liver, spleen, mammary glands, joints, kidneys and bone marrow. In macrophages, B. melitensis inhibits fusion of phagosome and lysosome and replicate within compartments that contain components of endoplasmic reticulum via a process facilitated by the type IV secretion system. If unchecked by macrophage bactericidal mechanisms, the bacteria destroy their host cells and infect additional cells [4].

The Brucella organisms spread through the hematogenous route in females then also reaches the placenta and finally to the fetus. The preferential localization to the reproductive tract of the pregnant animal is due to the presence of the allantois' fluid factors that would stimulate the growth of Brucella. Erythritol (four-carbon alcohol) is considered to be one of the factors, which are elevated in the placenta and fetal fluid from about the fifth month of gestation. An initial localization within erythron-phagostic trophoblasts of the placentome adjacent to chorio-allantoic membrane results in rupture of the cells and ulceration of the membrane. The damage to placental tissue together with fetal infection and fetal stress inducing maternal hormonal changes may cause abortion. In the absence of effective intracellular microbicidal mechanisms, these tissues permit exuberant bacterial growth, which leads to fetal death and abortion [23, 28].

Clinical Sign and Finding: The main clinical manifestations of brucellosis in sheep and goats are, as in all female ruminants, reproductive failure, abortion and birth of weak offspring. Abortion generally occurs during the last 2 months of pregnancy and is followed in some cases by retention of fetal membranes. In the male, localization in the testis, epididymis and accessory sex organs is common and bacteria may be shed in the semen. This may result in acute orchitis and epididymitis and later in infertility. Arthritis is also observed occasionally in both sexes. Animals generally abort once, although reinvasion of the uterus occurs in subsequent pregnancies and organisms are shed with the membranes and fluids. Non-pregnant animals exposed to small numbers of organisms may develop self-limiting, immunizing infections or they may become latent carriers. Persistent infection of the mammary glands and supra mammary lymph nodes is common in goats with constant or intermittent shedding of the organisms in the milk in succeeding lactations, while the self-limiting nature of the disease in sheep, which is seldom accompanied by prolonged excretion of the bacteria, has been observed [17, 29].

Infected animals generally develop granulomatous inflammatory lesions which frequently are found in lymphoid tissues and organs such as reproductive organs, udder and supra mammary lymph nodes and sometimes joints and synovial membranes. This disease has no pathognomonic lesions 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. Acute mastitis with palpable nodules and the production of clotted and watery milk may occur [30]. 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 [21].

In humans the incubation period of brucellosis is usually two to four weeks; occasionally, it may be as long as several months. Brucellosis is a systemic disease with a wide clinical spectrum from asymptomatic disease to severe or fatal illness. It mainly presents with insidious onset of fever, night sweats (associated with a strong, peculiar, moldy odor), weight loss, headache, fatigue, abdominal pain, malaise and arthralgias. Infective endocarditis, although rare, is the most devastating complication from systemic brucellosis and could require surgical intervention. Physical findings are variable and nonspecific; splenomegaly, hepatomegaly and/or lymphadenopathy may be observed [31].

Diagnosis: In active case, brucellosis of small ruminants can be diagnosed by isolation and identification of the responsible micro-organisms using bacteriological tests which determine the phenotypic characteristics of the bacteria. *Brucella* can also be detected using molecular tests which take account of all the characteristics of the genome. But in chronic infection the disease is diagnosed by different immunological (allergic test) and serological tests that can be screening and confirmatory serological tests [32].

Bacterial Isolation and Identification

Specimen Collection: The most valuable specimens for bacterial culture are aborted fetal tissues (especially lung, spleen and stomach contents), placenta, lymph nodes, post parturient uterus, vaginal discharge, semen, urine and bone marrow. All specimens must be packed separately and transported immediately to the laboratory in ice box with ice packs in leak proof containers). If the specimens are not inoculated immediately, preserve in refrigerator at 4°C [23].

Direct Microscopic Examination from Specimen: Smears are made from specimens and stained by modified Ziehl – Neelsen (MZN) stain. Brucella appears as small, red – staining coccobacilli in clumps because of their intracellular growth. In gram staining they appear gram negative coccobacilli in clumps.

Isolation of Pure Colony and Pure Culture: Pure colony of bacteria can be obtained by streaking the specimens on appropriate media. Culture material may also be taken from lymph nodes, cerebrospinal fluids and abscesses. It is recommended the cultures be repeated several times to get pure colony then pure culture [25].

Molecular Technique: Species of Brucella can be identified by molecular techniques. Molecular detection of Brucella species can be done directly on clinical samples without previous isolation of the organism. In addition, these techniques can be used to complement results obtained from phenotypic tests [33]. Polymerase Chain Reaction (PCR) and its variants, based on amplification of specific genomic sequences of the genus, species or even biotypes of Brucella species are the most broadly used molecular technique for brucellosis diagnosis [33, 34].

Serological and Immunological Diagnostic Methods: The tests which are used to identify animals with latent infection are immunological and serological tests. These tests are derived from research done mainly on brucellosis diagnosis in cattle. To a large extent the characteristics of the different tests can be transposed to sheep and goat, except for the milk ring test, which is not an accepted test in these species because it generates too many false-positive results [35].

Serological Tests: These tests are crucial for laboratorial diagnosis of brucellosis since most of control and eradication programs of brucellosis depend on these methods. Several serological methods are currently available; these tests can be classified as screening tests and complementary or confirmatory tests [32, 36].

Screening Test for Brucellosis: There are many screening tests which are used to diagnose brucellosis in small ruminants. The Rose Bengal Plate Test (RBPT) is the most common screening test for detection of *Brucella* agglutinins. The principle of the test is that the sera collected from animals were mixed with antigen and examined for agglutination. The use of the RBPT, which is easy to perform and is considered a valuable screening test, is less effective than the CFT at detecting brucellosis in small ruminants. Buffered plate agglutination (BPA) tests are the well-known buffered *Brucella* antigen tests. These tests are rapid agglutination tests lasting 4 minutes and it is done on a glass plate with the help of an acidic-buffered antigen (pH 3.65 ± 0.05). These tests have been introduced in many countries as the standard screening test because it is very simple and thought to be more sensitive than the SAT [37].

Confirmatory Serological Tests: There are many serological tests that can be used as confirmatory serological tests for brucellosis. Among them the most common are Complement Fixation Test (CFT), Enzyme Linked Immune Sorbent Assay (ELISA), Serum Agglutination Test (SAT), Agar Gel Immune Diffusion (AGID) test. Among them ELISA and CFT are the most commonly used confirmatory serological tests. The complement fixation test is highly efficient and therefore accepted worldwide [36]. Due to its high accuracy, complement fixation is used as confirmatory test for *B. abortus*, *B. melitensis* and *B. ovis* infections and it is the reference test recommended by the OIE for international transit of animals [35]. The CFT indicates active *Brucella* infection better than any other serologic test. It detects mostly IgG antibodies which are present in both acute and chronic stages of brucellosis [35].

Status of Small Ruminant Brucellosis in Ethiopia: Studies conducted on small-ruminant brucellosis in Ethiopia have indicated that sero-prevalence of the disease is varied from place-to-place ranging from 0.07 % in Somali region [8], to 12.35% in Afar region [9] which might be due to the differences in animal production and management systems as well as reasonably difference in agro-ecological conditions of the study places and see (Table 1). Reports indicated that the prevalence of small-ruminant brucellosis was much higher in area where farmers practice the communal use of grazing land than in clan-based flock/herd segregation areas [9, 12]. This might be due to mixing animals from various areas in communal grazing system and watering points.

There is no direct/clear research/study was conducted on the status human brucellosis in Ethiopia that can result from infection of small ruminant brucellosis. But a few researchers conducted a questionnaire survey to livestock owners concerning/testing the level of awareness they have on zoonotic importance of small ruminant brucellosis and means of acquiring the diseases. The studies conducted by different researchers at different places of the country indicated that the livestock owners have low awareness about small ruminant brucellosis. As an examples, 2% at Somali (Fafan Zone) [38], 11.1% at Borena (Yabelo) [11], 30% at Bale (Dallo-Manna and Haranna Bulluk) [22] and 33.3 % at Dire Dawa [15] are those who have an awareness about the diseases in the study area. Due to the absence/low level of awareness about the diseases most of the pastoral communities uses raw milk and handle aborted fetus and fetal membrane with their bare hands [22]. There are no clearly published studies concerning sero-prevalence of human brucellosis in Ethiopia.

Public Health Importance of Small Ruminant Brucellosis: Since there is close contact between humans and their livestock, which sometimes share the same housing enclosures, brucellosis is a significant health risk for the entire community. Brucellosis is readily transmissible to humans, causing acute febrile illness – undulant fever – which may progress to a more chronic form and can also produce serious complications affecting the musculoskeletal, cardiovascular and central nervous systems. Brucellosis is a zoonotic bacterial disease caused by Brucella spp. and is primarily a disease of animals whereas humans are accidental hosts [42, 43].

The disease is one of the most widespread zoonotic and is endemic in many countries. It is also considered a neglected zoonotic by the WHO [44]. There are six identified species and numerous biotypes. From these species *B. melitensis* causes disease primary among sheep and goats and is also the most pathogenic for humans. The bacteria show a strong host preference although cross-species infections happen, particularly with *B. melitensis* [42].

In endemic countries humans get infected mainly by drinking unpasteurized milk/cheese and/or exposure to aborted fetuses, placentas or infected animal's discharges and causes acute febrile illness – undulant fever –which may progress to a more chronic form and can also produce serious complications affecting the musculoskeletal, cardiovascular and central nervous systems due [7, 30, 45, 46].

Table 1: Sero-prevalence of brucellosis in small ruminants in different parts Ethiopia at different time

Region	Zone	No of [ovine, caprine] tested	Prevalence [ovine, caprine]	Over all prevalence	Source
Tigray	Tselemti	[145, 413]	[0.69, 2.18]	1.79	[10]
Somali	Jijiga	[1483, 371]	[0.1, 0.0]	0.07	[8]
Oromia	Jimma	[402, 402]	[4.2, 5.2]	4.7	[12]
SNNP	S. omo	[64, 555]	[0.0, 0.5]	.26	[8]
DireDawa	Dire Dawa	[159, 265]	[1.9, 3.02]	2.6	[15]
Afar	Chifra	[168, 662]	[7.14, 13.8]	12.35	[9]
Afar	Ewa	[146, 214]	[6.16, 15.89]	12.0	[9]
Oromia	Yabelo	[99, 184]	[6.1, 9.2]	8.1**	[11]
Amhara	Bahirdar	[270, 230]	[0.0, 0.4]	0.4	[39]
Somali	Dollo	[181, 203]	[1.1, 1.97]	1.56	[40]
Oromia	Adamitullu	[775, 1565]	[1.9, 4.8]	3.8	[41]
Oromia	Borena	[135, 474]	[2.2, 4.4]	3.3	[8]

** -confirmed by c-ELISA, Others by CFT

There is an occupational risk to veterinarians, abattoir workers and farmers who handle infected animals and aborted fetuses or placentas. Brucellosis is one of the most easily acquired laboratory infections and strict safety precautions should be observed when handling cultures and heavily infected samples, such as products of abortion [47]. Clinical manifestation among humans is acute febrile illness which may persist and develop into a chronic disease with serious complications, such as joint illness, organ failure and symptoms of mental illness [42, 48] The mortality rate is relatively low, especially when the patient is treated with adequate antibiotics; however, this is not the case for everyone in low income countries [42].

Economic Importance of Small Ruminantbrucellosis: Brucellosis presents a significant impediment to the economic potential of the large population of small ruminants. Since small ruminants and their products is an important export commodity, detaining seropositive animals in quarantine has a negative economic impact [49]. The main economic consequences of brucellosis in small ruminants are: infertility, a high mortality in lambs and kids, outbreak, vaccine and research costs, movement restrictions, culling, market loss due to risk of infected meat and milk, mortality, morbidity, lower production, loss of exports, loss of animal genetic resources and opportunities occasioned by spending on disease prevention and, mastitis and reduced milk production. The reproductive wastage associated with brucellosis is another obstacle to optimal exploitation of the small ruminant sector. Reproductive losses are due to abortion, birth of weak offspring and infertility [48, 50].

Economic losses caused by the disease in humans arise from the cost of hospital treatment, medicines, patient out-of-pocket treatment expenses and loss of work days and income due to illness [14].

Control and Prevention

Vaccination: Control of brucellosis can be achieved by using mass vaccination to increase the population's resistance to the disease [35, 42, 51]. Vaccination practically eliminates the clinical signs of brucellosis and is accompanied by a reduced contamination of the environment as well as exposure of the population at risk to the infectious agent. The *B. melitensis* REV 1 vaccine is an attenuated strain of *B. melitensis* and an effective method to reduce the prevalence of brucellosis among whole flocks or herds in low-income countries and/or endemic countries [35, 42]. However, in many countries, where the animals were kept under extensive conditions with nomadic or semi-nomadic husbandry, this approach was impractical and failed to reduce the incidence and prevalence of the disease, because the development of herd immunity was very slow.

Test and Slaughter: For the implementation of test and slaughter program it is essential that the flocks are under strict surveillance and movement control. Animals must be individually identified and an efficient and well-organized veterinary service for surveillance and laboratory testing must be in place [21]. The flock size as well as the prevalence of brucellosis is the most important factors of this strategy which has been shown to be ineffective and unreliable when attempted in large flocks with a high prevalence of brucellosis. The eradication of brucellosis by test-and-slaughter is impracticable in developing countries because of limited resources to compensate farmers whose animals are slaughtered during such screening programs [44, 51].

Hygiene and Awareness Creation: These include general hygiene measures and the provision of clean accommodation that can be disinfected at parturition. The provision of information and education concerning

the disease to farmers and local communities are the most essential points for prevention and control of small ruminant brucellosis. Professional training is also very important issue for the implementation of the strategies by the appropriate national services. The prevention of human brucellosis is based on education to avoid consuming unpasteurized milk and milk derivatives. All dairy products should be prepared from heat-treated milk; Consumption of raw milk or products made from raw milk should be avoided. Meat should be adequately cooked. Special precautions should be taken by laboratory workers; Physicians and health workers should be aware of the possibility of brucellosis [31, 51]. Public health education should emphasize food hygiene and occupational hygiene [45]. The best method for preventing human brucellosis is the control and elimination of the infection in animals [51].

Treatment: The treatment of brucellosis in humans with aims to relieve symptoms, prevent a relapse of the disease and avoid complications. The antibiotics should be used continuously for at least six weeks and symptoms may not go away completely for several months. The disease can also return and may become chronic. Rifampicin is active in vitro against Brucella species, is remarkably lipid soluble and it accumulates within eukaryotic cells. In order to provide a completely oral regimen with which to treat brucellosis, the combination of doxycycline plus rifampicin, with both drugs administered for six weeks, was recommended by the WHO in 1986.Tetracycline administered for at least six weeks has long been the standard treatment of human brucellosis [45].

The standard treatment for brucellosis includes the use of antibiotics with activity in acidic intracellular environments (such as doxycycline and rifampin), use of combination therapy (given high relapse rates with monotherapy) and prolonged duration of treatment. There are no vaccines for the prevention of brucellosis in humans. Patients should be counseled to wait until the completion of therapy before unprotected sexual contact and lactating women should be advised to discontinue breastfeeding until completion of treatment [52].

CONCULISION AND RECOMMENDETIONS

Small ruminant brucellosis is the commonest bacterial infection that affect healthy of small ruminant throughout world, especially in developing country with extensive management system. *B. abortus, B. melitensis* and *B. ovis are the causative agents*. *B. melitensis* is the most virulent, which cause mass abortion in small ruminants during the first outbreak of the disease in the flock. Discharge from reproductive organs of infected animal, aborted fetus and contaminated environment are the common source of infection and transmission is facilitated by contacting with this agent. Isolation and identification of bacteria, serological and immunological tests are the common diagnostic method for diagnosis of small ruminant brucellosis. The disease has high economic impact by reducing reproductivity and productivity of the animal and has zoonotic importance. This disease transmitted to humans through contact with infected material and ingestion raw milk and other product of infected animal. The status of small ruminant brucellosis is not well studied in Ethiopia and much is remained to address the problem. Hence, the following points are recommended as they are very important to design strategy of control and eradication of the disease.

- More researches to be done on small ruminant brucellosis to know its status and economic and public effect.
- There should be a strategy at national level to regulate the control mechanism of brucellosis in small ruminants.
- The government, Public health officers and Veterinarians have to work together to (One Health Approach) reduce its economic and zoonotic impact.
- Eradication programs should be enforced in order to protect human health

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