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Sero-Prevalence, Epidemiology, and Public Health Significance of Small Ruminant Brucellosis

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Abstract

Brucellosis is a widespread zoonosis mainly transmitted from cattle, sheep, goats, pigs, and camels through direct contact with blood, placenta fetuses, or uterine secretion or through consumption of the contaminated raw animal product (especially unpasteurized milk and soft cheeses) in endemic areas. Therefore, the objective of this paper are to explain the Current Epidemiological Aspects of Brucellosis and the Importance of Small ruminant Brucellosis for Public Health and briefly illustrate the Economic Importance of Small ruminant Brucellosis. Sources of infection include aborted fetuses, fetal membranes, vaginal discharges and milk from infected sheep and goat. Brucellosis is caused by facultative, intracellular and Gram- negative bacteria called *Brucella*. Small ruminant brucellosis is caused by *B. ovis* (for sheep) and *B. melitensis* (mainly for goats), the latter one is the most virulent species of the *Brucella genus*. The disease in naturally infected sheep and goats is characterized by abortion in the last trimester of pregnancy, stillbirth and birth of weak offspring in females, and acute orchitis and epididymitis in males. Brucellosis occurs worldwide in domestic animals such as cattle, sheep, goats, camels and pigs and creates a high economic problem for both the intensive and extensive livestock production system in the tropics and a threat to public health. Diagnostic tests fall into two categories: those that demonstrate the presence of the organisms and those that detect an immune response to its antigens. As a general rule, treatment of infected livestock is not attempted because of the high treatment failure rate, cost, and potential problems related to maintaining infected animals in the face of ongoing eradication programs. To control the disease in human, prevention of the disease in reservoir host is important, so test and slaughter followed by proper disposal of seropositive animals to decrease the incidence of infection and effective vaccination and hygienic practices would reduce the disease spreading in/from endemic regions and to lessen the economic and zoonotic effects of brucellosis, the government, public health officials, and veterinarians must collaborate.

Keywords: small ruminant; abortion; facultative intracellular; brucella; zoonosis

Introduction

Ethiopia has the largest livestock population in Africa, with 65 million cattle, 40 million sheep, 51 million goats, 8 million camels and 49 million chickens [1]. Small ruminants, which account for more than half of the domesticated ruminants in the world, are an important component of the farming systems in most developing countries [2]. A recent estimate indicates that there are about 40 million sheep and 51 million goats in the country. The Ethiopian livestock population is almost entirely composed of indigenous animals. Recent estimates for sheep are 99.6% and 0.3% for local breeds and hybrids respectively. Nearly all goats (99.9%) are indigenous breeds [1]. Despite the importance of small ruminants in the livelihoods of producers, the current productivity of goats and sheep in developing countries remains low, mainly due to under-feeding, poor management systems, and diseases [3]. Brucellosis is caused by facultative, intracellular and Gram-negative bacteria called *Brucella* [4]. Nine *Brucella* species are currently recognized, seven of them that affect terrestrial animals are: *B. abortus, B. melitensis, B. suis, B. ovis, B. canis, B. neotomae, and B. microti* [5] and two that affect marine mammals are: *B. ceti* and *B. pinnipedialis* [6]. Brucellosis is an infectious bacterial disease caused by members of the genus *Brucella, and* that characterized by late abortion, retained foetal membranes, and to a lesser extent, orchitis and infection of the accessory sex glands in males and impaired fertility. The disease primarily affects cattle, buffalo, bison, pigs, goats, sheep, dogs, elk, and camels and occasionally horses [7]. It is essentially a disease of sexually mature animals, the predilection sites being the reproductive tracts of males and female. However, if such an animal becomes pregnant the production of simple carbohydrate eryhritol in the fetus and its membranes cases enormous multiplication of bacteria in the

uterus and this are likely to end in abortion [8]. Animals become infected by ingesting contaminated pastures, feedstuffs and water or licking infected placentae, foeti or the genitalia of infected female animals soon after abortion or delivery. *Brucella abortus, Brucella melitensis, Brucella suis* and *Brucella canis* can all cause human brucellosis, whereas *Brucella ovis* and *Brucella neotomae* have not been reported to cause disease in humans [9].

For the diagnosis of brucellosis, the organism may be recovered from a variety of materials which usually depends on the presenting clinical signs [10]. As a general rule, treatment of infected livestock is not attempted because of the high treatment failure rate, cost, and potential problems related to maintaining infected animals in the face of ongoing eradication programs [11]. To control the disease in human, prevention of the disease in reservoir host is important, so test and slaughter followed by proper disposal of seropositive animals to decrease the incidence of infection and effective vaccination and hygienic practices would reduce the disease spreading in/from endemic regions [12].Office International des Epizooties (OIE) sketch brucellosis as the second most important zoonotic disease in the world, accounting for the annual occurrence of more than 500,000 human cases [13].The distribution of B. melitensis is more restricted than that of B. abortus and its primary area of occurrence is in the Mediterranean region including southern Europe. Infection is also present in West and Central Asia, Mexico and countries in South America and countries in Africa.[14]. As a result, the goals of this paper are to: Explain the Current Epidemiological Aspects of Brucellosis and the Importance of Small ruminant Brucellosis for Public Health. Briefly illustrate the Economic and Importance of Small ruminant Brucellosis. Show the seroprevalencen status of small ruminant brucellosis in different geographical areas of Ethiopia

Literature Review

Etiology

Brucella species are facultative intracellular gram-negative cocco-bacilli, non-spore-forming and non-capsulated. Although *Brucella* species are described as non-motile, they carry all the genes except the chemotactic system, necessary to assemble a functional flagellum. Nine *Brucella* species are currently recognized, (Table1) seven of them that affect terrestrial animals are: *B. abortus, B. melitensis, B. suis, B. ovis, B. canis, B. neotomae, and B. microti* [5] and two that affect marine mammals are: *B. ceti* and *B. pinnipedialis* [6]. The first three species are called classical *Brucella* and within these species, seven biovars are recognized for *B. abortus*, three for *B. melitensis* and five for *B. suis* [15].

Table 1: Brucella species and their hosts

Organism	Host
B. melitensis	Sheep, Goat and Camel
B. abortus	Buffalo, Cows and Camels
B. canis	Dog
B. suis	Pig
B. neotomaei	Rodent
B. ovis	Sheep
B. pinnipediae	Marine animals
B. cetaceae	Marine animals

Source: [16].

Epidemiology

The geographical distribution of brucellosis is constantly changing, with new foci emerging or reemerging. Brucellosis is a disease of worldwide distribution occurring in domestic as well as wild animals. It has been reported wherever animals are raised all over the world [17]. Although some of the industrialized countries in Europe and America have achieved the eradication of brucellosis in domestic animals through intensive control and eradication schemes, the disease is still a serious problem in developing countries [18-19]. *B. melitensis* is the most virulent species of the *Brucella* genus and the ones isolated most frequently in small ruminants in the Mediterranean, the Middle East and Latin America [20]. Brucellosis is a barrier to trade in animals and animal products and causes significant losses from

abortion, as well as being a serious zoonosis [21].

Modes of transmission

The primary route of infection is through ingestion of contaminated feed and water, inhalation during overcrowding, contact through intact skin and conjunctiva, lambs may be infected while in the uterus or by suckling infected milk of their mother. Venereal transmissions by the infected ram to susceptible ewes appear to be rare. Transmission may occur by artificial insemination [22]. Sources of infection include aborted fetuses, fetal membranes, vaginal discharges and milk from infected sheep and goat. Studies indicate that 70-90% cause of Brucella infection occurs via the skin and mucus membrane by direct contact [23].

Risk Factors

Host factors

It is widely accepted that susceptibility increases with sexual development and pregnancy [24]. *Brucella melitensis* infection causes disease only in adult (sexually mature) females and males. Young animals may be infected but do not show any clinical sign and generally show only a weak and transient serological response ([22]. In *B. melitensis* infection males of sheep and goat are less susceptible than females. *Brucella ovis* has a great affinity for the reproductive tract of the male than the female [25]

Pathogen risk factor

Brucella is intracellular bacteria, hence has protection from the innate host defense and from therapeutics, moreover in quiescent state does not cause formation of humeral antibodies [24]. *Brucella* survives for up to 4 months in milk, urine, water and damp soil under proper environmental condition [25]. Disinfectants like caustic soda, formalin 2%, and Lysol 1% destroy *Brucella* [22].

Environmental and climatic factors

The survival of the organism in the environment plays a great role in the epidemiology of the disease [26]. *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 [27]. Humidity and PH of the environment influence the survival of *B. melitensis*. The organism is sensitive to direct sunlight, disinfectant, and pasteurization *Brucella* survives for up to 4 months in milk, urine, water and damp soil under proper environmental condition [25].

Pathogenesis

B. melitensis can enter mammalian hosts through skin abrasions or cuts, the conjunctiva, the respiratory tract, the gastrointestinal tract, and reproductive tracts. In the alimentary tract, the epithelium covering the ileal Peyer's patches is the preferred site for entry [28]. Organisms are rapidly ingested by polymorphonuclear leukocytes, which generally fail to kill them and are also phagocytosed by macrophages. In macrophages, *B. melitensis* inhibits the fusion of phagosome and lysosome and replicates within compartments that contain components of the endoplasmic reticulum [29]. In ruminants, *Brucella* organisms bypass the most effective host defenses by targeting embryonic and trophoblastic tissue. In cells of these tissues, the bacteria grow not only in the phagosome but also in the cytoplasm and the rough endoplasmic reticulum. In the absence of effective intracellular microbicidal mechanisms, these tissues permit exuberant bacterial growth, which leads to fetal death and abortion [17].

Clinical Sign and Finding

The clinical features of *B. melitensis* infection in sheep and goats vary according to the biovar involved [30]. Brucellosis suspected in any flock with a history of abortion during the last stage of pregnancy, infertility, orchitis, epididymitis, stillbirths and neonatal mortality [31]. The major clinical sign in the first stage of the disease is abortion, but other signs due to localization of the organism may be observed. These signs include orchitis, epididymitis, hygroma, arthritis, metritis, and subclinical mastitis among others [22]. Infection is not established if the female is exposed to the organism at the end of the pregnancy. The second stage is characterized by either elimination of *Brucella* or more frequently, by persistent inflammation of mammary gland and supramammary and genital lymph nodes, with constant or intermittent shedding of the organisms in milk and genital secretions. Animals generally abort once during the mid-third of gestation but re-invasion of the uterus occurs in subsequent pregnancies with shedding in fluids and fetal membranes. The pregnancy can also get too full- term [31].

Diagnosis

Bacteriological methods

Isolation of the organism is considered the gold standard diagnostic method for brucellosis since it is specific and allows bio typing of the isolate, which is relevant under an epidemiological point of view Al Dahouk). However, in spite of its high specificity, culture of Brucella spp. is challenging. Brucella spp. is a fastidious bacterium and requires rich media for primary cultures. Furthermore, its isolation requires a large of viable bacteria in clinical samples, proper storage and quick delivery to the diagnostic laboratory [32].

Serological methods

Serological tests are crucial for laboratory diagnosis of brucellosis since most of control and eradication programs rely on these methods. Inactivated whole bacteria or purified fractions (i.e., lipopolysaccharide or membrane proteins) are used as antigens for detecting antibodies generated by the host during the infection. Antibodies against smooth Brucella species (e.g., *B. abortus, B. melitensis*, and *B. suis*) cross react with antigen preparations from *B. abortus*, whereas antibodies against rough Brucella species (e.g., *B. ovis* and *B. canis*) cross react with antigen preparations from B. ovis [31]. Although several serological methods are currently available, these tests can be classified as screening tests [31].

Enzyme linked immunosorbent assay

Enzyme linked immunosorbent assay (ELISA) has become popular as a standard assay for the diagnosis of brucellosis, serologically. It measures IgG, IgA and IgM antibodies and this allows a better interpretation of the clinical situation. The diagnosis of brucellosis is based on the detection of antibodies against the smooth LPS. Detection of IgG antibodies is more sensitive than detection of IgM antibodies for diagnosing cases of brucellosis but specificity is comparable [33]. Compared to the conventional agglutination methods, ELISA is more sensitive in acute and chronic cases of brucellosis and it offers a significant diagnostic advantage in the diagnosis of brucellosis in endemic areas [34, 35]. The indirect ELISA (i-ELISA) has been used for serologic diagnosis of brucellosis in sheep, goats and pigs. It has also been used for diagnosis using serum or milk from cattle [36]. O ELISA-i has been usually used for smooth LPS *Brucella* spp., and it is sensitive and specific for *B. abortus* or *B. melitensis*, but it is not capable of differentiating antibodies induced by the vaccine strains S19 or Rev1[37]. Sensitivity of i-ELISA varies from 96 to 100% and its specificity from 93.8% and 100% [38]. The competitive ELISA (c-ELISA) with smooth *Brucella* LPS as antigen is used for detection of anti-Brucella in serum samples from cattle, sheep, goats, and pigs. This test is capable of differentiating vaccine antibody response from actual infections, and its sensitivity varies from 92 to 100%, whereas the specificity ranges from 90 and 99% [39].

Rose Bengal plate test

Rose Bengal plate test [RBT] is an agglutination test that is based on reactivity of antibodies against smooth lipopolysaccharide (LPS). As sensitivity is high, false negative results are rarely encountered. To increase specificity, the test may be applied to a serial dilution (1:2 through 1:64) of the serum samples [40]. The present World Health Organization (WHO) guidelines recommend the confirmation of the RBT by other assays such as serum agglutination tests [40].

Treatments

Due to intracellular localization of *Brucella* and its ability to adapt to the environmental conditions encountered in its replicative niche e.g., macrophage [15]. treatment failure and relapse rates are high and depend on the drug combination and patient compliance. The optimal treatment for brucellosis is a combination regimen using two antibiotics since monotherapies with single antibiotics have been associated with high relapse rates [42)]. The combination of Doxycycline with Streptomycin (DS) is currently the best therapeutic option with less side effects and less relapses, especially in cases of acute and localized forms of brucellosis [43].

Public Health and Economic Impact of Small Ruminant Brucellosis

Public health impact

Human brucellosis is widely distributed all over the world. It is considered by the FAO, the WHO and the OIE as one of the widest spread zonooses in the world [44]. Almost all human cases of brucellosis are acquired from animals, in particular goats and sheep. In humans, ovine/caprine brucellosis caused by *B. melitensis* is the most important clinically apparent disease and remains one of the most common zoonotic diseases worldwide, with more than 500,000 human cases reported annually [43, 45]. The disease is primarily an occupational risk in exposed professions, i.e., veterinarians, farmers, laboratory

technicians, abattoir workers, and others who work with animals and their products. Inhalation is often responsible for a significant percentage of cases in abattoir employees. Contamination of skin wounds may be a problem for persons working in slaughterhouses or meat packing plants or for veterinarians [12].

Economic significance impact

Brucellosis results in an obstacle to trade of animals, animal products and animal movement. It causes economic losses because of abortion or breeding failure in the affected animal population, diminished milk production and in human brucellosis result in reduced work capacity through the sickness of the affected people [46]. Brucellosis also presents a significant impediment to the economic potential of the large population of small ruminants. Since small ruminants and their products are an important export commodity, detaining seropositive animals in quarantine has a negative economic impact [47].

Control and Prevention

As the ultimate source of human brucellosis is direct or indirect exposure to infected animals or their products, prevention must be based on elimination of such contact. The obvious way to do this-elimination of the disease from animals is often beyond the financial and human resources of many developing countries. The technical and social difficulties involved in eradicating B. melitensis from small ruminants have even taxed the resources of some developed countries. In many situations, there is little alternative but to attempt to minimize the impact of the disease and to reduce the risk of infection by personal hygiene, adoption of safe working practices, protection of the environment and food hygiene. prophylaxis currently plays little part in the prevention of human disease [25].

Prevention and control of brucellosis can be adopted realistically through an understanding of local and regional variations in animal husbandry practices, social customs, infrastructures and epidemiological patterns of the disease [48]. The common approaches used to control brucellosis includes quarantine of imported stoke and decide for or against immunization of the negative animals [22]. Eradication by test and slaughter principles are based on the magnitude of disease prevalence and economic status at countries and handling hygienic disposal of aborted fetuses, fetal membrane and discharges with subsequent disinfection of contaminated area [25].

In endemic areas, all placentas and dead fetuses should be buried as a routine practice. The need to test and cull, introduced and resident animals likely to be carriers is recommended, but difficult to be effective because of the inaccuracy of the tests [22]. The experience from all over the world, that vaccination is in most situations the only practical method of control of brucellosis in sheep and goats. Immunization with effective vaccines helps to get the infection under control, limit its spread, prevent human infections and reduce economic losses [49].

Prevalence Status of Small Ruminant Brucellosis

The pastoral and agro-pastoral production system represent approximately 45-55% of the cattle, 75% of the small ruminants, 20% of the equines and 100% of the camels of the total national livestock population. The main mobile pastoralists in Ethiopia are the Somalis (Somali region) in the east, the Afars (Afar region) in the northeast, the Borena Oromos (Oromiya region) in the south and south-east and the Southern Omo people (SNNPS region) in the south and partly in the Gambela and Benishangul regions and around the Dire Dawa Administration. Despite the large size of the regional livestock population, its economic contribution to the regional and national economy is not significant, mostly due to natural and human limitations [50]. Most of the studies which conducted on brucellosis were entirely based on estimation of seroprevalence of the disease. A sero-surveillance study carried out in small ruminants in different regions clearly demonstrated that the disease exists in Ethiopia. According to the current sero-surveillance findings of the disease in the country, low infection rate was recorded at Bahir Dar Town of Amhara Regional State [52]. and the highest was reported at Tellalak District of Afar Regional State [53] (Table 2).

Table 2: Sero-Prevalence of small ruminant brucellosis in different pastoral and agro pastoral area of Ethiopia.

Study Region	Prevalence (%)	Authors and years
Amhara	0.40%	[52]
SNNP and Oromia	1.90%	[54]
Oromia	4.60%	]55]
Afar	13.70%	[53]
Tigray	1.79%	[56]
Somali	1.37%	[57]
Oromia	6.20%	[58]
Oromia	2.90%	[59]

Conclusion and Recommendations

Brucellosis is worldwide and has a 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 is transmitted from infected animals to human beings through several routes. It is a special hazard to occupational groups. It causes considerable losses in small ruminants as a result of abortion and a reduction in milkyield. The following suggestions were made in light of the information provided in the conclusion: A national plan should be in place to manage the brucellosis control mechanism in small ruminants. A new vaccination against brucellosis in sheep and goats should be created using unrefined strains that do not have the vaccine's drawbacks. To lessen the economic and zoonotic effects of brucellosis, the government, public health officials, and veterinarians must collaborate.

References

1. CSA. 2020a. Agricultural Sample Survey 2019/20 [2012 E.C.]. Volume II report on livestock and livestock characteristics (private peasant holdings). Central Statistical Agency (CSA): Addis Ababa, Ethiopia.
2. Gebremedhin, B., Hoekstra, D., Tegegne, A., Shiferaw, K. and Bogale, A. (2015). Household Market Participation Behavior in Small Ruminants in the Highlands of Ethiopia: The Role of Herd Size, Herd Structure and Institutional Services (No. 1008-2016-80000).
3. Gizaw, S. (2010). Sheep and goat production and marketing systems in Ethiopia: Characteristics and strategies for improvement (23).
4. Adem, A. and Duguma, A., (2020). Characteristics and Intracellular Life of Brucella Organism: A Review. *J. Microb. Biochem. Technol,* 12(3):431.
5. Sriranganathan, N., Mohamed, N. S. and Stephen, M. B. (2010): Brucellosis: A re-emerging zoonosis. Vet. *Microbiol.,* 140:392-398.
6. Foster, G., Osterman, B. S., Godfroid, J., Jacques, I. and Cloeckaert, A. (2007). *Brucella* ceti sp. nov. and *Brucella* pinnipedialis sp. nov. for *Brucella* strains with cetaceans and seals as their preferred hosts. *Int. J. Syst. Evol. Microbiol.*, 57:2688-2693
7. Zinsstag, J., Schelling, E., Solera, X., Blasco, J., and Moriyon, I., (2011). Brucellosis: Oxford.
8. Tesfaye, G., Wondimu, A., Asebe, G., Regasa, G. andMamo, G. (2017). Sero-prevalence of Bovine Brucellosis in and Around Kombolcha, Amhara Regional State, Ethiopia. *Mycobact. Dis.* 7:242.
9. Shirima, G. (2005). The epidemiology of brucellosis inanimals and humans in Arusha and Manyara regions in Tanzania. Faculty of Veterinary Medicine, University of Glasgow, Tanzania, PhD thesis.
10. OIE. (2009). Ovine *B. ovis*. In: Manual of diagnostic tests and vaccines for terrestrial animals. Paris: Office international des epizooties, 1-9.
11. Yousefi-Nooraie, R., Mortaz-Hejri, S., Mehrani, M. and Sadeghipour: (2012). Antibiotics for treating human brucellosis. *Cochrane Database of Systematic Reviews*, (10).
12. Li, T., Tong, Z., Huang, M., Tang, L., Zhang, H. and Chen, C. (2017). Brucella melitensis M5-90Δbp26 as a potential live vaccine that allows for the distinction between natural infection and immunization. *Canadian journal of microbiology*, 63(8):719-729.
13. Hull, N.C. and Schumaker, B.A. (2018). Comparisons of brucellosis between human and veterinary medicine. *Infection ecology & epidemiology*, 8(1):1500846.

14. Radostitis, E.D., Gay, C.C. and I nchcliff, K.W. (2000). Veterinary MedicineTextbook of the disease of cattle, sheep, pigs, goats, and horses, 9th ed., Ne wyork: W. B. Sounders Company Ltd. 867-882.
15. Seleem, M.N., Boyle, S.M. and Sriranganathan, N. (2008). Brucella: a pathogen without classic virulence genes. *Veterinary microbiology*, 129(1-2):1-14.
16. Seifert HSH. (1996). Diseases caused by aerobic rods. I. Brucellosis. In: Tropical Animal Health. *Kluwer Academic Publishers*, 356-367.
17. Warner D. Brucellosis in animals and man. (2001). In: Goodman DE, editor. Zoonosis: animal disease that affect man. Christian Vet Miss. *Seattle*, 23-32.
18. Ragan VE. (2002). The Animal and Plant Health Inspection Services. brucellosis eradication program in the United States. *Vet Microbiol*. 90(1-4):11-18.
19. Lucero NE1, Ayala SM, Escobar GI, Jacob NR. (2008). Brucella isolated in humans and animals in Latin America from 1968 to 2006. *Epidemiol Infect*, 136(4):496-503
20. Seleem MN, Boyle SM. Sriranganathan N. Brucellosis: re-emerging zoonosis. Vet Microbiol. 2010;140(3-4):392-398.
21. Radostits O. M, Gay C, Blood D. C, Hinchclift K. W. (2007). Veterinary Medicine: a text book of the Disease of cattle, sheep, pigs, goats and horse. *Harcourt publishers limited, London*, 882-885.
22. Franc, K.A., Krecek, R.C., Häsler, B.N. and Arenas-Gamboa, A.M. (2018). Brucellosis remains a neglected disease in the developing world: a call for interdisciplinary action. *BMC public health*, 18(1):19.
23. Guven, T., Ugurlu, K., Ergonul, O., Celikbas, A.K., Gok, S.E., et al. (2013). Neurobrucellosis: clinical and diagnostic features. *Clinical Infectious Diseases*, 56(10):1407-1412.
24. WHO. (2006). Brucellosis in humans and animals. Geneva: World Health Organ, 27-66.
25. Beruktayet, W. and Mersha, C. (2016). Review of cattle brucellosis in Ethiopia. *Acad. J. Anim. Dis*, *5*(2):28-39.
26. Tabak F, Hakko E, Mete B, Ozaras R, Mert A, Ozturk R. (2008). Is family screening necessary in Brucellosis? Infect, 36(6):575-577.
27. Pizarro J, Meresse S, Parton RG. (1998). Brucella abortus transits through the autophagic path way and replicates in the endoplasmic reticulum of non-professional phagocytes. *Infect Immun.*, 66(12):5711-5724.
28. Köse, Ş., Senger, S.S., Akkoçlu, G., Kuzucu, L., Ulu, et al. (2014). Clinical manifestations, complications, and treatment of brucellosis: evaluation of 72 cases. *Turkish journal of medical sciences*, 44(2):220-223.
29. Poester P, Nielsen K, Samartino E (2010). Diagnosis of brucellosis. *Open Vet Sci J*, 4:46-60.
30. Hadush, A. and Pal, M. (2013). Brucellosis-An infectious re-emerging bacterial zoonosis of global importance. *Int J Livest Res*, 3(1):28-34.
31. Agasthya S, Isloor S, Krishnamsetty P. (2012). Seroprevalence study of human brucellosis by conventional tests and indigenous indirect enzymelinked immunosorbent assay. *Sci World J.*, 1:1-5.
32. Mantur B, Parande A, Amarnath S, Patil G, Walvekar R, et al. (2010). ELISA versus conventional methods of diagnosing endemic brucellosis. *Am J Trop Med Hyg.*, 83:314-318.
33. Asaad AM, Alqahtani JM. (2012). Serological and molecular diagnosis of human brucellosis in Najran, Southwestern Saudi Arabia. *J Infect Public Health*, 5189-5194.
34. Di Febo T, Luciani M, Portanti O, Bonfini B, Lelli R, et al. (2012) Development and evaluation of diagnostic tests for the serological diagnosis of brucellosis in swine. *Vet Ital*, 48:133-156.
35. Ko KY, Kim JW, Her M, Kang SI, Jung SC, et al. (2012). Immunogenic proteins of Brucella abortus to minimize cross reactions in brucellosis diagnosis. *Vet Microbiol*, 156:374-380.
36. Gall D, Nielsen K (2004) Serological diagnosis of bovine brucellosis: a review of test performance and cost comparison. *Rev Sci Tech*, 23:989-1002.
37. Godfroid J, Nielsen K, Saegerman C (2010) Diagnosis of brucellosis in livestock and wildlife. Croat Med J 51: 296-305.of human brucellosis. *Int J Biol Med Res*, 2:569-572.
38. Christopher S, Umapathy BL, Ravikumar KL (2010) Brucellosis: review on the recent trends in pathogenicity and laboratory diagnosis. *J Lab Physicians*, 2:55-60.
39. Pappas G, Papadimitriou P, Akritidis N, Christou L, Tsianos EV. (2006). The new global map of human brucellosis. *Lancet Infect Dis*, 6:91-99.
40. Acha PU, Szyfers B. (2001). Zoonosis and communicable disease common to man and

animals, (3rdedn). Pan America Health Organization. *Washington, DC, USA*: 1-395.
41. Garcell HG, Garcia GE, Pueyo PV, Martin IR, Arias AV, et al (2016). Outbreaks of brucellosis related to the consumption of unpasteurized camel milk. *J Infec Public Health*, 9: 523-527.
42. Robinson A. (2005). Guidelines for coordinated human and animal brucellosis surveillance.
43. Gul, S.T. and Khan, A. (2007). Epidemiology and epizootology of brucellosis: A review. *Pakistan veterinary journal*, 27(3):145.
44. Dorneles, E. M., Sriranganathan, N., Lage, A. P. (2015). Recent advances in Brucella abortusvaccines. *Vet. Res.*, 46:76.
45. Musallam, I. I., Abo-Shehada, N. M., Hegazy, M. Y., Holt, R. H., Guitian, J. F. (2016). Systematic review of brucellosis in the Middle East: Disease frequency in ruminants and humans and risk factors for human infection. Epidemiol. Infect, 144:671-685.
46. Amaha, K. (2006): Characterization of rangeland resources and dynamics of the pastoral production systems in the Somali region of eastern Ethiopia. PhD dissertation. University of the Free State, Bloemfontein.
47. Ferede Y, Mengesha D, Mekonen G, Hilemelekot M. (2011). Study on the seroprevalence of small ruminant brucellosis in and around Bahir Dar, North West Ethiopia. Ethiop. *Vet. J.,* 15(2):35-44.
48. Tadeg, W.M., Gudeta, F.R., Mekonen, T.Y., Asfaw, Y.T., Birru, A.L. and Reda, A.A. (2015). Seroprevalence of small ruminant brucellosis and its effect on reproduction at Tellalak District of Afar region, Ethiopia. *Journal of Veterinary Medicine and Animal Health*, 7(4):111-116.
49. Asmare, K., Megersa, B., Denbarga, Y., Abebe, G., Taye, A., et al. (2013). A study on seroprevalence of caprine brucellosis under three livestock production systems in southern and central Ethiopia. *Tropical animal health and production*, 45(2):555-560.
50. Deddefo, A., Sisay, T. and Tuli, G. (2015). Seroprevalence and risk factors of small ruminant brucellosis in selected districts of Arsi and East Shoa zones, Oromia region, Ethiopia. *African Journal of Microbiology Research*, 9(19):1338-1344.
51. Kelkay, M.Z., Gugsa, G., Hagos, Y. and Taddelle, H. (2017). Sero-prevalence and associated risk factors for Brucella sero-positivity among small ruminants in Tselemti districts, Northern Ethiopia. *Journal of Veterinary Medicine and Animal Health*, 9(11):320-326.
52. Mohammed, M., Mindaye, S., Hailemariam, Z., Tamerat, N. and Muktar, Y. (2017). Sero-Prevalence of Small Ruminant Brucellosis in Three Selected Districts of Somali Region, Eastern Ethiopia. *J. Vet. Sci. Anim. Hus*, 5(1):105.
53. Wubishet, Z., Golo, D., Chala, F., Shubisa, A., Huqa, L.G.H. and Ararsa, D. (2017). Sero-Prevalence of Brucellosis in Goats and Community Awareness in Liban District of Guji Zone, Oromia Regional State, Southern Ethiopia. *JOJ Pub Health*, 2(3):555587.
54. Adem, A., Hiko, A., Waktole, H., Abunna, F., Ameni, G. and Mamo, G. (2021). Small Ruminant Brucella Sero-prevalence and potential risk factor at Dallo-Manna and Haranna Bulluk Districts of Bale Zone, Oromia regional state, Ethiopia. *Ethiopian Veterinary Journal, 25*(1):77-95.

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