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Review Article

Epidemiology and Risk Factors, and Effect of Brucellosis in Cattle Production in Ethiopia: A Review

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Present the prevalence rates and effects of brucellosis in the abstract. Additionally, present the the major *Brucella* spp which affect cattle and human health

This review denotes the epidemiology and risk factors, and effect of Brucellosis in Cattle Production in Ethiopia. Brucellosis is an infectious bacterial disease caused by member of the genus Brucella. Bovine Brucellosis is an important disease of cattle which has zoonotic importance with substantial economic losses. Risk factors to brucellosis include animal factors, pathogen factors, environmental factors, managemental factors and occupational risk factors. 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 because of abortion and reduction in milk yield. In Ethiopia, Brucella sero prevalence within extensive cattle rearing system is lower than that of intensive systems. Vaccination of animals is effective to control the disease. Perception and awareness of potential risk groups about zoonotic and economic importance of brucellosis can be enhanced through veterinary extension education.

Keywords: Brucellosis; Cattle; Public Health; Sero- Prevalence

Introduction

Ethiopia is home for about 60 million cattle, 31 million sheep and 30 million goats in the rural sedentary areas [1]. On the other hand, the share of the livestock sector to the national economy has been reported to be small compared to its potential. One of the main causes of the mismatch is undoubtedly the widespread occurrence of huge numbers of infectious diseases, which drastically reduce animal production [2]. Brucellosis is an infectious disease of domestic and wild animals with serious zoonotic implication in humans. It is significant zoonotic disease prioritized next to rabies [3]. It is caused by bacteria of the *Brucella* genus. Six species (*B. abortus, B. melitensis, B. suis, B. ovis, B. canis, B. neotomae)* [4] whereas [8] reported several closely related species of the genus Brucella have been recognized, namely *B. abortus*, *B. melitensis*, *B. suis*, *B. ovis*, *B. canis*, *B. neotomae*, *B. pinnipedialis*, *B.ceti*, *B. microti*, and *B. inopinata* [8].

Bovine brucellosis is mainly caused by *Brucella abortus*; to a lesser extent by *B. melitensis* and occasionally by *B. suis* [5]. The economic and public health impact of brucellosis remains of particular concern in developing countries [6]. The disease can affect almost all domestic species and cross transmission can occur between cattle, sheep, goat, camel and other species [7]. It has negative economic impact causing reproductive wastage through infertility, delayed heat, loss of calves, reduced meat and milk production, culling and economic losses from international trade bans [9]. Brucellosis is considered as neglected zoonotic disease by the World Health Organization (WHO). Millions of individuals are at risk worldwide, especially in countries where infection in animals has not been brought under control and standards of hygiene in animal husbandry are low [10]. Materials excreted from the female genital tract are the main supply of organisms for transmission to other animals and man [11]**.** The disease is transmitted to man mainly by direct contact with infected livestock or through consumption of raw or uncooked animal products [12]. The epidemiology of brucellosis in livestock and humans as well as appropriate preventive measures is not well understood in developing countries like Ethiopia [13]. The disease spreads from one herd to another due to movement of infected animals. Hence, lack of biosecurity measures play a great role in the increment of the prevalence of brucellosis [14]. Therefore, the objective of this paper is to review the epidemiology and risk factors, and effect of Brucellosis in cattle production in Ethiopia.

Epidemiology, risk factors and zoonotic implications and economic losses of brucellosis in Ethiopia

Epidemiology of the Disease

Geographic distribution

Brucellosis is a worldwide highly contagious bacterial disease affecting both animal and human. *Brucella abortus* is found worldwide in cattle-raising regions, except in Japan, Canada, and some

European countries. Australia, New Zealand, and Israel are among few countries where it has been eradicated. Eradication of the disease from domesticated herds is nearly complete in the USA. *B abortus* can be found in wildlife hosts in some regions, including the Greater Yellowstone Area of North America [14].

Nowadays the disease is rare in many developed nations because of routine screening of domestic livestock and animal vaccination programs. This disease, however, is a leading cause of zoonotic infections in developing countries and is a disease of economic importance [16]. Bovine brucellosis has been reported from several parts of Ethiopia, the sero-prevalence of bovine brucellosis in cattle is under traditional extensive husbandry [17]. In Borena zone of oromia region, and Ethiopia. The highest sero-prevalence (50%) was documented using ELISA [15].

Occurrence and prevalence of cattle Brucellosis in Ethiopia

The disease was observed in most countries in the Sahel, with Ethiopia, Chad, Tanzania, Nigeria, Uganda, Kenya, Zimbabwe and Somalia reporting brucellosis in humans attributed to domestic cattle, camels, goats and sheep calculated an estimated sero-prevalence of 16.2% with in cattle in sub-Saharan African [16].

In Ethiopia, most research done on brucellosis has been focused on intensive dairy cattle herds in urban and peri-urban areas. In 1987, the World Organization for Animal Health (OIE) reported a prevalence of 20%; the prevalence was higher around large towns than in rural areas. Since the first report of brucellosis in the 1970's in Ethiopia, the disease has been noted as one of the important livestock diseases in the country [18]. The individual sero-prevalence ranges from 1.1% to 22.6% in intensive management systems [16] and 0.1–15.2% in extensive management system [19]. In zebu cattle of the central highlands, a prevalence of 4.2% was reported [20]. Another study from Addis Ababa, reported a prevalence of 10% [21]. A study conducted on smallholder farmers of central Ethiopia (Wuchale Jida district) reported a prevalence rate of 11% [22].

In cattle under extensive management systems, studies conducted in different regions of Ethiopia between 2003 and 2005 reported individual-level prevalence rates of 0.8% and 3.2% and herd-level prevalence of 2.9% and 42.3% respectively [23]. The overall sero prevalence of bovine brucellosis in pastoral and agro pastoral regions of East Showa Zone, Oromia Regional State, was 11.2% by the Rose Bengal Plate Test (RBPT). This report was within the range 10 to 15% that was estimated for any assumed brucellosis sero-prevalence for East Africa [24].

According to study of bovine Brucellosis in cattle under traditional production system in North- West Ethiopia Benishangul-gumuz, among the 1,152 cattle screened for *B abortus* antibodies, 14 (1.2%) tested positive by RBPT. Of these, 11 animals (79%;) were confirmed positive by complement fixation test (CFT), giving an apparent sero-prevalence of 1.0% in the study area [25].

Ethiopia 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. The country has several institutionally owned commercial dairy farms, mostly situated in and around the capital city and in some regional towns. These farms have been the focus of most of Brucella surveys, potentially producing a bias in reported findings [13]. The prevalence reports in table 1 have been systematically reviewed as intensive and extensive management systems of various regions in Ethiopia. Studies showed that, Brucella sero prevalence with in extensive cattle rearing system is lower than that of intensive systems.

Table 1: Prevalence of Bovine brucellosis in different parts of Ethiopia.

Study area	Test used	Prevalence (%)	Author(s)
Tselemti, Tigray	RBPT/CFT	4.80	[39]
Tigray Region	CFT	7.7	[41]
Alage, Oromia	c-ELISA	2.2	[40]
Shinile,Somali region	CFT	6.6	[19]
Amhara Region	CFT	4.63	[42]
Benshangul Gumuz	RBPT/CFT	1.2/1	[25]
Sidama Zone, SNNP	CFT	2.46	[43]
Borena Zone	CFT	4.7	[19]
Peri-urban dairy farm	CFT	1.9	[44]
Breeding Farm	CFT	1.5	[44]
Commercial farm	CFT	2.4	[44]
Becho, Oromia	RBPTI-ELISA	3.39/1.04	[45]
Debrezeit, Central Ethiopia	RBPT/CFT	3.3/2	[46]
Adadle, Somali	I-ELISA	1.5	[47]

Source of infection and mode of transmission

Brucellosis occurs worldwide in domestic and game animals and it is one of the major drug neglected disease [13]. 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 [16].

Furthermore, the increasing towards intensification of animal production favors the spread and transmission of the infection [13]. 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 [26]. 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 newborn calves; all of which may contain a large number of organisms and constitute a very important source of infection [16].

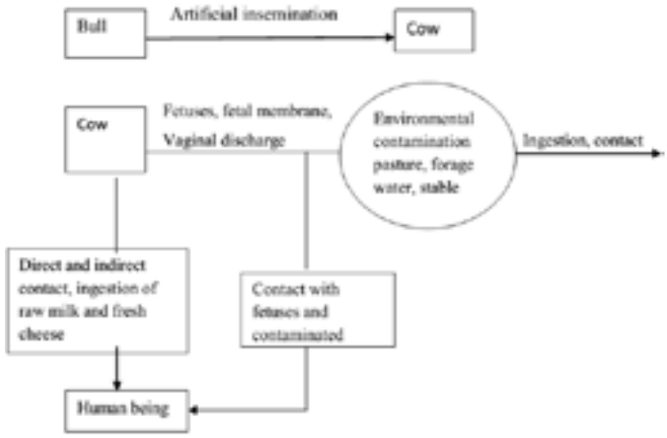

Figure 1: Mode of transmission of bovine brucellosis (*B. abortus*) [5].

Clinical signs in animals

The incubation period varies between 14 and 120 days. Primary clinical manifestations of brucellosis among livestock are related to the reproductive tract. In highly susceptible non vaccinated pregnant cow, abortion occurs after the 5 months of pregnancy; in bull orchitis and epididymitis are cardinal signs [16]. Abortion with retention of placenta and resultant metritis may cause prolonged calving interval and permanent infertility [26].

In cattle, *B abortus* causes abortions, stillbirths, weak calves and decreased lactation. Epididymitis, seminal vesiculitis, orchitis and testicular abscesses are sometimes seen in bulls. Infertility occurs occasionally in both sexes, due to metritis or orchitis/epididymitis. Hygromas, particularly on the leg joints, are a common symptom in some tropical countries. Arthritis can develop after long-term infections. Systemic signs do not usually occur in uncomplicated infections, and deaths are rare except in the fetus or newborn. Infections in non-pregnant females are usually asymptomatic, but pregnant adult females infected with *B abortus* develop placentitis, which causes abortion between the fifth and ninth month of pregnancy. Even in the absence of abortion, there is heavy shedding of bacteria through the placenta, fetal fluids and vaginal exudates. The mammary gland and regional lymph nodes can also be infected and bacteria can be excreted in milk [27].

Risk factors of cattle brucellosis

Animal factors

Susceptibility of cattle to *B.abortus* infection is affected by the age, sex and reproductive status of the individual animal. Sexually mature pregnant cattle are more susceptible to infection than sexually immature cattle. Susceptibility increases as stage of gestation increases [13]. Sexually mature and pregnant animals are more susceptible to brucellosis than sexually immature animals of either sex [48]. However, variations in the age of sexual maturity among breeds could present differences between age and brucellosis positivity [48].

Pathogen factors

Brucella abortus is intracellular pathogen which is able to survive and replicate within phagocytic cells. It can persist on fetal tissues and soil or vegetation for 21-81-days depending on the month, temperature, and exposure to sunlight. *B. abortus* can persist up to 43-days in oil and vegetation at naturally contaminated birth or abortion sites [28].

The organisms are able to survive within host leukocytes and may utilize both neutrophils and macrophages for protection from humoral and cellular bactericidal mechanism. The inability of the leukocytes to effectively kill virulent *B. abortus* at the primary site of infection is a key factor in the dissemination to regional lymph nodes and other sites such as reticuloendothelial system and organs such as the uterus and udder. The congregation of a large number of mixed ruminants at water points facilitates disease spread [29].

Environmental and climatic factors

Brucella can persist for months in water, aborted fetuses and fetal membranes, feces and liquid manure, wool, hay, on buildings, equipment and clothes. The survival of the organism in the environment plays a great role in the epidemiology of the disease [30]. Brucella is also able to withstand drying particularly in the presence of extraneous organic material and will remain viable in dust and soil [28]. Temperature, humidity and pH influence the organism's ability to survive in the environment. Brucella is sensitive to direct sunlight, disinfectant and pasteurization [29].

Management risk factors

The spread of the disease from one herd to another and from one area to another is due to the movement of infected animals from an infected herd into a non-infected susceptible herd. Hence, lack of strict movement control, lack of proper hygienic practices and poor husbandry practice play significant role in the spread of brucellosis

[30]. Introduction of infected purchased cattle and insemination with semen from infected bull are the main risks associated with cattle brucellosis. Poor husbandry methods and lack of effective disposal of biological materials and carcasses into the environment cause significant environmental contamination and scavengers and rodents play a considerable role in the prevalence of the disease [48].

Occupational risk factors

People who work with animals or with infected blood are at higher risk of brucellosis. Examples include: laboratory workers, veterinarians, dairy farmers, ranchers, slaughterhouse workers, hunters, microbiologists and farmer and also those handling artificial insemination, abattoir and slaughterhouse personnel working in endemic areas are at risk. Brucellae are considered as potential bio weapons [31]. Veterinarians, laboratory workers, butchers, breeders, hunters, and cattle rearing farmers are at high risk of acquiring infection through close direct contact with contaminated biological materials or infected animals and accidental exposure to culture and inactivated brucella cells. Cattle brucellosis in man is most often a disease of occupation [48].

Figure 2: Risk factors for Brucella infection in animals [31].

Zoonotic Implication, and Effect of Brucellosis in cattle production in Ethiopia

Zoonotic Implication of Brucellosis

Brucella abortus, B melitensis and *B suis* are highly pathogenic for humans [27]. Brucellosis causes serious human infections in the world, with more than 500,000 new cases reported annually [33]. The actual number of cases, including undetected and unreported cases, is believed to be considerably higher [34]. Brucellosis is often a neglected disease despite being endemic with high zoonotic potential in many countries [30]. The prevalence of human brucellosis differs between areas and has been reported to vary with standards of personal and environmental hygiene, animal husbandry practices, and species of the causative agent and local methods of food processing [16].

The majority of reported human brucellosis cases are caused by *B melitensis*, *B abortus*, and *B suis*, in occurrence order, novel and a typical *Brucella* are also being investigated [34]. Human brucellosis in Ethiopia is not sufficiently investigated and hence there is less information on risk factors for human infection. Study showed, out of 56 cases with fever of unknown origin two (3.6%) were reported to be positive for *B. abortus* antibodies by RBPT and CFT [35]. Other studies conducted in traditional pastoral communities using *B. abortus* antigen indicated that 34.1% patients with febrile illness from Borena, 29.4% patients from Hammer, and 3% patients from Metema areas were tested positive using *Brucella* IgM/IgG lateral flow assay [16].

Humans can be infected by ingestion of unpasteurized milk, direct contact with the skin or mucosa during parturition and abortion or by handling specimens containing *Brucella* spp. in laboratory. Cattle are natural hosts for *Brucella abortus*, and sheep *(Ovis aries*) and goats (*Capra hircus*) for *B melitensis* and *B ovis*, respectively. Humans are susceptible to *both B abortus* and *B melitensis,* the latter being most frequently reported in humans [32]. The most common signs and symptoms of human brucellosis are fever, asthenia, myalgia, arthralgia, sweats, lymphadenopathy, hepatomegaly and splenomegaly. Oste-oarticular manifestations (peripheral arthritis, sacroiliitis, spondylitis) are the most common forms of localized disease [16].

Economic losses associated with animal brucellosis

Bovine brucellosis causes huge losses to the dairy Industry. Economic impact can include direct (e.g., reduced milk yield, increased mortality) and indirect (e.g., vaccination, culling) costs. Direct impacts may further be classified as visible (e.g., abortion, repeat breeding), invisible (e.g. lower fertility), additional costs (e.g. treatment, vaccination) and revenue forgone (e.g. distress selling) [31]. Brucellosis in developing countries has multiple economic implications across agriculture and public health and broader socio-economic development sectors. There should be a paradigm shift to control Brucellosis in developing countries. Simply replicating past successes in brucellosis control and eradication in developed countries will not work. Low-income countries have at least a ten-fold higher burden of infectious disease from a wide variety of pathogens [36].

The assessment of the economic aspects of brucellosis is higher in low-income countries of Africa and Asia. The tools and approaches for assessing and control programs are of relevance to low-income countries [37]. When brucellosis is detected in a herd, flock, region, or country, international veterinary regulations impose restrictions on animal movements and trade, which result in

huge economic losses. The economic losses as well as its zoonotic importance are the reasons why programs to control or eradicate brucellosis in cattle [27]. In Ethiopia, information on losses specifically through brucellosis in the different types of production systems is sparse, except for [38] who reported an annual loss from brucellosis estimated to be 88,941.96 Ethiopian Birr ($5231 equivalent) among 193 cattle, largely due to reduced milk production and abortions in Chaffa State Farm, Wollo [38].

Conclusion

Brucellosis is worldwide and has high prevalence in different areas of Ethiopia. Brucellosis affects both animals and humans, and has a very high economic and public health negative impacts. 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 production because of abortion and reduction in milk yield. Even though the disease is prevalent in Ethiopia, only few reports exist in human cases and its effect in cattle production. 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 Replacement stock should be purchased from herd known to be free of brucellosis.

Recommendation

Comprehensive study of brucellosis should be conducted in Ethiopia.

Competing Interests

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