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Review

Review of common causes of abortion in dairy cattle in Ethiopia

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Abortion in dairy cattle may be caused by infectious and non-infectious agents. Infectious causes of abortion in dairy cattle include brucellosis, leptospirosis, listeriosis, Q fever, bovine viral diarrhea, mycotic abortion and neosporosis. Non-infectious causes of abortion in dairy cattle are genetic and non-genetic disorder. Risk factors associated with abortion in dairy cattle are genetic, environmental, management, geographical factors and infectious factors. Abortion in dairy cows brings about breeding and productive damages. Abortions cause significant economic loss to dairy farm. These losses can be attributed to loss of replacement calves, reduced milk production, costs of treatment, feeding of animals and premature culling of productive cows and heifers. Diagnosis of bovine abortion includes the collection of a complete history of the case and relevant epidemiological data and collected sample for analysis. However, determining the cause of bovine abortion is difficult as abortions are caused by numerous infectious and noninfectious factors. Status of abortion and breeds affected by abortion in Ethiopia were also reviewed.

Key words: Causes, abortion, dairy cattle, Ethiopia.

INTRODUCTION

Ethiopia has the largest livestock population in Africa, with a total cattle population of 57.83 million. Out of this total cattle population, the female cattle constitute about 55.38% and the remaining 44.62% are male cattle. At present, about 99% of Ethiopia's national herd is of local breeds managed under extensive farming systems (CSA, 2016). The livestock contributes about 16.5% of the national Gross Domestic Product (GDP) and 35.6% of the agricultural GDP. It also contributes 15% of export earnings and 30% of agricultural employment (Leta and Mesele, 2014). However, the rate of urbanization is high, which places challenges on farmers and government to meet the demand for food (red meat and dairy products) for an increasing population. To increase livestock productivity and satisfy the increasing demand for livestock products, Ethiopia has given more attention to breed improvement, pasture development and animal health (Azage et al., 2001; Shapiro et al., 2015).

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Ethiopia has paid considerable attention to livestock productivity (meat and milk) through breeding and health interventions to increase the contribution of livestock to economic growth as well as to meet the increasing local demands. The country has given priority on the development of dairying at farmer's level to increase the supply of milk from smallholder dairy farms (Zegeye, 2003). However, reproductive health problems are becoming the major obstacles hindering this development plan (Adane et al., 2014; Ararsa and Wubshet, 2014). Among these, abortion is the main constraint in sector development plan to achieve its goal. Moreover abortion has direct impacts on reproductive performance of dairy cows (Lobago et al., 2006; Ernest, 2009). Abortion is defined as the termination of pregnancy between 42 and 260 days of gestation (Peter, 2000). The diagnosis of abortions is challenge to the farmers and veterinarian. There is sudden and dramatic increase of abortion in herds over a long period of time (Hossein-Zadeh, 2013).

Bovine abortion has infectious and none infectious causes (Hovingh, 2009). Infectious causes of abortion associated with abortion in cattle include viruses, bacteria, protozoa and fungus. The exact proportion of cases due to infectious agents is not known, but in 90% of cases in which an etiologic diagnosis is achieved, the cause is infectious (Parthiban et al., 2015). These pathogens can result in extensive economic losses, indicating the need for control measures to prevent infection or disease (Givens and Marley, 2008). Non-infectious factors such as genetic and non-genetic disorders have been reported in some investigations. The most important non genetic factors are heat stress, production stress, seasonal effect and seasonal changes (Hansen, 2002; Sani and Amanloo, 2007). The most important genetic disorders include chromosomal and single gene disorders and these disorders result in high abortion rate in cows and increased calf sterility. Cow parity, sire effect, age at conception and abortion history could be some of the non-infectious maternal and paternal factors that cause abortion (Thurmond et al., 2005; Lee and Kim, 2007).

Abortions have a highly negative impact on reproductive efficiency, resulting in significant economic losses for the cattle industry (De Vries, 2006). Spontaneous abortion of dairy cows is the most common problem that contributes substantially to low herd viability and decreasing production potential by reducing the number of potential female herd replacements and lifetime milk production, and by increasing costs associated with breeding and premature culling (Thurmond et al., 2005). The cost of abortion depends mainly on the time of gestation, milk production and time of insemination after parturition, the cost of nutrition, sperm costs, insemination time and labor costs (Rafati et al., 2010). Late term abortions could also result in loss of potential replacement heifers, early culling of productive cows and loss in herd's potential calf production (Carpenter et al., 2006). The prevalence rate of abortion varies in different production system and from place to place. Prevalence rate of abortion in Ethiopia range from 2.2 to 28.9% (Table 3) (Gizaw et al., 2007; Siyoum et al., 2016). This difference in prevalence rate may be due to variation in cattle breed and husbandry management system. Eshete and Moges (2014) indicated that incidence of abortion of more than 2 to 5% should be viewed seriously, efforts should be made to determine the causes and measures should be taken to control abortion. This paper reviews common cause of abortion, economic important and risk factor of abortion in dairy cattle.

ABORTION IN DAIRY CATTLE

Abortion is the termination of pregnancy at a stage where the expelled fetus is of recognizable size ranging from 45 to 260 days of gestation and not viable (Peter, 2000). Sarder et al. (2010) also defined abortion as a condition in which fetus is delivered live or dead before reaching the stage of viability where the delivered fetus is visible by naked eyes. Some diseases that cause abortion in cattle, such as brucellosis, Leptospirosis are also zoonotic (Levett, 2005; De Vries, 2006). The important infectious agents that have been reported to cause abortion in cattle can be viral, bacterial, protozoa as well as several fungal species among others (Table 1) (Juyal et al., 2011). In addition, any disease causing high fever may also cause abortion (Radostits et al., 2007).

Common infectious causes of bovine abortion

Brucellosis

Brucellosis is an important disease of humans, and domestic and wild animals worldwide and is also a serious zoonosis (Mekonen et al., 2010). In female cattle, the disease is characterized by abortions storms in pregnant cattle, infertility, mastitis, retained placentae and arthritis (Radostits et al., 2007). Infected cow usually abort between the fifth and seventh month of pregnancy. Abortion due to brucellosis commonly occurs during the last trimester of pregnancy (Parthiban et al., 2015). All these manifestations lead to losses in the production system. Several species of the bacterium *Brucella* can cause brucellosis in cattle; however, *Brucella abortus* is the primary bovine pathogen (Godfroid et al., 2011). Brucellosis in cattle is spread by ingestion of contaminated pasture, feed and water, licking aborted foetuses or genital exudates from recently aborted cows or carrier cattle that have calved normally. However, with infection through injured/intact skin, the mucosa at the respiratory system and conjunctiva frequently occurs (Acha and Szyfres, 2001; Degefa et al., 2011).

While vaccination of cattle with strains S19 and RB51 has been the cornerstone of brucellosis control programmers in the developed world, adequate information on its occurrence in the developing world is lacking and the adoption of control programmers is still low (Godfroid et al., 2011). Several risk factors for bovine brucellosis have been reported. Among these are increased herd sizes, increased age, sex of the animal, husbandry practices such as animal confinement, contact with wildlife, geographical area and keeping different breeds in a herd (Muma et al., 2007; Tolosa et al., 2010; Matope et al., 2010; Mekonen et al., 2010).

Various techniques have been used to diagnose bovine brucellosis. These include the use of staining techniques, such as modified acid fast staining, culture and molecular techniques, such as polymerase chain reaction. However, in most epidemiological studies, serological tests, such as serum agglutination test (SAT), Rose-Bengal test (RBT), Buffered plate agglutination test (BPAT), fluorescence polarization assay (FPA) and ELISA, are often used. The limitations to the use of serological tests are false positives from vaccinated animals, cross-reactivity with other Gram-negative bacteria, and low sensitivity from tests such as SAT and RBT (OIE, 2009).

Leptospirosis

Leptospirosis is a contagious, bacterial disease of animals and humans. It is a globally important zoonotic disease caused by the pathogenic Gram negative bacteria of the genus, *Leptospira* (Bharti et al., 2003). The disease occurs worldwide, it is most common in temperate regions in the late summer and early fall and in tropical regions during rainy seasons (Tilahun et al., 2013). Although, the incidence of disease seems to have decreased in developed countries, it is apparently emerging rapidly as a significant public health problem in developing countries (Tangkanakul et al., 2000).

All mammals appear to be susceptible to at least one species of *Leptospira*. The primary reservoir hosts for most *Leptospira* serovars are wild mammals, particularly rodents. Reservoir hosts among domestic animals includes cattle, dogs, sheep and pigs and they may act as carriers for several months (temporary carrier) while rodents usually remain carrier throughout their life (permanent carrier) (Sophia, 2013). Rodents are therefore considered as the major reservoir of infection. The specific reservoir hosts vary with the serovar and the geographic region (OIE, 2005). In cattle, leptospirosis has been characterized by a wide variety of conditions including fever, icterus, hemoglobinuria, abortion and death. Cattle are the maintenance hosts for *Leptospira* serovar *hardjo* and *Leptospira borgpeter-senii* serovar *hardjo*, and incidental hosts for serovar pomona which is maintained in swine (Parthiban et al., 2015).

Leptospirosis can be transmitted either directly between hosts or indirectly in the environment. *Leptospira* species can be ingested in contaminated food or water, spread in aerosolized urine or water, or transmitted by direct contact with the skin. The organisms usually enter the body through mucous membranes or abraded skin. They may also be able to penetrate intact skin that has been immersed for a long time in water (Sophia et al., 2014). *Leptospira* species are excreted in the urine and can be found in aborted or stillborn fetuses, as well as in normal fetuses or vaginal discharges after calving (Levett, 2001).

Leptospirosis of animals is investigated by direct and indirect laboratory methods. Direct methods are the isolation of the causative agent and the identification of *Leptospira* species antigens in tissue and body fluids using methods such as immunofluorescence staining, immunochemistry immune peroxidase staining, silver staining and various methods of polymerase chain reaction (PCR) (WHO, 2006). Direct visualization of leptospirae in blood or urine by dark field microscopic examination has been used for diagnosis. But artefacts are commonly mistaken for leptospirae and the method has both low sensitivity and specificity (Vijayachari et al., 2001). For early diagnosis, serum is the optimal specimen. Urine from severely ill patients is often highly concentrated and contains significant inhibitory activity (Brown et al., 2003). The indirect methods of investigating leptospirosis are based on the detection of specific serum antibodies. These methods are either methods detecting serum antibodies without discriminating serovars, such as various ELISA tests, indirect immunofluorescence, the spot agglutination test or methods reliably identifying the infecting serovars, such as the microscopic agglutination test (MAT). Microscopic agglutination test (MAT) is used as the 'gold standard' serological tests even though the test is very tedious and requires the maintenance of several leptospiral serovars in the laboratory. Also, the test requires the expertise personnel to read the results (Ooteman, 2006).

Understanding the epidemiological features of leptospirosis is a critical step in designing interventions for reducing the risk of the disease transmission (Levett, 2001). Intervention strategies can target many points in the transmission cycle of leptospirosis. Although, little can be done in wild animals, leptospirosis in cattle is controlled through vaccination, prophylactic treatment of exposed cattle with antibiotics, quarantining of newly introduced cattle for at least 4 weeks, rodent control, regular serological testing, improved environmental hygiene, separating young animals from adults and safe artificial insemination (Dhanze et al., 2013).

Leptospirosis could result in a "storm of abortions" causing considerable economic losses from meat and milk reductions. Furthermore, these losses appear as more significant among cattle, because this animal

Table 1. Infectious causes of abortion in dairy cattle in Ethiopia.

Bacteria	Fungal	Protozoan	Viral
Campylobacter fetus	Aspergillus fumigatus	Neospora caninum	Bovine herpesvirus1
Histophilus somni	Mucor spp	Tritrichomanas fetus	Bovine viral diarrhea virus
Ureaplasma spp.	Morteriella wolfii	Toxopllasma gondii	Bluetongue virus
Brucella abortus		Anaplasma marginale	Epizootic bovine abortion
Leptospira spp.			Schmallenberg virus
Listeria monocytogene; Arcanobacterium pyogenes; Chlamydophila spp.; *Salmonella; Coxiella burnetti*			

Source: Givens and Marley, 2008.

species are considered less resistant than small ruminants (Tooloei et al., 2008). Abortion may occur several weeks after infection of the dam and is usually not associated with any obvious illness in the cow. Abortions due to serovar *hardjo* infection tend to occur sporadically. But abortion "storms" may occur as a result of infection with serovars *pomona* or *grippotyphosa.* Abortion storms are more common when the weather is wet and there is standing water that is contaminated with infective organisms (Bharti et al., 2011). Abortion usually occurs during the last trimester of pregnancy but can occur from the 4th month onwards. Infertility and milk drop occurs only in pregnant or lactating cows because *Leptospira* organisms prefer pregnant uterus and lactating mammary gland to proliferate (Yadeta et al., 2016).

Although, there is few documented information so far concerning the occurrence of leptospirosis in animals in Ethiopia, climatologic, socioeconomic and other factors are highly favorable for the occurrence and spread of the disease in the country. In Ethiopia, leptospirosis has been reported to occur in domestic animals working in Ethiopia, with incidences of 70.7% in cows (Yadeta et al.*,* 2016*)*. In the case of human leptospirosis, there is a pilot study in Wonji Hospital. According to Eshetu et al. (2004) from a total of 59 febrile patients attending the outpatient department of Wonji Hospital, 47.5% were positive for leptospirosis and the occurrence of the disease was more common in males than females.

Listeriosis

Listeriosis is an infectious disease of human and animals with a world-wide distribution. It manifests in three major clinical forms, meningoencephalitis, abortion and septicaemia (Hirsh et al., 2004). Listeriosis is caused by a member of the genus Listeria. Majority of the clinical cases are associated with *Listeria monocytogenes* infection. Only a few reported cases have been associated with *L. ivanovii* (Radostits et al., 2007). *Listeria* species are found widely throughout the environment. *Listeria* can be ingested with poorly preserved silage which is not fermented properly and is not acidic enough to kill the bacteria. It can be ingested via soil on the grass roots and also the placenta and discharges from the infected cow (Aderson, 2007).

Listeria monocytogenes is a well-recognized cause of abortion, encephalitis and septicemia in cattle*. Listeria ivanovii* has also been implicated as a cause of abortion in cattle but occurs less frequently than *L. monocytogenes.* Abortion occurs after ingestion of *L. monocytogenes* contaminated feed and a resultant bacteremia. Experimental studies have shown that after ingestion or parenteral injection of *L. monocytogenes*, the genital organs and foetus are invaded within 24 h of the onset of bacteremia. This results in abortion in 5 to 10 days (Radostits, 2007). *Listeria* infections and abortions usually develop in the late winter or early spring. Abortions are most commonly recognized in the last trimester of pregnancy and abortion storms can occur when all herd eat same batch of contaminated silage at same time (Yaeger et al., 2007).

In abortion, the pathological picture depends on the stage of pregnancy. If it occurs in the early stages of the last trimester, the placenta is quickly invaded by the bacteria and the foetus dies as a result of septicaemia. The dead foetus is expelled within 5 days and by this time autolytic changes cover the minor gross lesions produced by the organism. Metritis usually occurs and results in retention of the foetal membranes. If it occurs at a late stage, the offspring may be born in the normal way but is usually unable to survive. In the aborted foetus the lesions are less severe. Gross lesions are tiny pin-point yellow foci in the liver. Similar foci but visible only microscopically are seen in the lung, myocardium, kidney, spleen and brain. The bacteria can be demonstrated in the center of these focal areas (Thomson, 1988; Quinn et al., 2002).

The organism is sensitive to a wide range of antibiotics. Culling infected animals should be advocated as they secrete the organisms in secretions and excretions, especially in the cases of mastitis. Care in the use and preparation of silage is important as the pathogen grows

luxuriantly at a pH greater than 5.5 (Walker, 2007). Farm management practices, such as improvement of nutritional status of animals and better housing conditions, can also be of some value in preventing disease (Dhama et al., 2017).

In Ethiopia, few findings of *L. monocytogenes* have been reported, possibly due to lack of attention or resources (Molla et al., 2004). Study conducted by Seyoum et al. (2015) showed that prevalence of *Listeria* species was 28.4% and specifically that of *L. monocytogenes* was 5.6% from raw bovine milk and milk products from central highlands of Ethiopia. Other study conducted in Gondar on foods of animal origin indicated that 25% were positive for Listeria species and that of *L. monocytogenes* was 6.25% (Garedew et al., 2015)

Mycotic abortions

Mycotic abortion causes great economic losses to the individual farmer and cattle-breeding industry as a whole. Mycotic infection of the placenta is one of the most common causes of sporadic bovine abortion (Ali and Khan, 2006). Mycotic abortion is caused by different species of fungi and yeasts. About 35 different species of fungi have been known to cause abortion, *Aspergillus fumigatus* being the most commonly diagnosed casual organism which accounts for 60 to 80% of abortions. 20 to 35% of abortions have been attributed to fungal causes (Pal, 2015). *Aspergillus fumigatus* is the cause of over 70% mycotic abortions recorded in cattle, around the world (Ali and Khan, 2006)

Abortion occurs when fungal spores enter a pregnant cow's blood stream, settle at the junction of the maternal and foetal placentas, grow and attack the placental tissues (Walker, 2007). In general, fungal spores may be present in cattle feed. However, some feeds such as improperly preserved silage and hay that has been wet, contain many more spores than others. Storm of abortion occur in cattle when feeding with mouldy hay at same time. The mycotic abortions were confirmed by isolation of *Aspergillus fumigatus* fungi from mouldy hay as well as from foetal abomasal contents (Chandranaik et al., 2014).

Pregnancy in a cow with metabolic derangements from stress may predispose the pregnant cow to fungal infection. The incidence of the condition is high in late summer or early autumn, due to the presence of large number of fungal spores in pastures during this period (Ali and Khan, 2006). There is also evidence of a winter rise of disease incidence. The organism may cause abortion from 4 months to term. Other species of molds and yeasts have been associated with abortion (Parthiban et al., 2015).

Any condition that reduces the cow's resistance to infection increases the chances of mycotic abortion. Providing good health (via good management and nutrition) and not feeding moldy feeds can reduce the incidence. When possible, depending on the availability and demand decreases the period of confinement, decrease cow density and improve ventilation (Pal, 2015).

Query fever (Q fever)

Q fever is a zoonosis of worldwide distribution caused by Gram-negative intracellular bacteria *Coxiella burnetii*, which can infect arthropods, birds and animals (Cutler et al., 2007). Currently it is not possible to accurately estimate the true prevalence infection in domestic ruminants, due to lack of well-designed studies. However, there has been detection of *C. burnetii* in all five continents (except in New Zealand being the only country with a reported apparent prevalence of zero), with a wide range, in whatever kind. The apparent prevalence is slightly higher in cattle (20.0 and 37.7%) than in sheep and goats (around 15 to 25%) (Guatteo et al., 2011).

Infections by *C. burnetii* in animal production are mostly asymptomatic, however, may be related to reproductive disorders such as abortion, stillbirths, repetition heat, low birth weight animals and metritis. Nevertheless, latter clinical manifestation appears to be unique in cattle, occurring during first three weeks after birth, with fetid vaginal discharge and/or increase in body temperature (Sheldon et al., 2006).

In most cases, abortion occurs in late pregnancy which range from 3 to 80% with unspecified characteristic clinical signs of infection with *C. burnetii* (Angelakis and Raoult, 2010). Aborted fetuses appear normal but infected placentas exhibit intercotyledonary fibrous thickening and discolored exudates, which are not specific to Q fever (Arricau-Bouvery and Rodolakis, 2005). *Coxiella burnetii* can also be recovered from milk for up to 32 months. Furthermore, there may be shedding bacteria in the urine, semen and vaginal discharge mucus. An important factor related to abortion rates in herds is the temperature, since fewer abortions take place between months of November and December. However, this occurrence increases gradually from January to February, decreasing again in March (Cantas et al., 2011).

A relevant issue is infestation of cattle by ticks during months when temperature is higher. Previous studies have shown that ticks seem to play an important role in the dissemination of bacteria in animals, especially wild, believing it to be an important factor in the transmission to domestic animals (Psaroulaki et al., 2006). On the other hand, a recent study developed in the Netherlands, after three years of an outbreak of Q fever, researchers investigated the role ticks play in the transmission *C. burnetii*, showing that actual risk of this infection by ticks is negligible. Moreover, for future risk assessments, it might be relevant to sample more ticks in the vicinity of previously *C. burnetii* infected goat farms and to assess

whether *C. burnetii* can be transmitted transovarially and transstadially in *Ixodus ricinus* ticks (Sprong et al., 2011).

Few studies conducted in Ethiopia indicated that 6.5% seroprevalence of *C. burnetii* was observed in Addis Ababa abattoir workers. Also, the existence of antibody against *C. burnetii* was reported in goats and sheep slaughtered at Addis Ababa abattoir, and its peri-urban zones. A seroprevalence of 31.6% of *C. burnetii* was recorded in cattle in South Eastern Ethiopian pastoral zones of the Somali and Oromia regional states (Gumi et al., 2013).

Bovine viral diarrhea (BVD)

Bovine viral diarrhea is a disease caused by bovine viral diarrhea virus (BVDV). Bovine viral diarrhea is one of the most important diseases of cattle worldwide (Almeida et al., 2010). It is an important cause of diarrhea, reproductive problems and reduced milk yield in affected herds (Lindberg and Houe, 2005). This is a Pestivirus in the family Flaviviridae that is closely related to border disease virus of sheep and classical swine fever virus of pigs (OIE, 2004). The disease occurs worldwide and infections may be subclinical in some animals (Lindberg and Houe, 2005). Bovine viral diarrhea virus can be persistent in infected animal and wild animal asymptomatic while shedding large amount of virus throughout their life time (Nelson et al., 2016).

Bovine viral diarrhea virus is transmitted by direct contact with saliva, faeces, semen, urine, tears and milk of infected cattle, or by in utero infection of fetuses (Radostits et al., 2007). Infection of naive pregnant cows and heifers may lead to abortion and other reproductive disorders, such as early embryonic death (the death of a conceptus within the first 2 months after conception) in the first 45 days, fetal death and mummification (Kabongo and Van Vuuren, 2004). Infection during the first trimester of pregnancy will cause storm of abortions approximately one month prior to parturition. Infection during the second trimester will often lead to a higher risk of birth defects and less abortion, and this is more common in beef cattle than dairy breeds. But in final trimester of pregnancy, there are no more effects (Van Campen, 2010). The other effects of BVDV are birth of calves with congenital defects, calves with poor growth rates, and increased average age at first calving in affected herds (Heuer et al., 2007). The virus has also been shown to depress ovarian function in infected heifers by disrupting gonadal steroidogenesis, and impairing the quality of oocytes produced (Fray et al., 2000; Altamarand et al., 2013). Infection from day 9 to 45 of gestation results in reduced conception rates and infertility, early embryonic death and infertility. From days 45 to 75 of gestation, infection with BVDV will result in abortions, intrauterine growth retardation, and calves with congenital defects especially of the nervous system.

Infection in late gestation (125 to 285) results in birth of normal calves with neutralizing antibodies (Grooms, 2004). This virus has a high affinity for leucocytes and reduces their numbers in infected animals. This immunosuppression potentiates the effects of other pathogens, including abortifacient ones, such as *Neospora caninum* (Bjorkman et al., 2000; Konnai et al., 2008).

Among the risk factors for BVDV infection in cattle are increased age and the origin of the animal (Mainar-Jaime et al., 2001); pasturing and increased herd sizes; and dam factors, such as high BVDV titres at calving and increased parity (Munoz-Zanzi et al., 2003). In addition, the use of artificial insemination breeding technique without the institution of biosecurity measures on the farm has been shown to increase the risk of BVDV spread by 2.8 times, most likely due to contamination of the herd through contaminated insemination equipment and personnel (Almeida et al., 2013).

Several methods have been developed to detect BVDV infection in cattle (OIE, 2008). These include virus isolation in bovine tissue culture (kidney, lung, testis and turbinate cells), immunohistochemistry to detect virus antigen in tissue, nucleic acid detection by polymerase chain reaction, and serological tests, such as virus neutralization and enzyme-linked immune sorbent assay (ELISA). Samples collected for analysis include: bulk milk to determine the herd status, individual milk, serum and plasma samples to determine individual animal sero-status, as well as tissue samples for immunohistochemistry. Serological tests, such as ELISA, are commonly employed in explorative studies since they can be used to determine the sero-status of large numbers of animals sampled in a population (OIE, 2008).

In Ethiopia, few studies conducted on the disease indicated that 9.6, 16.6 and 6.11% seroprevalence of BVDV was reported in dairy cattle herds in Jimma, south western Shoa, and West Shoa, respectively (Nigussie et al., 2010). Seroprevalence of 11.7% of BVDV was also reported in breeding and dairy farms of southern and central Ethiopia (Asmare et al., 2012). There is no study conducted to determine the rate of persistent of infection caused by BVDV in Ethiopia.

Neosporosis

Neosporosis is a disease caused by *Neospora caninum*. This is a protozoan coccidian parasite that structurally resembles and is genetically related to *Toxoplasma gondii* (Silva et al., 2007). There are two species of *Neospora* currently recognized: *N. caninum* which causes clinical disease in dogs, cattle, sheep, equines and many wild animal species, and *Neospora hughesi,* which has been associated with reproductive losses and myoencephalitis in horses. Dogs are the definitive hosts of *N. caninum* and cattle are among the intermediate

hosts (Hall et al., 2006; Fernandez et al., 2006).

Cattle become infected by ingestion of feed and water contaminated by oocysts shed in dog faeces, or by congenital infection (Jenkins et al., 2002; Pan et al., 2004). This parasite has been reported to be the most important cause of abortion and neonatal mortality in beef and dairy cattle populations worldwide including Ethiopia (Murray, 2006; Silva et al., 2007; Asmare et al., 2012).

Abortions in cattle due to *N. caninum* occur from 3 months of gestation but are most common from 5 to 6 months of pregnancy. *Neospora* can be associated with sporadic abortions, endemic or abortion storms in cows have been reported. Other signs presented by infected cattle are foetal resorption, mummification, autolysis and stillbirth, and some calves are born alive with neuromuscular defects, while other calves are apparently healthy but persistently infected (Dubey and Schares, 2006). The incidence of abortion is often repeated in subsequent pregnancies, and congenital/vertical transmission from seropositive dams to their offspring is important in the epidemiology of neosporosis (Dubey et al., 2007). Reported risk factors for bovine abortions due to *N. caninum* include geographical location, breed, exposure to dogs or wild carnivores, and pregnant heifers (Dubey and Schares, 2006; Asmare et al., 2013). Various methods have been used to diagnose neosporosis in animals.

These include histopathology of tissues from aborted foetuses and still-births, parasite isolation from sacrificed animals, inoculation in mice, molecular techniques such as polymerase chain reaction, and oocyst recovery from dog faeces. However, serology (ELISA and immuno-fluorescent antibody test [IFAT]) is the most common technique used to diagnose neosporosis since it can be done ante-mortem and postmortem. Serology is useful in epidemiological studies since it can be used to reliably test exposure and infection in large animal populations (Dubey and Schares, 2006; Silva et al., 2007). In Africa, reports on neosporosis are limited; however, the available information is in line with global understanding of the protozoan that underscores the relevance of the *N. caninum* to the dairy sector (Ghalmi et al., 2012). The general seroprevalence of this disease globally ranges from 1.9 to 39.7% (Njiro et al., 2011; Ayinmode and Akanbi, 2013).

Recent studies confirmed that neosporosis is prevailing in dairy cattle of Ethiopia (Asmare et al., 2012; Asmare et al., 2013). However, the available published information comparing different pathogens exposure vis-à-vis reproductive disorders is limited to a single article based on the data from central and southern part of the country (Asmare et al., 2013). Few studies conducted in Ethiopia indicated that seroprevalence of 17.2% of *N. caninum* was reported in breeding and dairy farms of southern and central Ethiopia and 13.3% seroprevalence was also recorded in intensive or semi-intensively managed dairy and breeding cattle of Ethiopia (Asmare et al., 2012,

2013). Neosporosis appears to be a highly prevalent and widely distributed infectious cause of bovine reproductive disorders in urban and peri-urban smallholder farms, commercial dairy farms and breeding cattle in Ethiopia (Asmare et al., 2013). *N. caninum* is common in dairy cattle and is probably a more important cause of abortion in dairy cattle in Ethiopia than other infection cause of abortion (Asmare et al., 2012). The general control and prevention of causes of abortion in dairy cattle summary in Table 2.

Risk factors of abortion

Several causative factors, including external, maternal and genetic factors, have been reported for abortion in dairy cattle. These include heat stress, season, milk production, cow parity, serum progesterone level after conception, the inseminating bull, twin pregnancy and the herd (Lee and Kim, 2007). However, other investigations have reported that milk production and cow parity were not associated with abortion (Moore et al., 2005). Parity status and breed were significant factors affecting the incidence of abortion (Yakubu et al., 2015). However, Haileselassie et al. (2011) reported that parity status had no significant effect on the incidence of abortion. Factors that have been reported to increase the risk of abortion in dairy cattle herds include: being a heifer; being a cow of more than 10 years old; feeding on communal pastures; lack of vaccination against abortifacient diseases, hygiene, animal management and reproductive problems such as retained placentae, dystocia, uterine prolapse and stillbirth in the previous pregnancies (Waldner and Garcia, 2013; Waldner, 2014). Risk factors such as environmental (nutrition, temperature extremes and toxins, among others), management (crowding and use of natural mating), geographical factors and infectious factors, with infections contributing up to 90% of the abortions also reported (Konnai et al., 2008; Mekonen et al., 2010). Environmental high temperature may affect inside-pens temperature and performance of dairy cattle. Omori et al. (2014) reported that hyperthermia during pregnancy causes abortion in dairy cattle. Environmental temperature also affect the level of aflatoxin in the feed given to animals where above tolerable level could be a predisposing stress factor; aflatoxin is more often found in fodder grown in warm and humid climates which support growth of moulds. It has been suggested that aflatoxin lowers resistance to diseases and interferes with vaccine-induced immunity (Diekman and Green, 1992). In another study, third-trimester abortion was reported after cattle consumed mouldy peanuts (Ray et al., 1986).

Normal annual abortion rate were cited to be 3 to 5% once cows are above 42 days of pregnancy (Hovingh, 2009), or similarly, an observable 2 to 5% in most dairies (Kirk, 2003). While some suggest the annual abortion rate should be less than 3% in dairy, others believe this is

Table 2. Summary of common causes of abortion in cattle.

Agents	Abort occur (Trimesters)	Control
Brucella	Second half of gestation (usually around 7th month)	Regulatory program, vaccinate heifers and test/cull
Leptospira spp.	Third Trimesters (*L.pomona*) any time (other Leptospira spp.)	Vaccination and antibiotic
Listeria	2nd or 3rd Trimesters	vaccination and antibiotic treatment
Bovine viral diarrhea (BVD)	1st or 2nd Trimesters	Vaccination of dams, cull PI animals
Mycotoxins	4th and above months	Moldy feed should be avoided
Coxiella burneti	3rd Trimesters	vaccination and antibiotic treatment
Neospore caninum	2nd or 3rd Trimesters	Dog control- fetal tissues' out of feed area

Table 3. Summary of the prevalence rate of abortion in dairy cattle in Ethiopia.

Author	Year	Site	Breed	Prevalence (%)
Haftu and Gashaw	2009	Bako	Cross	6.0
Esheti and Moges	2014	Debre Zeit	Holstein and Borena cross	5.3
Haile et al.	2010	Addis Ababa	Cross	5.9
Dinka	2013	Assella	Local and Cross	14.5
Hadush et al.	2013	Debre Zeit	Cross	6.7
Regassa et al.	2016	Mekelle city	Local and Cross	13.3
Haile et al.	2014	Hossana	Local and Cross	2.6
Bitew and Prased	2011	Bedelle	Local and Cross	13.9
Degefa et al.	2011	Arsi zone	Local and Cross	8.7
Dawit and Ahmed	2013	Kombolcha town	Cross	9.1
Gizaw et al.	2007	Nazareth town	Local and Cross	2.2
Ararsa and Wubishet	2014	Borena zone	Borena	12.2
Enda and Moges	2016	Wolaita Sodo	Jersey and Cross	4.8
Ayana and Gudeta	2015	Bako	Horro and Cross	5.9
Mekonnin et al	2015	Mekelle	Cross	6.4
Wagari and Shiferaw	2016	Horro Guduru	Horro and Cross	4.4
Siyoum et al.	2016	Adea Berga	Jersey	28.9

not typical. This difference may arise from the fact that many abortions may be due to early embryonic death where cows are identified as pregnant and then found to be open without visible signs of an abortion. As a consequence, many early abortions may go undetected or even dismissed as an unsuccessful insemination rather than a failed pregnancy (Carpenter et al., 2006). A low rate of abortions from 2 to 5% per 100 pregnancies per year is usually considered within the expected rate as sporadic abortions occur in any herd. However, occurrence of several abortions in a short period or high rate of abortions warrants investigation to detect the cause and take control measures (Esheti and Moges, 2014; Al Humam, 2014).

ECONOMIC IMPORTANT OF ABORTION IN CATTLE

Abortion is one of the most important major reproductive health disorders of dairy cows in the world including Ethiopia in terms of economic impact (James and Rushton, 2002; Regassa and Ashebir, 2016). Abortions cause significant economic loss, especially those occurring during late gestation. These losses can be attributed to loss of replacement of calves, reduced milk production, costs of treatment, feeding of animals and premature culling of productive cows and heifers (Carpenter et al., 2006; Abdelhadi et al*.,* 2015). The cost of abortion varies according to effective factors such as the time of gestation, milk production, days in milk, the time of insemination after parturition, the cost of nutrition, sperm costs, insemination time and labor costs, which differ from region to region. Abortions during early pregnancy result in increased days open (De Vries, 2006; Hovingh, 2009). Different values were reported for the cost of abortion ranging from $90 to $2333 based on different studies. These differences are caused by the stage of gestation in which the abortion occurs and by the differences in factors such as predicted cow

performance, breeding and replacement decisions, feed and milk price and the stage of lactation (De Vries, 2006; Lee and Kim, 2007; Hovingh, 2009). Estimates of the cost of an abortion to a producer range from $90 to $1,900 (Peter, 2000; Kirk, 2003), depending on when pregnancy and occurred and differences in predicted cow performance, prices, and breeding and replacement decisions. Hanson et al. (2003) stated that losses were $200 million per year in California herds.

Each case of abortion in dairy cattle has been estimated to lead to losses of about US $500 to $900. Per case, the cost of abortion has been estimated at $640 (Thurmond and Picanso, 1990) and from $600 to $800 (Eicker and Fetrow, 2003). Pfeiffer et al. (1997) estimated the cost of an abortion caused by *N. caninum* infections at $624 in New Zealand. Peter (2000) documented a cost of $600 to $1,000 per midterm abortion. Weersink et al. (2002) estimated the cost of an abortion, including reproductive loss and reduced milk yield at $1,286 in Canada. In addition, some of the causes of abortion, such as *Brucella abortus, Toxoplasma* and *Leptospira,* are zoonotic, thus posing a risk to human health (Carpenter et al., 2006; Murray, 2006). However, no reports are available on the estimation of the economic impact of bovine abortion in Ethiopia.

DIAGNOSIS OF ABORTION

General principles in the diagnosis of abortion in dairy animals include the collection of a complete history of the case and relevant epidemiological data, such as recent introductions into the farm, determination of the number of animals affected, examination of the breeding, health and feeding records, careful examination of the affected dam(s), and collection of the expelled fetus and placenta for pathological and microbial examination. Furthermore, samples such as paired serum samples, urine, milk and vaginal swabs can also be collected for analysis. The results are then collated and analyzed to reach a diagnosis (Radostits et al., 2007). However, the diagnostic rate in bovine abortions is very low due to the diverse range of pathogens involved, as well as the fact that factors affecting the dam, fetus and placenta may be involved (Murray, 2006; Ernest, 2009). Abortion also often follows an initial infection which may have occurred for several weeks or months; the etiology often is not detectable by the time the abortion occurs. The high cost of laboratory work to aid in the diagnosis of bovine abortion also compounds the problem (Carpenter et al., 2006; Murray, 2006). Diagnosis of the cause of bovine abortion is difficult as abortions are caused by many infectious and noninfectious factors (Miller, 1987; Jamaluddin et al., 1996). It has been demonstrated in numerous surveys that many abortions occur due to endemic infectious which are normally present in cattle

populations world-wide (Kim et al., 2002). The diagnosis of abortions often presents a challenge to the farm owner and the veterinarian in charge. A sudden and dramatic increase in the abortion rate in a herd is more commonly seen, although a gradual increase may be noted over a long period of time. For this reason, prompt and thorough action is required if abortions occur at any rate. Well-arranged records of a herd is often of benefit during the investigation of abortion problems (Al Humam, 2014). However, it is important to note that the causes of abortion in cattle are numerous and thus, their diagnosis is often challenging (Murray, 2006; Ernest, 2009). Epidemiological tools could help in narrowing down the field of investigation for a better interpretation of laboratory results (Markusfeld, 1997).

Status of abortion in dairy cows in Ethiopia

Ethiopia has various agro ecological zones, which have contributed to the evolution of different agricultural production systems (Beruktayet and Mersha, 2016). Husbandry systems, variation in cattle breed and environmental factors greatly influence the spread of the cause of abortion (Mekonen et al., 2010). Thus, the prevalence of abortion varies in different production system, cattle breed and agro ecological zones (Esheti and Moges, 2014).

Studies on major reproductive problems of cows in different parts of Ethiopia have shown the occurrence of abortion in cattle. Study conducted by Haftu and Gashaw (2009) on major clinical reproductive health problems of dairy cows in and around Bako of West Ethiopia showed that 6.0% (n=217) of dairy cows are affected by abortion. A study of the major reproductive health disorders of dairy cows in ILCA and Almaz dairy farms in Ada'a district, Debre Zeit town in East Shoa showed that 5.3%(n=245) of cows had abortion problem (Esheti and Moges, 2014). Other study conducted in Addis Ababa Milk showed major reproductive disorders in cross breed dairy cows under small holding indicating an overall prevalence of 5.9% (n=384) of abortion problems (Haile et al., 2010). A study conducted by Dinka (2012) showed that 14.6% (n=300) of dairy cattle was affected by abortion based on questionnaire interviews in and around Assella in Central Ethiopia. A retrospective study by Hadush et al. (2013) revealed that 6.7% (n=711) of the cows had abortion problem from dairy cows in three selected farms in Debre Zeit town. Another study conducted using questionnaire and observational survey in urban and peri urban area of Hossana indicated 2.6% (n=390) prevalence of abortion in dairy cattle (Haile et al., 2014). A study in and around Bedelle showed a prevalence of 13.9% (n=302) of abortion in South west Ethiopia (Bitew and Prased, 2011) and 8.7% (n=370) prevalence in selected sites of Arsi zone (Degefa et al., 2011). A prevalence of 9.1% (n=231) abortion was

reported at Kombolcha town in north east Ethiopia by Dawit and Ahmed (2013). A study conducted by Gizaw et al. (2007) and Ararsa and Wubishet (2014) also reported 2.2 (n=403) and 12.2% (n=409) in Nazareth town of central Ethiopia and Borena zone in southern Ethiopia, respectively. A prevalence of 6.4% (n=1013) abortion was also recorded in dairy cattle in and around Mekelle, Tigray (Mekonnin et al., 2015) and 5.9% (n=372) of prevalence of abortion was reported in Bako Livestock Research Farm (Ayana and Gudeta, 2015). A study conducted by Regassa et al. (2016) on major factors influencing the reproductive performance of dairy farms in Mekelle city, Tigray reported 13.3% (n=798) prevalence of abortion. Recent reports from Adea Berga (Siyoum et al., 2016), Horro Gudru (Wagari and Shiferaw, 2016) and Wolaita Sodo town (Enda and Moges, 2016) indicated that the prevalence of 28.9 (n=97), 4.4 (n=402) and 4.8% (n=104) of abortion was recorded in cattle, respectively.

The incidence of abortion of more than 2 to 5% should be viewed seriously, and efforts should be made to determine the causes so that proper methods of control can be instituted (Mainar-Jaime et al., 2005; Esheti and Moges, 2014). Abortion problem is the most common in dairy cows (Gizaw et al., 2007). In order to reduce these problems and their risk factors, formulation of strategic control measures including health education on the cause of abortion transmission, treatment and control has to be introduced (Dinka, 2012).

Conclusion

Abortion is one of the most important reproductive health problems of dairy cows in Ethiopia in terms of economic impact. Both infectious and non-infectious agents may cause abortion in cattle. Non-infectious factors are genetic and non-genetic disorders. The non-genetic causes of abortion are heat stress, production stress, seasonal effect and seasonal changes. The common infectious causes of abortion in cattle include brucellosis, leptospirosis, listeriosis, Q fever, bovine viral diarrhea, mycotic abortion and neosporosis. These causes can result in extensive economic losses, showing the need for control measures to prevent abortion. Whereas, the infectious causes of abortion have been a primary focus of attention, and non-infectious cause of abortion is actually more common in endemic situations. Several risk factors associated with abortion are genetic, environmental, management, geographical and infectious factors. Incidence of abortion in Ethiopia ranges from 2.2 to 28.9%, efforts should be made to determine the causes and measures should be taken to control abortion. Prevention should be focused on accurate records keeping and collection of samples for laboratory analysis and using good biosecurity practices that inhibit the introduction and spread of infectious causes of abortion and using vaccination programs could limit abortion occurrence. There should be maintenance of the general health and immune function of animals by providing a balanced feed, clean water and a clean and dry environment. It was suggested that detail epidemiological study on cause of abortion in cattle should be undertaken.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Full Length Research Paper

Prevalence, financial impact and public health significance of *Cysticercus bovis* at Bahir Dar Municipal Abattoir, Ethiopia

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A cross-sectional study was conducted from November 2016 to April 2017 to determine the prevalence of cysticercosis, asses the associated risk factors and public health importance of human taniasis at Bahir Dar municipal abattoir, Bahir Dar town. Active abattoir survey from local zebu cattle presented to Bahir Dar abattoir and questionnaire surveys data collected were analyzed using SPSS version 20. Out of 480 inspected animals, 20 animals had varying number of Cysticercus bovis with prevalence of 4.2% (20/480). Cyst distribution per organs were; tongue 12/20 (2.5%), shoulder 10/20 (2.08%), masseter muscle 7/20 (1.46%), heart 4/20 (0.8%) and liver 1/20(0.21%). From the total number of 119 *C. bovis* collected from the infected 20 cattle during the study period, 73 (61.3%) were found to be alive while the rest 46 (38.7%) were degenerative cysts. Cysticercosis prevalence showed that there was no statistically difference among age groups and body condition score with the occurrence of *C. bovis* (p>0.05). Of the total 69 interviewed respondents, 30.4% (21/69) had contracted Taenia saginata infection. The prevalence of taeniosis showed significant difference (p<0.05) with age groups, habit of raw meat consumption, toilet availability, sex and religion. However, there was no significance difference between marital status, educational level, knowledge of taeniasis and occupational risks (p>0.05). The findings of this study indicated the importance of bovine cysticercosis and taeniosis in the study area. Therefore, attention should be given to the public awareness and routine meat inspection to be safe to public health and promote meat industry in the country

Key words: Abattoir, Bahir dar, *Cysticercus bovis*, prevalence, public health.

INTRODUCTION

Taenia saginata is a worldwide zoonotic cestode whose epidemiology is ethnically and culturally determined with estimation of 50-77 million cases of infestation worldwide with 50, 000 people dying from this problem annually. Both the adult and larvae formed hazardously affect the health of their respective hosts, either directly or indirectly, accompanied with several secondary infections, particularly in human hosts. The occurrence of larvae of *Cysticercus bovis* in cattle musculature causes cysticercosis while the adult worms in human small

intestine cause taeniasis (Minozzo et al., 2002).

There are a number of zoonotic diseases that can be transmitted from animal to humans in various ways. Wide varieties of animal species, both domestic and wild, act as reservoirs for these pathogens (viruses, bacteria or parasites) which may be transmitted to humans (Sumbria et al., 2016). Given the extend of distribution of the animal species involved and the ineffective surveillance, prevention and control of zoonotic diseases pose a significant challenge (Meslin et al., (2000).

In the past, zoonotic diseases were limited to populations living in low- and middle-income countries, but the geographical limits and populations at risk are expanding and changing because of increasing international markets, improved transportation systems, and demographic changes (Chhabra and Singla, 2009). Most parasitic zoonoses are neglected diseases despite causing a considerable global burden of ill health in humans and having a substantial financial burden on livestock industries. Although the global burden for most parasitic zoonoses is not yet known, the major contributors to the global burden of parasitic zoonoses are toxoplasmosis, food borne trematode infections, cysticercosis, echinococcosis, leishmaniasis and zoonotic schistosomosis (Torgerson and Macpherson, 2011; Singla, 2012; Chhabra and Singla, 2014). Parasitic diseases are highly prevalent in Sub–Saharan Africa and incur severe economic losses by reducing productivity. *Taenia saginata* taeniasis / bovine cysticercosis is one of the major parasitic diseases, which does not only lead to economic loses, but also adversely affect public health.

Meat-borne diseases are common in developing countries including Ethiopia because of the prevailing poor meat handling, sanitation practices, inadequate food safety laws and lack of education for food-handlers (WHO, 2004). National Hygiene and Sanitation Strategy Program (WHO/FAO, 2005) reported that about 60% of the disease burden was related to poor hygiene and sanitation in Ethiopia.

In East African countries, prevalence rates of 30-80% have been recorded (Tembo, 2001). In developing countries, the incidence of human infection with *T. saginata* is usually high, with the prevalence of over 20 %; whereas in developed countries, the prevalence of cysticercosis is low, usually less than 1% (Urquhart et al., 1996).

In Ethiopia several authors have reported the prevalence of *T. saginata* taeniasis and cysticercosis with in a wide range of 2.5 to 89.41% and 3.11 to 27.6% prevalence, respectively (Dawit, 2004; Hailu, 2005; Abunna et al., 2008).

The problem of food borne parasitic zoonosis could be further complicated in Ethiopia by lack of efficient inspection at critical control points in abattoirs, lack of awareness and knowledge on the mode of transmission and public health hazard of these diseases as well as due to presence of widespread habit of raw meat consumption both in rural and urban communities. A number of reports in Ethiopia indicated that, certain groups who had easy access to raw meat and meat products and those people with low level of formal education were reported to be more infected with meat parasitic zoonosis than those who had low access to raw and those with better education (Tadesse et al., 2012). This study aimed at determining the prevalence of *C. bovis* in cattle slaughtered at Bahirdar municipal abattoir, identify risk factors associated with cysticercosis and taeniasis and to estimate the prevalence of human taeniasis /*T. saginata* in the area.

MATERIALS AND METHODS

Study area

The study was conducted at Bahir Dar, the capital city of Amhara Regional State, located at 11°29'N latitude, 37°29'E longitude at about 565 km North-West of Addis Ababa from November 2016 to April 2017.

The altitude of the area is 1830 meter above sea level and has average annual rainfall of 1500 mm.The mean annual temperature of the study area is 23°C. Lake Tana and River Abay influence the climatic condition of the study area. The area has a mixed farming practice with crop and livestock production (Bard, 2009). Based on the Census conducted by the Central Statistical Agency of Ethiopia (CSA), Bahir Dar Special Zone has a total population of 221,991, of whom 108,456 are men and 113,535 women; 180,174 or 81.16% are urban inhabitants, the rest of population are living at rural kebeles around Bahir Dar (CSA, 2007).

Study population and study design

The study was a cross-sectional type in which a structured questionnaire survey and active abattoir survey was conducted. Animal study populations were cattle presented to Bahir Dar municipal abattoir for slaughtering. All cattle were local oxen that originated from Bahir Dar, Adet, Debre tabor and Este areas brought by the merchants. For human study population, residents of Bahir Dar town, were subjected to questionnaire surveys. The recruitment of volunteer individuals in the study was not based by age, sex, marital status, habit of raw meat consumption, education level and religion.

Sample size determination

The sample size was determined following the formula published in using the expected prevalence of bovine cysticercosis in Bahir Dar (19.4%) reported with 95% confidence interval at a desired absolute precession of 5%. Therefore, the required sample size was calculated according to the formula (Thrusfield, 2007 and Mulugeta, 1997):

$$N = {}^{1.96^2 \, Pexp \, (1 \, - \, Pexp)}/d^2$$

Where, N = required sample size, P exp= expected prevalence, d = desired absolute precision and N = 1.96^2 x 0.194(1-0.194)/ $(0.05)^2$= 240 animals.

However, to increase the level of accuracy of prevalence determination, 480 animals were sampled and inspected during the

study period for the presence of *C. bovis* cyst in different organs.

Sampling procedures

Active abattoir survey

The cross sectional study was conducted during meat inspection on randomly selected 480 cattle slaughtered at Bahir Dar municipal abattoir. Before slaughter, ante-mortem inspection was carried out and the tag number of each animal was recorded. According to the guideline (Ministry of Agriculture, 1972) for masseter muscle, deep linear incisions were made parallel to the mandible; the heart were incised from base to apex to open the pericardium and incise also made in the cardiac muscle for detail examination. Deep, adjacent and parallel incisions were made above the point of elbow in the shoulder muscle.

Examination of the kidney, liver, and the lung was also conducted accordingly.

All positive samples were transported to the parasitology laboratory of Bahir Dar regional laboratory for confirmation of cyst viability. The cysts were incubated at 37°C for 1 to 2 h using 40% ox bile solution diluted in normal saline.

After this, the scolex was examined under microscope by pressing between two glass slides. The cysts were regarded as viable if the scolex envaginates during the incubation period at the same time the scolex was checked whether it is *T. saginata* metacestode or others based on the size of cysticercus and absence of hook on the rostellem of the envaginated cyst (Gracey et al., 1999).

Questionnaire survey

To determine associated risk factors of taeniosis, 69 volunteer respondents were selected using simple random sampling methods based on willingness to participate on Questionnaire survey. Questionnaire survey respondents identified for this study were questioned on their habit of raw meat consumption, frequency of consumption, experience of taeniosis infection and finding of proglottids in their faeces, underwear, Religion (Christian and Muslim), educational status, age (less than 15 years, 16-30 years old and greater than 30 years old), sex, marital status, knowledge of *T. saginata* and toilet availability of respondents were registered as possible risk factors.

Data management and analysis

The data collected from the abattoir and questionnaire survey were stored into Microsoft excel. Statistical analysis was done using SPSS version 20. Chi-square ($X2$) test was used to determine the variation in infection, prevalence between body conditions, ages and origin. Statistical significance was set at $P<0.05$ to determine whether there are significant differences between the parameters measured between the groups.

The questionnaire data were also summarized and analyzed to the risk factors for human taeniasis using Chi Square($X2$) SPSS, Version 20.

RESULTS

Active abattoirs survey

From the total of 480 inspected animals in Bahir Dar

municipal abattoir, 20 animals had different number of *C. bovis* with prevalence of 4.2% (20/480). In routine meat inspection, *C. bovis* was found in different organs with higher number of cyst in the tongue (12, 2.5%), shoulder (10, 2.08%), masseter muscle (7, 1.46%), heart (4, 0.8%) and liver (1, 0.21%) (Table 1).

Out of 119, *C. bovis* (73, 61.3%) were found to be alive while the rest (46, 38.7%) were degenerative cysts. The viable cyst detected in shoulder muscle (31, 72.1%), masseter muscle (16, 59.26%), heart (5, 55.6%), tongue (20, 51.3%) and liver (1,100%) (Table 2).Out of 118 (<5 years old), 237(6-10 years old) and 125 (>10years old) cattle 4 (3.4%), 10 (4.2%) and 6(4.8%) were positive for *cysts* respectively. There was no statistical difference for the three age groups and body condition score with the occurrence of *C. bovis* (p>0.05). The distribution of infection in cattle according to location was highest in cattle from Debretabor (15, 7.2%), followed by Adet (3, 3.1%), Este (2,1.6%) and Bahir Dar 0%. There was statistically significant difference in infected animal from different locations with the occurrence with *C. bovis* (P<0.05) (Table 3).

Questionnaire survey

From the total of 69 respondents interviewed in this study, 30.4% (21/69) had contracted *T. saginata* infection. Associated risk factors, age groups, frequency of raw meat consumption, sex, presence or absence of the latrine and religion showed statistically difference (p<0.05) in the prevalence of human taeniasis in this study. However, marital status, educational status, occupation and knowledge about the disease was not statistically significance difference (p>0.05) (Table 4).

DISCUSSION

Abattoirs survey of bovine Cysticercosis

The prevalence of bovine cysticercosis obtained in this study was 4.2% which is comparable to the report of Dawit (2004) (4.9%) at Gondor, Megersa et al. (2009) (4.4%) in Jimma, Belay and Mekelle, (2014) who reported (5.2%) in shire and Ibrahim and Zerihun, (2011) (3.6%) in Addis Ababa. However, slightly higher than the finding of Meron (2012) (2.5%) in Jimma, Adem and Alemneh (2016) (2.0%) at Gondar, Addisu and Wondimu (2015) (2.6%) in Batu, Bedu et al. (2011) (3%) in Zeway and Teka (1997) (2.2%) in Central Ethiopia. The present study was by far less than the report of other authors such as Getachew (1990) (13.8%) at Debre-Zeit, Regassa et al., (2009)(13.3%) at Wolaita, Birhanu and Abda, (2014) (19.7%) at Adama. The lower prevalence of cysticercosis in the study area could be due to the differences in the agro-climatic conditions, variation in personal and environmental sanitation, proper usage of latrine, culture

Table 1. Organs based prevalence of *C. bovis.*

Organ inspected	Number of animals inspected	Number of positive animals	Prevalence (%)
Tongue	480	12	2.5
Shoulder	480	10	2.08
Masseter	480	7	1.46
Heart	480	4	0.8
Liver	480	1	0.21

Table 2. The proportion of viable cysts is calculated from the total number of viable cysts as denominator.

Organs inspected	Number of cysts per organ examined	Number of viable Cysts per organ	Proportion of viable Cysts in each organ (%)
Tongue	39	20	51.3
Masseter	27	16	59.26
Liver	1	1	100
Heart	9	5	55.6
Shoulder	43	31	72.1
Total	**119**	**73**	**61.3**

Table 3. The associated risk factors of bovine cysticercosis.

Risk factor		Number of tested animal	Number of positive animals	Prevalence (%)	X^2	P-value
Age	<5	118	4	3.4		
	6-10	237	10	4.2	0.306	0.858
	>10	125	6	4.8		
Body condition	2	55	1	1.8		
	3	246	11	4.5	0.858	0.651
	4	179	8	4.5		
Location	Debretabor	207	15	7.2		
	Adet	98	3	3.1	9.459	0.024
	Bahirdar	51	0	0		
	Este	124	2	1.6		

and feeding habit of raw meat.Regarding the anatomical prevalence of cysts, tongue 12 (2.5%), shoulder 10 (2.08%), masseter muscle 7 (1.46), heart 4 (0.8%) and liver 1 (0.21%) (Table 1). The tongue and shoulder muscle have high blood circulation and high oxygen circulation are available and due to this they are frequently affected by cysts. The tongue was the most frequently affected organ and this is in line with the finding of Bedu et al. (2011) at Zeway. Shoulder, masseter muscle and heart were also predilection sites Zerihun (2011) in Addis Ababa.

The viability test showed that 73 (61.3%) of the 119 cysts were alive (Table 2). Shoulder muscle had the highest proportion of viable cyst (31, 72.1%) followed by masseter (16, 59.26%), heart (5, 55.6%) and tongue (20, 51.3%). Only one viable cyst was detected in liver. The shoulder muscles affected 72.1%; greater than the reports of Bekele et al. (2009) (46.3%) and Regassa et al (2009) (32%). The proportion of viable cyst in tongue was 51.3% which was comparable to the work of Hussein et al. (2011) (53.1%).

Questionnaire survey

The prevalence of human taeniasis differs from country to

Table 4. Associated risk factors of human taeniasis.

Variable		Number interviewed	Number positive	Prevalence (%)	X^2	P-value
Age	< 15	7	0	0		
	16-30	30	5	16.7	11.534	0.003
	> 30	32	16	50		
Sex	Male	40	18	45		
	Female	29	3	10.3	9.536	0.002
Religion	Christian	51	19	37.25		
	Muslim	18	2	11.1	4.295	0.038
Occupation	Government-employed	21	5	23.8		
	Private worker	30	12	40		
	unemployed	18	4	22.2	2.305	0.316
Education	Elementary	13	2	15.4		
	High school	20	4	20		0.102
	College	36	15	41.7	4.564	
Marital status	Married	28	10	35.7		
	Single	37	11	29.7		0.345
	divorced	4	0	0	2.127	
Habit of raw Meat	High	22	14	63.6		
	Medium	28	6	21.4		0.000
	Less	8	1	12.5		
	Non user	11	0	0	18.555	
Latrine	Have	61	16	26.2		
	Do not have	8	5	62.5	4.395	0.036
Knowledge	Have	38	15	39.5		
	Do not have	31	6	19.4	3.264	0.071

country, and it can vary within the same country. This might be the habit of raw meat consumption, knowledge about the mode of transmission of the disease and variation in personal and environmental sanitation. In the present study, the questionnaire survey revealed that the respondents disclosed the finding of proglottids in the faeces, underwear, in laboratory diagnosis facilities at health institution which indicates the presence of taneniasis. Accordingly, 30.4% (21/69) of surveyed individuals were previously affected with the disease. This result was lower than the work of Taresa et al. (2011) (64.44%) in Jimma, Megersa et al. (2009) (56.6%) in Jimma, Dawit (2004) (69.2%) in Gondar. The lower prevalence of T. saginata in this study might be the fact that some people are not willing to tell that they had contracted taeniais, poor environmental hygiene and

knowledge of the societies about taeniasis, way of transmission and variation in composition of the respondents, and the habit or culture of raw meat consumption may be low.

There was statistical difference of age groups, sex, religion, habit of raw meat feeding and toilet availability with the occurrence of taeniasis (p < 0.05). Older age groups (>30) have higher prevalence associated with long-term exposure and the habit of preferring raw meat consumption and also, older individuals can financially afford consuming raw meat mainly at butcher houses. The present study showed that taeniasis occurrence was higher in male. This might be due to the cultural and social factors in which the males are usually involved in slaughter houses and butchery as well has having access to the hotels meal. This result is in agreement with

different reports in various parts of our country (Hailu, 2005) in eastern Shoa. The present study showed that there was higher prevalence of human taeniasis among individuals who often consume raw meat than those with occasional consumption. This was comparable with the report of Abunna et al. (2008). However, there was no statistical difference among marital status, education level, occupation and knowledge of taeniasis with occurrence of taeniasis (p>0.05).

During the studying period, there was total and partial condemned masseter muscle, shoulder muscle, tongue, heart and liver. Repetition of this reflected high economic loss annually. Besides the health or pathological impact of the problem on the exposed population, the cost of treatment to expel the parasite from the body is also high.

CONCLUSION AND RECOMMENDATIONS

Taeniasis and bovine cysticercosis are important zoonotic parasitic diseases in the study areas with prevalence of 30.4 and 4.2% respectively. Poor meat inspection procedures were applicable in Bahir Dar municipal abattoir. Consumption of raw and undercooked meat is the most important source of infection. Backyard slaughtering were also practiced which could be considered as the contributing factor for taeniasis. Religion, raw meat consumption, presence or absence of the latrine, age and sex were found to influence taeniasis. *T. saginata* is a medically and economically important parasite in humans. Infection with the *Cysticercus* larval stage in cattle causes economic loss in the beef industry. Based on the above conclusion, recommendations include backyard cattle slaughter should be discouraged, routine meat inspection procedure should be applied, the public should be made aware to use latrines, not to contaminate the environment with proglottids or *Taenia* eggs by defecating on pastures where cattle graze and further studies on the prevalence of taeniasis and cysticercosis should be encouraged in other areas.

CONFLICTS OF INTERESTS

The authors have not declared any conflict of interests.

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Full Length Research Paper

A study on sero prevalence of foot and mouth diseases in West and South West Shoa zones of Oromia regional state, central Ethiopia

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Cross-sectional study was conducted from December, 2008 to April, 2009 to determine the sero prevalence of foot and mouth disease (FMD) virus in West and South West Shoa zones of Oromia regional state, central Ethiopia. The samples were processed with the 3 ABC ELISA kits that can able to identify natural infected animal from vaccinated animals. From the total sera of 421 tested, the overall sero prevalence of FMD in cattle was 15.0% (63/421). The prevalence rate was higher (22%) in the South west shoa zone than West shoa zone (5.6%). The difference was statistically significant ($\rho < 0.05$). At district level, the highest sero prevalence were recorded at Dawo (26.7%), Alemgana (26.2%), Kokir (24.4%) and Haramaya (21.4%) districts, which were located at south west shoa zone. The difference among districts were statistically significant ($\rho < 0.05$). Statistically difference was also observed between different age groups ($\rho < 0.05$); being higher in adult (19.3%) followed by calves (9.3%). The sero prevalence of male and female were 16.0 and 14.1%, respectively, and which was not statistically significant ($\rho > 0.05$). The sero prevalence of FMD was found higher in mid highland (16.8%) than highland attitude (6.7%) which was statistically significant ($\rho < 0.05$). The result of this study indicated that FMD is highly prevalent in the South West Shoa zone than West Shoa zone due to contact of different origin of animals, and free animals movement in search of feed and water in zone. Age and attitude were also found as an important risk factor for the diseases. Finally, it is recommended that, sero typing of the virus circulating in the study area should be undertaken for effective control of the disease.

Key words: FMD, Sero prevalence, West Shoa, South west shoa, 3 ABC ELSA.

INTRODUCTION

Ethiopia has the largest livestock inventories in Africa, possessing more than 31 million cattle, 48 million small ruminants, 1.5 million camels, 7 million equines and 52 million chickens (Desta,1999). Livestock is an integral part of all farming system in it. They provide milk, meat, hides and skin, and the drought power required for tilling the farm land (Asseged, 2005). However, due to the higher prevalence of different diseases like foot and

mouth diseases (FMD) and poor management system, the country is not utilizing this huge potential in livestock resource (Hussen, 2006).

FMD, which is also known as aphthous fever (Kahrs, 2001), is a major global animal health problem (Murphy et al., 1999). It is the most contagious transboundary animal disease (TAD) affecting cloven hoofed animals (FAO, 2007) characterized by the formation of vesicles in the mouth, at coronary band and skin of inter digital cleft (Radostits et al., 2000). The disease is an infection, worldwide in incidence, caused by an entero virus of the genus aphtho virus, family picornaviridae which occurs as seven major A, O, C, SATI, SAT2 , SAT3 and Asia 1 (Radostits et al., 2000). Each serotypes of FMD virus is antigentically district (Kitching, 1987). All the seven (7) serotype produce a disease that is clinically indistinguishable but immunologically district and infection with one serotypes does not confer immunity against the other (Richard, 1998).

According to the office of international des epizootics (OIE, 1990), FMD ranks first among the notifiable infection disease of animals (OIE, 2000). The disease is notoriously contagious that it can be spread as much as 50 (fifty) miles downwind from one out break area to another (Sainsbury, 2000). Introduction of the virus types or subtypes to regions where they were previously absent, lead to epidemics of varying magnitude (Gibbs, 1981). When the disease breaks out in susceptible cattle, it spreads very rapidly, and the morbidity rates approximate 100%. The disease is rarely fatal expect in young anima (Kahan and Scottlline, 2005).

The disease has an incubation period of 3 to 14 days, and excretion of the virus from infected animals in all secretion and excretion usually begins before the appearance of the visible clinical signs (kitching and Donaldson, 1987). Initial virus multiplication occurs mainly in the pre-pharyngeal area and the lungs (Burrows et al., 1981). Acutely infected cattle salivate profusely and develop a nasal discharge (mucoid and muco purulent). Following pyrexia (about 40°C) vesicles appears on the dorsum of the tongue, hard palate, dental pad, lips, gums, muzzle, coronary band and inter digital space with consequent lameness. The lesions are susceptible to secondary bacterial infection. At this stage, it also include linking, cannot eat and move. Other signs include licking of the feet or shifting weight from one leg to other, holding one hoof off the ground, lagging behind the herd, lying down and reluctance to rise (Woodbury, 1995). Vesicles may also be seen on the teats of lactating animals. Morbidity is high and young caves may die before the appearance of clinical signs due to virus infection of the developing heart muscle and the production of a severe myocarditis (Woodbury, 1995). However, most animal recover within 2 weeks.

FMD has a great potential for causing severe economic loss in susceptible cloven-hoofed animals (OIE, 2000). Greater losses can result from refusal of FMD free

countries to import livestock and livestock products from infected regions (Kahrs, 2001). Adult mortality is not very high but causes heavy economic losses (losses of flesh, diminished milk production, mastitis and calf mortality and infertility etc). This combined with the time and money spent treating animals, and their long convalescence contributes to consider it as the most important animal disease in a world context (Solomon, 1980). The disease occasionally transmitted to humans causing a self limited, febrile illness, characterized by pain in the limps excessive salivation and the appearance of vesicular lesions on the buccal or lingual epithelium and on the skin of hand, feet and other parts of the body (Lennette et al., 1979). Very few cases have been reported even among people working with infected carcasses and laboratories. However, humans can also be vehicle for transmission of the disease to animals (Radostits et al., 2000).

No specific treatment exist for FMD; however, proper animal husbandry practice and treatment of secondary bacterial infection reduce losses (Hirsh and Zee, 1996), treatment with mild disinfectants and protective dressing to inflamed areas to prevent secondary bacterial infection is recommended in endemic countries where slaughter policy is not in force. If, however a disease outbreak occurs in suckling calves, no treatment will be possible (Seifert, 1990). Given the law absolute production of pastoral herds compared with commercial or semi commercial dairy with, some workers assume that FMD is relatively minor disease in pastoral. However, at certain time of years pastoralist rely heavily on milk for food and therefore, they often prioritize FMD due to its impact on milk supply. They also associate FMD with mortality in claves and "Chronic FMD" cases showing heat intolerance, reduced fertility and other signs (Rufael, 2006).

There is no reliable figure for the prevalence of FMD in different countries. The disease generally occurs in the form of an outbreak that rapidly spread from herd to herd before it is controlled (Radostits et al., 2000). The disease is endemic in Ethiopian, the main incidence to the stress of harvesting and trashing (Solomon, 1980). The occurrence of FMD in Ethiopia is increasing, and in 1999 almost 10% of cattle were under risk of infection, and in 2000 and 2001 a total of 27 and 88 disease outbreaks were reported, respectively (Esayas et al., 2005).

Four of the seven serotype of FMD of virus were recorded in Ethiopia. The four identified serotype were O, A, C and SAT2. SAT2 was first identified in 1989 from bovine sample collected from Leben Ranch, Borena area, southern Ethiopia. Similarly, serotype C identified in 2005 from virus was identical to a virus identified in 1971. Serotype SAT1 and 3 have not been identified until 2005 (Esayas et al., 2005). Similarly, from the sample recover in 2005 by the WRL for FMD at institute of animal health, pirbright (UK), 22 types O,9 types A and 4 types C were

recovered from Ethiopia.

Therefore, FMD is an highly contiguous disease, it is a very serious disease as it spreads rapidly, causes large scale economic losses and halt exports of all animals products as well as agricultural products used as animal feed in the country (Bouxton, 1977). Although, numerous researches were conducted on sero prevalence of FMD in the country, still there is lack of information in the study area. This is due to the controlling of FMD in endemics area that requires a good understanding of the status of the disease within the zones. Hence, this study was conducted to meet the following objectives:

1. To determine the Sero prevalence of foot and mouth disease in selected districts of West and South West Shoa zones.
2. To identify major risk factors of the disease.

MATERIALS AND METHODS

Study areas description

The study was conducted in South West and West Shoa zones of Oromia regional state, Ethiopia which located in West of Addis Ababa. The Zones have got a total land area of about 2.17 million hectare of land, and divide into three agro climatic zone. The low land located below 1500 m a.s.l which caver 17% of the total land area, the mid high land attitude from 1500 to 2500 m a.s.l covers 61% of the total land area and the high land cool temperature located above 2500 m a.s.l that covers 22% of the study area .

The study area has two rainy seasons, the long rainy season covering most of the place and occurs from June to September and the short rainy season occurs March to April with an average annual rain fall being 2900 mm. It is presumed generally that the climate of the study area is suitable for both agriculture and livestock production. The livestock population of the study area is estimated at 2.3 million of cattle, 619,000 Sheep, 172,000 Goat, 283,000 Equine and 1.4 million poultry. Agriculture, which is the main economy sector of activities of the zones, provides livelihood for more than 90% of the population. Almost 85% of the total land coverage used for crop production where 15% is used for animal grazing.

Animal health problems specially infections disease such as FMD, pasteurellosis, lumpy skin disease are important in the study area due to increase livestock population, transhumance way of movements from high land to low land area during long rainy season for season for grazing and low level of veterinary services. In addition external, internal parasites and tryp.\anomiasis are of considerable economic importance of veterinary concern in the area.

The study animals

The study conducted on cattle that were kept under majority of livestock production system in the Zones. Study animals were selected from West Shoa Zone of cattle population in ten (10) districts of West Shoa Zone namely: Welmera, Dendi, chelia, Ejere, Ambo, Nano, Metarobi, Jaldu Ada'aBarga, and Bake and from South West Shoa Zone cattle in seven (7) districts namely: Kersa Kondaltit, Alemgana, Dawo, Kokir, Wonchi,Weliso and Hamaya from which 180 and 241 animals were selected, respectively. Approximately 15 animals from each peasant associations (PAs) were selected randomly to be included in the study. Accordingly, 28

Pas and 421 animals were included in the study.

Sample size determination

The study was conducted on cattle that were kept under mixed farming system in which the sample size was determined by considering a prevalence of 50% to get the maximum number required to determine the prevalence in simple random sampling because there was no previous work of FMD in the study area. The precision was decided to be 5 to 95% confidence level. The sample size was estimated by the formula described by Thrusfield, (1995).

$$n = \frac{1.96^2 \times pexp\,(1\text{-}pexp)}{d^2}$$

Where:

n = required sample size

pexp = expected prevalence

d^2 = desired absolut precision

$$n = \frac{1.96^2 \times 0.5\,(1\text{-}0.5)}{(0.05)^2}$$

=384 cattle.

Even if 384 were the minimum sample size required, 421 cattle from West and south West Shoa zones area were considered in the study prevalence of FMD.

Study Animals and Characterization

A total of 421 samples were randomly collected from animals presented to grazing area. Animals were grouped into three categories based on agro climatic zone, age groups and sex. The animals were classified into three age groups (6 month to 2 years, 2 to 4years and >4years) according to Ken and Tony (1993).

Study design and methods

Study design

A cross sectional study was under taken from December, 2008 to April, 2009. During the laboratory work, a total of 421 sera samples collected from herds of West and South West Shoa zones of cattle, and were examined using 3 ABC ELISA for detection of FMD antibodies.

Sample collection and submission

Cattle blood samples were collected from mixed farming system of herds of cattle in South West and West Shoa zones for analysis of foot and mouth disease antibody. Blood samples were collected form jugular veins of individual animals using plain vacutainer tube of 10 ml capacity, 38 mm length and $1^{1/2}$ gauge sterile vacutainer needle. The owners handled the animals properly. After taking the sample code was given to test tube which contains the sample. Then blood/sample was allowed to clot by lacing it over night at room temperature. The serums were collected from clotted blood and transported using an icebox to national Animal health diagnostic and investigation center (NAHDIC) Sebeta, then transferred in a single sterile cryo vials and labeled with specific laboratory number. The sera sample was stored at -20°C until

Table 1. Sero prevalence of FMD in cattle of different origin/zones.

Zones	No. of samples	No. of sero positive	Sero prevalence
West Shoa	180	10	5.6
South West Shoa	241	53	22.0
Total	421	63	15.0

χ^2=21.875 ρ=0.000.

laboratory investigation

Laboratory analysis

During laboratory work, total of 421 sera were examined by the SVANOVIR foot and Mouth disease virus 3 ABC- EILSA kit to detect foot-and-mouth disease virus (FMDV) specific antibodies in bovine serum samples. The kit procedures were based on a solid phases indirect ELISA. In this procedure, samples were exposed to non structural FMDV antigen (NSP 3 ABC) coated wells on micro titer plates. FMDV antibodies (if present in their sample bind to the antigen in the well) horseradish peroxidase (HRP) conjugate added subsequently forms a complex with the FMDV antibodies. Unbound materials were removed by raising PBS-buffer before the addition of substrate solution, subsequently a blue-green color was developed which is due to the conversion of the substrate by conjugate.

The reaction was stopped by addition of stop solution. Within 15 min, the result was read by micro plate photometer, where the optical density (OD) was measured at 405 nm. The diagnostic relevance of the result was obtained by comparing the optical density (OD) which develops in wells containing the samples with the OD from the wells containing the positive control as it was read by the ELISA reader.

Data analysis

The data collected was entered into M-excel and coded for analysis, the laboratory investigation for prevalence result were analyzed using statistical package for the social sciences (SPSS) statistical package. Variation for the prevalence between the two different zones of Shoa (West and South West Shoa), districts, sex, age and altitude were analyzed by using chi-square (χ^2) test. In all the analysis, confidence level was at 95% and ρ<0.05 set for significance.

RESULT

Sero prevalence result of total 421 cattle sera from West and South West Shoa zones of Oromia regional state were assessed for the presence of non structural FMDV protein (antibodies) (Table1). The overall sero prevalence of FMD in cattle was 15.0% (63/421). The prevalence rate was higher in the South West Shoa zone 22.0% (53/241) as compared to West Shoa 5.6% (10/180) was significantly different (ρ<0.05).

From seventeen district investigated, 10 were from West Shoa seven, 7 were from South West Shoa (Table 2). The highest sero prevalence were recorded at Dawo

(26.7%), Alemgana (26.2%), kokir (24.4%) and Hamaya (21.4%) districst of South West Sho,a and no sero positivity was recorded in Enjere, Dendi, Bake and Ada Berga in West Shoa zone. The difference among district is statistically significant (ρ<0.05). The sero prevalence rate of FMD at West and South West Shoa zones are statistically significant difference (ρ<0.05) were recorded between the three age groups. Being highest in >4 years (Table 3).

The sero prevalence male and female were 16.0 (30/187) and 14.1% (33/234), respectively. However, statistically significant difference were not observed between the sexes (ρ>0.05) (Table 4). On the other hand, higher disease prevalence 16.8% (58/346) was observed in mid-high highland than cool highland 6.7% (5/75) with statistically significant variation (ρ < 0.05) (Table 5).

DISCUSSION

According to this study the sera prevalence of FMD in the study area was high, and statistically significance difference was observed between the two zones districts, age and altitude but not in sexes. Although, knowledge on the serotyping of the FMD is very important, this study has limitation in identifying the types FMD Sero types circulating in the study area.

Currently Ethiopia exports beef and live animals to Egypt and Middle East from different parts of Ethiopian in which foot and mouth disease is one the most important diseases that cause restriction on trade of animals both locally and internationally thereby threatening the livelihood of mixed farming system pastoralists area and national agricultural economy in general (Rufael *et al.*, 2007)

The overall sero prevalence rate of FMD in West and South West Shoa zones were recorded (15%) in individual animals. The study was less prevalence with previous findings from Ethiopia (Sahle et al., 2004) in which seropositivity of 26.5% (Rufael, 2006) reported 21.0% in Borana pastoral system. The increased in prevalence from the previous study may be associated to pastoral production system that with nature of increased live stock movement result in high rate of contact between animals at common grazing places as well as at watering point (Rufael et al., 2007)

The sero prevalence of South West Shoa Zone (22.0%)

Table 2. Sero prevalence of FMD in cattle at different districts of west and south wets zones.

Zones	District	No. of samples	No. of sero positive	Sero prevalence
West shoa	Welmera	15	1	6.7
	Ejere	15	0	0.0
	Meta Robe	30	3	10.0
	Dendi	15	0	0.0
	Bake	15	0	0.0
	Ambo	15	1	6.7
	Chelia	30	1	3.3
	Nono	15	2	13.3
	Jaldu	15	2	13.3
	Ada'a Berga	15	0	0.0
			16	26.2
South West Shoa	Alemgana	61	4	26.7
	Dawo	15	11	24.4
	Kokir	45	13	21.3
	Kersa	61	5	16.7
	Kondaltit	-	1	6.7
	Welliso	30	3	21.4
	Wanchi	15	-	-
	Hamaya	14	-	-
Total	-	421	63	15.0

χ^2=31.044, ρ= 0.013.

Table 3. Sero prevalence of foot and Mouth disease across age groups.

Age in years	No. of samples	No of sero positive	Sero prevalence (%)
0.6-2	54	5	9.3
2-4	97	6	6.2
Greater than 4	270	52	19.3
Total	63	15.0	15.0

2 =9.285,ρ= 0.010.

was higher as compared to west shoa zone (5.6%) (Table1). The different is statistically significant (ρ<0.05). This is probably due to the fact that South West Shoa zone has long border with the Southern Nations Nationalities and Peoples' Regional State (SNNPR) region and western part of Ethiopia which have two broad roads passing through it, and where free cattle movement across the boundaries for grazing and watering, and also by illegal trade thus promoting the concept that FMD peaked in cattle associated with cattle movement (Rufeal et al., 2007)

Among the sampled districtes, the highest sero prevalence was found in those districts of Alemgana, Kersa kondaltit, Dawo and kokir that are found in the south West Shoa Zone. These districts are located on the road of livestock trade root passed through, and found close to Addis Ababa. This is probably due to fact that South West Shoa Zone has long border with the SNNP and western part of Ethiopia. That has two cattle trek roots for trade from SNNP and western part of Ethiopia to Addis Ababa cattle Market. In this zone, it can cause high concept that FMD peaked in cattle associated with cattle movement (Rufael et al., 2007). But this is in agreement with the previous study indicating that all age groups are susceptible to the disease (Oluthemi and Mastiga, 1988).

A significant difference was observed in seroprevalence of FMD among age group of animal in the west Shoa Zones (Table 3). This may be due to the fact that those cattle with age group over four years had practiced more exposures to FMD at grazing, watering point and at market than in age group less than 2 years. Therefore, adult animals might have acquired infection from multiple sero type, and could produce anti bodies against all serotypes of FMD. The low prevalence in young and calves may be indicative of persistence passive immunity and less frequency of exposure of the animal to the disease as the farmers keep their calves around the home areas (Rufael et al., 2007).

Table 4. Sero prevalence of FMD in cattle of different sex groups.

Sex	No. of samples	Positive	Sero prevalence (%)
Male	187	30	16.0
Female	234	30	14.1
Total	421	63	15.0

$\chi 2 = 0.078$, $\rho = 0.780$.

Table 5. Distribution and sero prevalence of foot and mouth disease across altitudes.

Attitude (in meters)	No. of sample	No. of sero positive	Sero prevalence
<2500	346	58	16.8
>2500	75	5	6.7
Total	421	63	15.0

$\chi 2 = 5.125$, $\rho = 0.024$.

Although, the variation in sero prevalence was seen in between sexes there was no significant different observed (Table 4), and the observation of statistical insignificant difference on prevalence rate across the sex was supported in the study of Rufael (2006). This observation could be due to both sex groups are equally exposed to the environment at same time and place in addition, significant difference found between areas of different altitude with the prevalence of 16.8 and 6.6% at mid high land and high lands altitude respectively on (Table 5). This variation may be due to the fact that in low land and mind high lands, cattle have to move long distance in search of good pasture and source of water (Rufael, 2006) tend to be contacted at different origin, which is the predominant factor for the transmission of the disease.

Therefore, from this study the level of sero prevalence indicated that FMD is one of the economically important diseases in the study areas which needs further attention to reduce the economic impact of the disease on the country's economy.

CONCLUSION

The presence of sero prevalence of 15.0% of FMD in the study area shows that FMD is one of the economically important diseases in the region. The study has proven that FMD is highly contagious, and a serious impediment for cattle production. Moreover, the study shows that age and altitude are major risk factors for the distribution of FMD in the study area. Movements of animal in the border regions and Zones freely due to illegal trade and seasonal movements of animal are also the major contributing factor for FMD virus transmission, and circulating in the Zones.

Based on this study high prevalence of FMD in adult indicates that it causes loss of production that has significant economic impact on the country.

RECOMMENDATIONS

1. Further study on FMD virus isolation should be conducted. Recommendation and sero typing should be conducted to fill the gap of informational on the incidence of FMD.
2. Presence of foot and mouth disease in livestock population affects the economy at large by limiting international trade of live animals and animal by products, and consideration of this situation is important in controlling the disease.
3. Policymakers and economy analysts have to be provoked to put their relentless effort in the control of such disease that has serious impact on international trade.
4. Active surveillance should be conducted in all regions of the country so as to control the disease on time before its outbreak.
5. Control measures through vaccination and restriction of animal movements remain the mast important to minimize the risk of FMD in the study area.

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CONFLICTS OF INTEREST

The authors have none to declare.

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Full Length Research Paper

Prevalence of tick-borne haemoparasitic diseases (TBHDS) and haematological changes in sheep and goats in Maiduguri abattoir

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A preliminary survey was conducted to determine the prevalence of some tick-borne haemoparasitic diseases (TBHDs) and their effects on the haematological parameters of sheep and goats in Maiduguri abattoir. A total of 200 blood samples were collected from sheep (n = 100) and goats (n = 100) from November 2015 to May 2016. Giemsa stained blood smears were prepared and examined under light microscope, to screen for haemoparasites. Packed cell volume (PCV) was determined by microhaematocrit centrifugation technique while haemoglobin (Hb) concentration was determined by Sahli's method. The total white blood cell (WBC) and red blood cell (RBC) counts were estimated with Neubauer hemocytometer while erythrocyte indices were calculated. The results showed 13.5% overall prevalence of tick-borne haemoparasitic diseases in sheep 13 (6.5%) and goats 14 (7.0%). There was no significant (p>0.05) differences in prevalence of haemoparasites between sexes and age groups of sheep and goats. Anaplasma ovis and Babesia ovis were identified in the study of which A. ovis [23 (11.5%)] was higher (p<0.05) than B. ovis [2 (1.0%)]. A single co-infection of A. ovis and B. ovis was encountered in sheep. The mean values of PCV, Hb and RBC counts of infected sheep were lower (p<0.05) than the uninfected sheep. Similarly, the mean values of Hb and WBC of were significantly (p<0.05) lower in infected goats. This stud has reports important tick-borne haemoparasitic diseases in sheep and goats. We recommend tick control using suitable acaricides, periodic screening and treatment of small ruminants in Maiduguri.

Key words: Anaemia, *Anaplasma ovis*, *Babesia ovis*, haemoglobin, packed cell volume, white blood cell count.

INTRODUCTION

Sheep and goats are common household livestock in Nigeria. They are particularly important in the northern region, where a greater proportion can be found (Blench, 1999). Generally, three breeds of goats (Sahel, Sokoto red and West African dwarf) and four breeds of sheep (Balami, Ouda, Yankasa and West African dwarf) are recognized in Nigeria (Blench, 1999).The socio-economic importance of sheep and goats varies in different parts of

the country, but they generally have agricultural, cultural and economic values (Lawal-Adebowale, 2012; Adamu and Balarabe, 2012). Most commonly, their flesh is recognized as sources of protein for human consumption, and their hides and skin also generates revenue (Lawal-Adebowale, 2012).

The productivity of sheep and goats in the Sahel zone of Nigeria is threatened by diseases and inclement weather conditions. Among parasitic diseases, sub-clinical gastrointestinal parasitism is responsible for great economic losses (Singla, 1995; Singh et al., 2017a, b). The incidence of parasitic infections with special reference to tick-borne intracellular haemoparasites of the genus *Anaplasma*, *Babesia* and *Theileria* has been linked with significant losses in productivity of small ruminants in the tropics and subtropical areas of the world (Soulsby, 1982; Jatau et al., 2011; Adamu and Balarabe, 2012; Demessie and Derso, 2015; Salih et al., 2015*; Sumbria and Singla, 2017). Anaplasma species are mainly transmitted by various species of the genus *Amblyomma*, *Dermacentor*, *Ixodes* and *Rhipicephalus* (Soulsby, 1982) and occasionally by biting flies of the genus *Tabanus* (Radostits et al., 2007).

The disease is caused by *Anaplasma ovis* in small ruminants and is characterized by anaemia, high fever, weight loss, breathlesness, incoordination, abortion and death (Khan, 2005). *A. ovis* has a worldwide distribution and is responsible for huge losses in sheep and goats stock, with considerable impact on the economy of developing countries in tropics and subtropics, which rely heavily on small ruminant production (Rymaszewska and Grenda, 2008). Babesiosis in sheep and goats is caused by *Babesia motasi, Babesia foliata, Babesia taylori* and *Babesia ovis* (Soulsby, 1982). In sheep and goats, the disease is characterized by fever, anaemia, icterus, haemoglobinuria, anorexia, and death (Demessie and Derso, 2015). Other species of haemoparsites such as *Theileria hirci* (Metenawy, 1999), *Theileria ovis* (Okaiyeto et al., 2008), *Trypanosoma vivax, T. congolense* and *T. brucei* (Samdi et al., 2008) have also been reported in small ruminants in Nigeria.

Sheep and goats contribute significantly to food security and value chain of the Nigerian economy (Lawal-Adebowale, 2011), but their productivity is threatened by ticks and associated haemoparasitic diseases, especially Babesiosis and Anaplasmosis (Okaiyeto et al., 2008; Jatau et al., 2011). This study was therefore conducted to investigate the prevalence of tick-borne haemoparasites and the associated changes in haematological parameters of slaughtered sheep and goats in Maiduguri abattoir.

MATERIALS AND METHODS

Study area

This study was conducted in Maiduguri, the capital city of Borno

state, located in the Sahel savannah zone of North-eastern Nigeria, between latitude 11°50′48″N and longitude 13°09′25″E of the equator. The climate of Maiduguri is characterized by a short period of rainfall from June to October, followed by a long period of dry season for the rest of the year (Hess et al., 1995). Sheep and goats are among the important household livestock in Maiduguri and its environs. They are mainly raised under traditional semi-intensive or free-range management systems in low income communities (Figure 1).

Sample collection

A total of 200 blood samples was randomly collected from sheep (n=100) and goats (n=100), consisting of 50 males and females. 5 mls of blood was collected immediately after slaughter from the severed jugular vein into vacutainer tubes, containing 1 mg of ethylene diaminetetra-acetic acid (EDTA).

The age, sex and specie of each animal were also identified based on morphometric characteristics and recorded in a case book. The samples were transported on icepacks at 4°C to the veterinary parasitology and clinical pathology laboratories, University of Maiduguri for parasitological and haematological examinations.

Laboratory examination

In the laboratory, thin and thick blood smears were prepared on clean glass slides and stained with Giemsa according to standard protocol described by Soulsby (1982), to screen for the presence of haemoparasites. The stained blood films were examined with oil immersion objective (×100) of a compound microscope (Gupta and Singla, 2012). Identification of haemoparasites was performed using morphologic characteristics (Soulsby, 1982).

The packed cell volume (PCV) was determined by microhaematocrit method; haemoglobin (Hb) by Sahli's method; the total white blood cell (WBC) and red blood cell (RBC) counts by Neubauer hemocytometer while erythrocyte indices, mean corpuscular volume (MCV), mean corpuscular haemoglobin(MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated using standard formula (Brar et al., 2000).

Statistical analysis

Chi Square test was computed with statistical package for social sciences (SPSS) version 22, to determine the prevalence of haemoparasites and its associations with age and sex of sheep and goats. The student's t-test was performed to determine the difference between mean haematological parameters of infected and uninfected sheep and goats. Significant differences were declared at P<0.05.

RESULTS

The results obtained from this study has shown that out of 200 blood samples of sheep and goats examined, 27(13.5%) were positive for various tick-borne haemoparasites. The results further revealed 13(6.5%) and 14(7.0%) of infected animals were sheep and goats, respectively. There was no significant difference (p>0.05) in prevalence of tick-borne haemoparasites among the different sexes and age groups of sheep and goats

Table 1. Prevalence of tick-borne haemoparasitic diseases in sheep and goats.

Variable	No. examined		No. (%) infected		×2 (1df)	p-value	95% CI
	Sheep	Goats	Sheep	Goats			
Age							
Young	32	38	5 (5.0)	3 (3.0)	0.9379	0.3328	0.3174 – 1.430
Adult	68	62	8 (8.0)	11 (11.0)	-	-	-
Sex							
Male	50	50	5 (5.0)	6 (6.0)	0.05395	0.8163	0.4036 – 2.048
Female	50	50	8 (8.0)	8 (8.0)	-	-	-
Total	100	100	13 (6.5)	14 (7.0)	0.03263	0.8566	0.9169 – 1.110

N= 200.

Table 2. Distribution of tick-borne haemoparasites in sheep and goats in Maiduguri.

Animal species	No. Examined	Haemoparasites		
		Anaplasma ovis	*Babesia ovis*	Mixed infection
Sheep	100	10 (5.0)	1 (0.5)	2 (1.0)
Goats	100	13 (6.5)	1 (0.5)	0 (0.0)
Total	200	23 (11.5)	2 (1.0)	2 (1.0)

Table 3. Mean (±SE) haematological parameters of uninfected and infected sheep.

Parameter	Uninfected(n=87)	Infected(n=13)	Normal (Khan, 2005)
PCV (%)	30.99 ± 0.31*	25.54 ± 0.69*	27-45
Hbg (g/dL)	10.69 ± 0.15*	8.72 ± 0.29*	9-15
WBC (x10^3/µL)	10.17 ± 0.12	10.45 ± 0.76	4-12
RBC (x10^6/µL)	12.62 ± 0.15*	9.39 ± 0.63*	9-15
MCV (fL)	24.64 ± 0.22	24.25 ± 1.27	28-40
MCH (pg)	8.48 ± 0.83	8.16 ±0.44	8-12
MCHC (mg/dL)	35.06 ±0.52	32.95 ± 0.93	31-34

*$p<0.05$ denotes significant difference between infected and uninfected group.

(Table 1).

The two species of haemoparasites identified in this study were tick-borne *A. ovis* and *B. ovis*. There was no significant difference ($p>0.05$) in prevalence of infection with haemoparasites in sheep and goats. However, the prevalence of *A. ovis* (11.5%) in both sheep and goats was significantly ($p<0.05$) higher than *B. ovis* (1.0%). Furthermore, 2(1.0%) sheep had co-infection with *A. ovis* and *B. ovis* (Table 2).

The mean values of PCV, Hb and RBC counts of infected and uninfected sheep were significantly ($p<0.05$) different. Furthermore, the mean PCV (25.54 ± 0.69) was below normal range (27 to 45) of values for sheep (Table 3). Similarly, the mean Hb concentration and WBC counts of infected and uninfected goats were significantly

($p<0.05$) different but fell within normal range of values for goats (Table 4). Other haematological parameters of infected and uninfected sheep and goats were comparable ($p>0.05$).

DISCUSSION

The results obtained from our present study revealed that tick-borne haemoparasites are prevalent in both sheep and goats examined at slaughter in Maiduguri. The study further revealed a numerically higher prevalence in female adult sheep and goats than their counterparts. The occurrence of haemoparasites in both sheep and goats in this study may be associated with previous

Table 4. Mean (±SE) haematological parameters of uninfected and infected goats.

Parameter	Uninfected (n=87)	Infected (n=13)	Normal (Khan, 2005)
PCV (%)	27.35 ± 0.36	25.64 ± 1.03	22-38
Hbg (g/dL)	9.53 ± 0.13*	8.81 ± 0.40*	8-12
WBC (x10^3/μL)	9.88 ± 0.11*	8.97 ± 0.33*	4-13
RBC (x10^6/μL)	12.94 ± 0.30	11.91 ± 0.89	8-18
MCV (fL)	21.83 ± 0.37	23.59 ± 1.04	16-25
MCH (pg)	7.58 ± 0.14	7.52 ± 0.33	5.2-8.0
MCHC (mg/dL)	35.41 ± 0.56	33.99 ± 0.97	30-36

*p<0.05 denotes significant difference between infected and uninfected group.

Figure 1. Map of Borno state showing Maiduguri, the study area.

reports on high prevalence of ixodid ticks in livestock in Maiduguri and environs (James-Rugu and Jidayi, 2004; Oparah and Ezeh, 2011; Musa et al., 2014; Paul et al., 2017). Ticks of the genus *Amblyomma*, *Rhipicephalus* including subgenus *Boophilus*, *Hyalomma* and *Dermacentor*, which are potential vectors of *Anaplasma* and *Babesia* species in sheep and goats were previously reported in Borno state (James-Rugu and Jidayi, 2004; Oparah and Ezeh, 2011; Musa et al., 2014; Paul et al., 2017). Furthermore, the sheep and goats slaughtered in Maiduguri are raised under extensive and semi-intensive management systems in outdoor environments graze alongside with cattle. These increase their exposure to the arthropod vectors.

Both *A. ovis* and *B. ovis* were identified in this study. *A. ovis* was the most prevalent species in both sheep and goats. This finding agrees with previous reports (Okaiyeto et al., 2008; Jatau et al., 2011; Adamu and Balarabe, 2012). The prevalence of these parasites elsewhere in Nigeria was linked with suitable microclimate favouring the propagation of their arthropod vectors (Jatau et al., 2011). Similarly, the prevalence of haemoparasites in slaughtered cattle in Maiduguri was linked with conditions favouring the bionomics of ixodid ticks (Paul et al., 2016).

Moreover, *A. ovis* is a ubiquitous organism that has been reported in all the six continents (Rymaszewska and Grenda, 2008) and especially in the tropics and subtropics, due to the abundance of its tick vectors (Jongejan and Uilenberg, 2004). The low prevalence of *B. ovis* recorded in both sheep and goats in this study agreed with previous reports (Bell-Sakyi et al., 2004; Jatau et al., 2011). This finding could be attributed to the enzootic occurrence of babesiosis in indigenous animals in Nigeria. Sheep and goats usually develop strong immunity in early life and resist subsequent challenges favourably by preventing establishment of the parasite (Soulsby, 1982).

This study revealed that, infection with haemoparasites in sheep caused a significant (p<0.05) reduction in PCV, Hb and total RBC counts. Furthermore, our results show a significant (p<0.05) reduction in the Hb concentration and total WBC count of goats. The anaemia observed in this study characterized by a reduction in PCV and Hb concentration of infected sheep and goats, is consistent with previous reports. Anosa (1988) reported that, anaemia is a predominant feature that often serves as a reliable indicator for severity of haemoparasitic infections. Rymaszewska and Grenda (2008) observed that progressive anaemia usually develops during anaplasmosis and babesiosis.

Furthermore, Anumol et al. (2011) reported that haemoparasites are responsible for most cases of anaemia in goats. The pathogenesis of anemia in haemoparasitic infections is multifactorial in nature; emergence of parasites from RBC, mechanical rupture of RBC, spontaneous lysis of RBC due to increased osmotic fragility, direct removal of non-infected erythrocytes by phagocytosis and adsorption of circulating antigen-antibody complexes to the surface of RBC, leading to their removal by phagocytosis as described by Soulsby (1982).

The observed reduction in WBC counts of infected goats in this study has been previously reported. A significant reduction in total WBC counts of dromedary camels infected with babesiosis in Saudi Arabia was described by Swelum et al. (2014). This finding could be linked with concurrent infections and stress which may lead to immune suppression. Helminthosis and bacterial infections are usually encountered concurrently with haemoparasitic infections under field conditions in Nigeria (Okaiyeto et al., 2008; Jatau et al., 2011), which may complicate the clinical course of haemoparasitic infections.

Conclusion

This study has revealed the presence of important tick-borne haemoprotozoan parasites in slaughtered sheep and goat in Maiduguri. The prevalence of *A. ovis* and *B. ovis* was accompanied by anaemia in sheep and goats. This finding suggests that *A. ovis* and *B. ovis* are common causes of anaemia leading to decreased productivity of sheep and goats in Maiduguri and environs.

RECOMMENDATION

Molecular studies used to characterize *Anaplasma* and *Babesia* genotypes and specific tick vectors responsible for the transmission of these parasites in Maiduguri, in other to aid proper planning of effective control measures is recommended.

Meanwhile, vector control with effective acaricides and the periodic screening and treatment of sheep and goats in Maiduguri with suitable antiprotozoal drugs will reduce the impact of tick-borne haemoparasitic diseases which enhance their productivity.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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