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Full Length Research Paper

Prevalence, gross pathological lesions and financial losses of bovine Fasciolosis in Arba Minch Municipal Abattoir, Gamo Gofa Zone, Southern Ethiopia

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A cross sectional study on bovine fasciolosis was carried out from October 2009 to April 2010 at Arba Minch Municipal abattoir with the aim of determining the prevalence and estimating financial loss. Out of the total 600 cattle examined during the study period, 203 were positive for *Fasciola* spp. infection with the prevalence rate of 33.83%. *Fasciola gigantica* was found to be the predominant *Fasciola* species affecting cattle slaughtered in the study area, 179 (88.18%) of the total livers positive for bovine fasciolosis were infected by *F. gigantica*, while 15 (7.39%) livers had *F. hepatica* and 9 (4.43) were infected by both species (*Fasciola hepatica* and *F. gigantica*). From positive livers for the parasite, 44.33, 33.50 and 22.17% of the livers had slight, moderate and severe gross lesions, respectively. There was a significant difference in the prevalence of fasciolosis (P<0.01) among different body conditions and also among different origins. Higher prevalence of the parasite was observed in animals with poor body condition and lowland origin. The total estimated annual financial losses due to fasciolosis in the abattoir during the study period was726,561.5 ETB ($52,649.38 US) of which 49,493.29 ETB ($3,586.47 USD) was due to liver condemnation (direct) and 677,068.21 ETB ($49,062.91 USD) was because of carcass weight loss (indirect). The estimated annual financial loss showed that fasciolosis is an economically important disease in the abattoir. Therefore, there is a need for further detailed studies on the epidemiology of the disease and snail intermediate hosts found in the area and strategic measure should be taken to control the disease.

Key words: Abattoir, Arba Minch, cattle, Ethiopia, Fasciolosis, financial loss, prevalence.

INTRODUCTION

Ethiopia owns huge number of ruminants with high contribution to the economy and livelihood to the people. Despite the significantly large livestock population, its contribution to the national economy is below the potential due to poor management practices, poor nutrition or low response to improved nutritional inputs, high disease incidence, and low genetic potential. Moreover, improper evaluation of public health importance is due to various individual parasitic disease and inadequate knowledge of epidemiology of disease

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which otherwise is of great relevance where the distribution of disease determine the type and scope of control measures to be applied (Zegeye, 2003; Taylor et al., 2007; ILRI, 2009).

Fasciolosis is an important parasitic disease of domestic animals, especially cattle and the significance of fasciolosis as emerging helminthic zoonoses is highlighted (Chhabra and Singla, 2009). The two species most commonly implicated as the aetiological agents of fasciolosis are *Fasciola hepatica* and *Fasciola gigantic* (Pal, 2007). It is serious hazards to efficient production of cattle particularly in its sub clinical form (Radostitis et al, 2007). Occasionally, fasciolosis can infect human beings (CDC, 2013) and has recently been shown to be a re-emerging and widespread zoonosis affecting many people (Esteban et al., 2003).

Fasciola hepatica has a worldwide distribution but predominates in temperate zones, while *F. gigantica* is found on most continents, primarily in tropical regions (Andrews, 1999). Mixed infection by both species of *Fasciola* may occur in area where the ecology is conducive for replication of intermediate host. The economic impact of fasciolosis may greatly vary from year to year depending on the weather condition, management, level of infection, host immunity status and age of animals in endemic areas. In this, cumulative substantial loss could be very high in fluke remaining untreated and suffering from sub clinical fasciolosis (Taylor et al., 2007).

The development of infection in definitive host is divided into migratory phase and the biliary phase (Dubinsky, 1993). The parenchyma phase begins when encysted juvenile flukes penetrate the intestinal wall. After the penetration of the intestine, flukes migrate within the abdominal cavity and penetrate the liver or other organs and cause lesion. The young flukes tunnel through the parenchyma then enter the small bile ducts where they migrate to the larger bile ducts and cause lesion (Behm and Sangsten, 1999; Taylor et al., 2007).

Important economic losses associated with fasciolosis include great expenses on anthelmintics for treatment; liver condemnation; production loss due to mortality; lower production of meat, milk and wool; reduced weight gain; metabolic diseases and impaired fertility (Mason, 2004; Hillyer and Apt, 1997).

Economic losses in Africa and other parts of the world is due to the condemnation of liver as unsuitable for human consumption and associated with poor carcass conformation and predispose the animal to other infectious principally clostridium disease, weight loss, loss in productivity and loss due to death (Andrew et al., 2003)

A review of available literature strongly suggests that fasciolosis exists in almost all parts of Ethiopia. The prevalence and economic significance has been reported form different parts of the country by different researchers (Moje et al., 2015; Petros et al., 2013; Regassa et al., 2012; Miheretab et al., 2010; Manyzewal et al., 2014; Terefe et al., 2012). Even though, different researchers in the country studied the parasite prevalence and economic significance, there is limited work in the southern part of Ethiopia, specifically, there was no work done at Arba Minch Municipal abattoir so far. Therefore, the main objectives of this study were to determine the prevalence of fasciolosis, identify the species of liver flukes involved in fasciolosis, compare the intensity of the infection with the liver lesion involved in fasciolosis and assess the financial loss due to fasciolosis in cattle slaughtered at Arba Minch Municipal Abattoir

MATERIALS AND METHODS

Study area

The study was conducted in Arba Minch, Southern Nation Nationality and People's Regional State (SNNPRS), from October, 2009 to April, 2010. The town is located geographically at 37°5' East of longitude and 6° North of latitude with altitude ranging from 1200 to 3125 m above sea level. The average annual rain fall ranges from 750 to 930 mm with mean average temperature of 30°C. The town is situated in the well-known East African Rift valley and surrounded by Lake Chamo and Abaya as well as the Nech Sar National Park. Mixed livestock agriculture farming system was practiced (GZARDO, 2007).

Study population

A total of 600 indigenous cattle are slaughtered at Arba Minch municipal abattoir. The animals were brought from district markets and brought to the abattoir for slaughtering purpose which originated from different origins with in Gamo Gofa Zonea and nearby areas mainly from highlands (Bonke, Chencha and highlands around Arba Minch), midlands (Kamba and Daramalo) and lowlands (in and around Arba Minch, Jinka and Borena).

Study design, sampling and sample size determination

A cross sectional study was carried out from October, 2009 to April, 2010 by collecting data on events associated with fasciolosis on cattle slaughtered at Arba Minch Municipality abattoir. The study was made on the slaughtered cattle at abattoir by the regular visiting. During abattoir survey includes both ante mortem and postmortem examination

The sample size was calculated according to Thrustfield (1995) by considering estimated prevalence of 50% since there was no previous abattoir survey conducted in the study area. The sample size calculated was 384 with 95% confidence interval and 5% expected error. However, in order to increase the precision, a total of 600 cattle were examined at Arba Minch Municipal abattoir by using systemtic sampling method.

The study animals were selected from the slaughter line using systematic random sampling and examined following ante-mortem and post mortem inspection procedure. Body condition was scored following the guidelines set by Nicholson and Butterworth (1986). Each animal was identified based on the enumerate marks on its body tagged before slaughter. Information regarding age, origin and body condition of the study animals was recorded during ante-mortem examination. Assessment of body condition was carried out using a modified method described by Nicholson and Butterworth

(1986). All cattle presented to the abattoir for slaughter were local indigenous breed and male cattle. The liver of each study animal was carefully examined through palpation and incision on each liver and bile duct for presence of lesions indicative of Fasciola infection externally and sliced for confirmation. Liver flukes were recovered for differential count by cutting the infected liver into fine, approximately 1 cm slices with a sharp knife.

Then, positive livers with adult parasites were collected by squeezing into universal bottle containing 10% formalin preservative and then examined to identify the involved fluke species by their size and morphological character. The size of *F. gigantica* is larger (20-75 x 3-12 mm) than *F. hepatica* (20-30 x 10 mm) and the anterior cone *F. gigantica* is not prominent as that of *F. hepatica* and the body is more transparent (Soulsby, 1982).

Characterization of gross liver lesion

Hepatic lesions in *Fasciola* positive livers were further grouped in to three different pathological categories depending on the severity of damage inflected by the parasite. The task of categorization was based on the criteria forwarded by Ogurinade and Ogurnrinade (1980). The criteria were:

Lightly affected liver: A quarter of liver was affected or one bile duct was prominently enlarged on the ventral surface of the liver and cutting revealed enlarged or calcified bile ducts and/or thick.

Moderately affected liver: Half of the organ was affected or two or more bile ducts are enlarged and visible before cutting.

Severely affected liver: The entire organ was involved or the liver was cirrhotic or the left lobe atrophy and hyperplasia of the right lobe is seen giving the liver triangular.

Financial loss assessment

The total financial loss due to fasciolosis in cattle slaughtered at Arba Minch municipal abattoir was estimated from the summation of annual liver condemnation (direct loss) and due to carcass weight reduction and poor quality (indirect loss).

Direct financial loss

All livers affected with fasciolosis were totally condemned. The annual direct financial loss was assessed by considering the overall prevalence rate of the disease, the total annual slaughtered animal in the abattoir and retail price during the time of sample collection of an average animal liver. The information obtained was subjected to mathematical compilation using the formula set by Ogurinade and Ogurnrinade (1980).

ALC= CSR*MLC*P

Where, ALC = Annual loss from liver condemnation; CSR = Mean annual cattle slaughtered per year at Arba Minch abattoir; MLC= Mean cost of one liver at Arba Minch town, P = Prevalence rate of the fasciolosis at Arba Minch abattoir.

Indirect financial loss

The indirect (carcass weight reduction) economic loss due to fasciolosis was calculated by considering an estimated 10% carcass weight loss due to fasciolosis in cattle as reported by Robertson (1976) and average carcass weight of an Ethiopian zebu was taken as 126 kg (ILCA, 1992). According to Ogunrinade and Ogunrinade (1980), the annual economic loss because of carcass weight reduction due to bovine fasciolosis was assessed using the formula:

(ACW) = CSR* CL * BC * P*126 kg

Where, ACW is annual loss from carcass weight reduction; CSR, average number of cattle slaughtered at Arba Minch abattoir per year; CL, carcass weight loss in individual cattle due to fasciolosis; BC, an average price of 1 kg beef at the study abattoir; P, prevalence rate of fasciolosis at the study abattoir; 126 kg, average carcass weight of Ethiopia Zebu cattle.

Data management and analysis

The collected data were coded and stored in Microsoft Excel spread sheet. Statistical analysis was done using STATA Version 11.0 (Stata Corp. College Station, TX)) statistical software. Prevalence of fasciolola infection was calculated by descriptive statistics as percentage value, whereas association of Fasciola prevalence with origin, body condition score of the animals and others was analyzed using Chi-square analysis.

RESULTS

Prevalence of bovine fasciolosis

Out of 600 livers examined of cattle slaughtered at the abattoir during the study period, 203 were positive, indicating 33.83% over all prevalence rate. From the total positive livers for fluke 7.39% possess *F. hepatica*, 88.18% were found infected with *F. gigantica* and 4.43% have both *F. hepatica* and *F. gigantica* mixed infection (Table 2).

Prevalence of bovine fasciolosis from highland, midland and lowland origins were 15.93, 26.7 and 45.27%, respectively. Prevalence of bovine fasciolosis was significant (P< 0.01) based on three origins of animals from different ecological condition. There was significant statistical difference (p<0.001) among different body condition scores (good, medium and poor). More than half of the animals brought to the abattoir (58.02%) were with poor body condition which indicates that fasciolosis is chronic disease of cattle, and the main sign of is emaciation or loss of weight (Taylor et al., 2007). Statistical analysis of the effect of age on prevalence indicated no significance variation (P>0.05) among different age groups of animals.

Hepatic lesion characterization

Based on the severity of gross liver lesion, 44.33, 33.49 and 22.17% were lightly, moderately and severely affected, respectively (Table 1).

Direct financial loss assessment

The average annual cattle slaughtered were estimated to

Table 1. Classification of liver based on the extent of gross lesion.

Extent of lesions (judgment of condemnation)	Number of livers	Prevalence (%)
Lightly affected (1/4 condemned)	90	44.33
Moderately affected (1/2 condemned)	68	33.5
Severely affected (totally condemned)	45	22.17
Total	203	100

Table 2. The prevalence of bovine fasciolosis and associated risk factors.

	Number of examined animal	No of positive animals	Prevalence (%)
Species of *Fasciola*			
F. hepatica	600	15	7.39
F. gigantica	600	179	88.18
Mixed	600	9	4.43
Animal origin			
Low- land	296	134	45.27
Mid- land	191	51	26.70
High- land	113	18	15.93
Body condition			
Poor	81	46	58.02
Medium	242	100	41.32
Good	277	56	20.22
Age			
<6 years	228	72	31.58
6-10 years	258	92	35.66
>10 years	114	39	34.21
Total	600	203	33.83

Financial loss assessment.

be 4180, while mean retail price of bovine liver, 35 ETB and prevalence of fasciolosis was 33.83%, the estimated annual financial loss from liver condemnation was calculated as

ALC= CSR × LC × P

= 49,493.29 ETB or 3,586.47 $USD

Indirect financial loss assessment

It is the loss due to reduced carcass weight of Fasciola infected animals and was calculated by using average annual cattle slaughtered estimated to be 4180, while the price of carcass weight reduction (indirect) loss of 1 kg beef was 38 ETB. Then, the annual economic loss due to carcass weight reduction was assessed using the formula set by Ogunrinade and Ogunrinade (1980):

ACW = CSR* CL * BC * P*126 kg

= 677,068.21 ETB ($49,062.91 US)

Therefore, the total annual financial loss due to bovine fasciolosis in the Arba Minch Municipality abattoir was the summation of losses from organ condemnation (direct loss) and losses from carcass weight reduction (indirect loss) was about 726,561.5 ETB ($ 52,649.38).

DISCUSSION

Bovine fasciolosis is economically important and widely distributed disease in almost all region of Ethiopia. The result revealed that the disease is also problem in cattle slaughtered at Ariba Minch municipal abattoir causing high economic loss due to liver condemnation and carcass weight reduction. The overall prevalence of bovine fasciolosis (33%) from the current result was in agreement with the findings of Moje et al. (2015) (30%) in Areka, Mulat et al. (2012) (29.6%) and Miheretab et al. (2010) (32.3%) in Adwa, Ibrahim et al. (2009) (28%) in Kombolcha et al. (2004) (31.7%) from Zimbabwe and Badreldeen and Elfadil (2015) (31.6%) in Sudan.

The present prevalence was much lower than some studies in different parts of the country. In northern Ethiopia, Yilma and Mesfin (2000) reported 90.7% prevalence at Gondar abattoir and also Aregay et al. (2013) found 39.95% in Bahir Dar. In addition, Tolosa and Tigre (2007) recorded a prevalence of 46.2% at Jimma abattoir. Manyazewal et al. (2014) and Abebe et al. (2011) presented 47.1 and 53.7% in Southwest Ethiopia, respectively. The current prevalence findings are also lower than previous studies from other countries in sub-Saharan Africa with prevalence of 53.9% from Zambia, 63.8% from Tanzania and 38.5% from Uganda reported by Phiri et al. (2005), Keyyu et al. (2006) and Ssimbwa et al. (2014), respectively.

On the other hand, the finding is higher than some reports from different parts of Ethiopian and nearby east African country with prevalence of 14.0, 14.4, 24.3, 20.3, 21.9, *25.2,* 21.5, 21.6, 24.4 and 26% in Wolaita Soddo (Abunna et al. 2009), Diredawa (Daniel, 1995), Mekele (Gebretsadik et al., 2009), Addis Ababa (Aragaw et al. 2012), Bishoftu (Regassa et al., 2012), Dessie, *(*Belay et al 2012*),* Adigrat (Afera, 2012), Nekemte (Petros et al., 2013), Haramaya (Yusuf et al., 2016) and Kenya (Mungube et al., 2006), respectively. Difference in prevalence among geographical locations is attributed mainly to the variation in the climatic and ecological conditions such as altitude, rainfall and temperature. *Fasciola* spp. prevalence has been reported to vary over the years mainly due to variation in amount and pattern of rainfall.

In relation to risk factors, there was a significant difference in the infection rate (P<0.05) among the animal origins and body condition scores condition groups but, revealed no statistical difference among age groups. The study revealed that there was a statistically significant association (*P* <0.001) in bovine fasciolosis prevalence among different body condition groups of the animals. Higher prevalence of fasciolosis in cattle with poor body condition as compared to cattle in medium and good body condition (Hagos, 2007; Terefe et al., 2012; Aragaw et al., 2012) as chronic fasciolosis is characterized by progressive loss of condition (Urquhart et al., 1996). However, it must be borne in mind that cattle coming from feedlots, which are expected to be in good body condition, are most likely to be de-wormed than cattle coming directly from grazing (Aragaw et al., 2012).

Out of the total positive livers for fasciolosis species identified, 88.18% of them were infected by *F. gigantica* where as 7.39% were infected by *F. hepatica* and 4.43% were mixed infections (both *F. hepatica* and *F. gigantica*). The predominant species involved in bovine fasciolosis in the study area was *F. gigantica*. The high prevalence of *F. gigantica* as compared to *F. hepatica* may be associated with the presence of intermediate host *L. natalensis* and may be explained by the fact that most cattle for slaughter came from low land and mid altitude zones and also as described by Troncy (1989), the favorable condition the snail was border of lakes, flood prone area and low lying marshy and drainage ditches for favorable habitat. Aribaminch and the surroundings were surrounded by lakes Abaya and Chamo and rivers with spring and forest which may be conducive for the development of the intermediate host, *L. natalensis.*

Analysis of gross liver pathology showing 44.33, 33.5 and 22.17% were affected lightly, moderately and severely, respectively. According to Dwinger et al. (1982) and Yilma and Mesfin (2000), the number of fluke has no direct relationship with the liver gross lesion as it was observed that relatively less flukes in severely affected livers of beef cattle.

However, severe fibrosis impedes the passage of immature flukes and acquired resistance and calcification of bile ducts that impaired the further passage of young flukes and play a role by creating unfavorable microenvironment which results in the expulsion of flukes (Dwinger et al., 1982; Ramato, 1992).

The total annual financial loss estimated at 726,561.5 ETB ($ 52,649.38) which is summation of liver condemnation (direct) and carcass weight reduction (indirect) in this study account for 49,493.29 ETB ($3,586.47) and 677,068.21 ETB ($49,062.91). The direct financial loss due to liver condemnation is comparable to 47,124 ETB by Moje et al. (2015) but, lower than that of Manyzewal et al. (2014) (47,570 ETB) and Petros et al. (2013) (63,072 ETB) at Mettu and Nekemte abattoirs, respectively.

The total financial loss at Arba Minch municipal abattoir in this study was lower than the findings of Belay et al. (2012) at Dessie and Terefe et al. (2012) at Jimma. Moreover, the total financial loss is comparable to the report of Mulugeta et al. (2011) in and around Asella. The existing variation might be correlated with slaughter capacity and number of condemned organs at those specific areas.

Conclusion

The study revealed that bovine fasciolosis is a prevalent disease in the study area causing great financial loss due to condemnation of affected liver and carcass weight reduction. Predominant species involved in bovine fasciolosis in the study area was *F. gigantica.* This may be due to the fact that most cattle originated from low land and suitable ecological condition for the existence and multiplication of the intermediate host snail. Therefore, proper attention should be paid to control this disease in the study area in particular and in the country in general.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

REFERENCES

Abebe F, Meharenet B, Mekibib B (2011). Major Fasciolosis infections of cattle slaughtered at Jimma municipality abattoir and the occurrence of the intermediate hosts in selected water bodies of the zone. J. Anim. Vet. Adv. 10:1592-1597

Abunna F, Asfaw L, Megersa B, Regassa, A (2009). Bovine fasciolosis: coprological, abattoir survey and its economic impact due to liver condemnation at Soddo municipal abattoir, Southern Ethiopia. Trop. Anim. Health Prod. 42(2):289-292.

Afera B (2012). Prevalence of bovine fascilosis in municipal Abbatoir of Adigrat, Tigray, Ethiopia. Available at: http://www.veterinaria.org/revistas/redvet/n090912/091202.pdf

Andrews S (1999).The Life Cycle of *Fasciola hepatica*. In Fasciolosis, Ed. Dalton, J.P. CABI Publishing. pp:1-29.

Aragaw K, Negus Y, Denbarga Y, Sheferaw De (2012). Fasciolosis in Slaughtered Cattle in Addis Ababa Abattoir, Ethiopia. Global Vet. 8 (2):115-118.

Aregay F, Bekele J, Ferede Y, Hailemelekot M (2013). Study on the prevalence of bovine fasciolosis in and around Bahir Dar, Ethiopia. Ethiop. Vet. J. 17(1):1-11.

Badreldeen BM, Elfadil AA (2015). A Cross-Sectional Survey of Bovine Fasciolosis at Elkadaro Abattoir, Khartoum State, Sudan. Glob. J. Med. Res. 15(2):1-9.

Behm C, Sangster N (1999). Pathology, pathophysiology and clinical aspects. In: Dalton, JP ed, Fasciolosis. CABI Publishing. Wallingford. pp: 185-224.

Belay E, Molla W, Amare A (2012). Prevalence and Economic Losses of Bovine Fasciolosis in Dessie Municipal Abattoir, South Wollo Zone, Ethiopia. Europ. J. Biol. Sci. 4 (2):53-59.

Centre of Disease Control and Prevention (CDC): Va. USA. (2013). Available at: https://www.cdc.gov/dpdx/fascioliasis/index.html

Chhabra MB, Singla LD (2009) Food-borne parasitic zoonoses in India: Review of recent reports of human infections. J. Vet. Parasitol. 23(2):103-110.

Daniel F (1995). Economic Importance of organ condemnation due to Fasciolosis and Hydatidosis in Cattle and Sheep slaughtered at Dire Dawa abattoir, DVM, Thesis, FVM, AAU Debre zeit, Ethiopia. pp: 18-26.

Dubinsky P (1993). Trematody atrematodozy. In: Jurasek V, Dubinsky P, kolektiv A, Vet. Parasitol. Priroda AS, Bratislava. pp:158-187.

Dwinger RH, Leriche PD, Kuhne GI (1982). Fascioliasis in beef cattle in North Western Argentina. Trop. Anim. Health Prod. 14(3):167-171.

Esteban JG, Gonzalez C, Curtale F, Mun˜oz-Antoli C, Valero MA, Bargues MD, El-Sayed M, El Wakeel A, Andel-Wahab Y, Montresor A, Engels D, Savioli L, Mas-Coma S (2003). Hyperendemic fascioliasis associated with schistosomiasis in villages in the Nile Delta of Egypt. Am. J. Trop. Med. Hyg. 69:429-437.

Gamo Goffa Zone Agricultural and Rural Development Office (GZARDO) (2007). Livestock Resource Development and Animal Health Department Annual Report, Arbaminch, Ethiopia.

Gebretsadik B, Kassahun B, Gebrehiwot T (2009). Prevalence and economic significance of fasciolosis in cattle in Mekelle Area of Ethiopia. Trop. Anim. Health Prod. 41:1503-1504.

Hagos A (2007). Study on prevalence and economic impact of bovine Hydatidosis and Fasciolosis at Mekelle Municipal Abattoir, DVM Thesis, FVM, AAU, Debre zeit, Ethiopia. pp:15-23.

Hillyer GV, Apt W (1997). Food-borne trematode infections in the Americas. Parasitol. Today 13:87-88.

Ibrahim N, Wasihun P, Tolosa T (2009). Prevalence of Bovines Fasciolosis and Economic Importance due to Liver Condemnation at Kombolcah Industrial Abattoir, Ethioipia. Internet J. Vet. Med. 8(2).

ILRI (2009). Management of vertisols in Sub-Saharan Africa, Proceedings of a Conference Post-mortem differential parasite counts FAO corporate document Repository.

.

International Livestock Center for Africa (ILCA) (1992). Debre Berhan experimental station annual report. P 46.

Keyyu JD, Kassuku AA, Msalilwa PL, Monrad J, Kyvsgaard CN (2006). Crosssectional prevalence of helminth infections in cattle on traditional, small-scale and large scale dairy farms in Iringa District, Tanzania. Vet. Res. Commun. 30:45-55.

Manyazewal AZ, Gurnesa M, Tesfaye T (2014). Economic Significance of Fasciolosis at Mettu Municipal Abattoir, Southwest, and Ethiopia. J. Adv. Vet. Res. 4(2):53-59.

Mason C (2004). Fasciolosis associated with metabolic disease in a dairy herd and its effects on health and productivity. Cattle Pract. 12:7-13

Miheretab B, Tesfay H, Getachew Y (2010). Bovine Fasciolosis: Prevalence and its economic loss due to liver condemnation at Adwa Municipal Abattoir, North Ethiopia. EJAST 1(1):39-47.

Moje N, Mathewos S, Desissa F, Regassa A (2015). Cross-sectional study on bovine fasciolosis: prevalence, coprological, abattoir survey and financial loss due to liver condemnation at Areka Municipal Abattoir, Southern Ethiopia. J. Vet. Med. Anim. Health **7**(1):33-38.

Mulat N, Basaznew B, Mersha C, Achenef M, Tewodros F (2012). Comparison of coprological and postmortem examination techniques for the determination of prevalence and economic significance of bovine fasciolosis. J. Adv. Vet. Res. 2:18-23.

Mulugeta S, Begna F, Tesgaye E (2011). Prevalence of Bovine Fasciolosis and itsnEconomic Significance in and Around Assela, Ethiopia. Glob. J. Med. Res. 11(3):1-7.

Mungube EO, Bauni MS, Tenghagen BA, Wamae WL, Nginyi MJ, Mugambi MJ (2006). The Prevalence and Economic Significance of Fasciola gigantica and Stilesia hepatica in Slaughtered Animals in the Semi Arid Coastal Kenya. Trop. Anim. Health Prod. 38:475-483.

Nicholson MJ, Butterworth HM (1986). A guide to condition scoring of zebu cattle. International Livestock Center for Africa (ILCA), Addis Ababa, Ethiopia.

Ogunrinade A, Ogunrinade B (1980). Economic importance bovine fasciolosis in Nigeria. Trop. Anim. Health Prod.12(3):155-1590.

Pal M (2007). Zoonoses. (2nd edn.), Satyam Publishers, Jaipur, India

Petros A, Kebede A, Wolde A (2013). Prevalence and economic significance of bovine fasciolosis in Nekemt Municipal Abattoir. J. Vet. Med. Anim. Health 5(8):202-205.

Phiri AM, Phiri IK, Sikasunge CS, Monrad J (2005). Prevalence of fasciolosis in Zambian cattle observed at selected abattoirs with emphasis on age, sex and origin. J. Vet. Med. 52:414-416.

Radostitis OM, Gray CC, Hinchcliff KW, Constable PD (2007). Hepatic disease associated with thrematods. In text book of cattle, horse, pigs and goats. Veterinary Medicine 10th ed. pp:1576-1580.

Ramato A (1992). Fasciolosis: clinical occurrence, coprological, abattoir and snail survey in Around Wolliso. DVM Thesis, FVM, AAU, Debre Zeit. P 35.

Regassa A, Woldemariam T, Demisie S, Moje N, Ayana D, Abunna F (2012). Bovine Fasciolosis: Coprological, Abattoir Survey and Financial loss Due to Liver Condemnation in Bishooftu Municipal Abattoir, Central Ethiopia. Europ. J. Biol. Sci. 4:83-90.

Robertson A (1976). Hand book on animal disease in tropics. pp: 3:304.

Soulsby EJL (1982). Helminths, Arthropods and Protozoa of Domesticated Animals,7th edition. Balliere Tindall, London, UK. pp: 40-52.

Ssimbwa G, Baluka AS, Ocaido M (2014). Prevalence and financial losses associated with bovine fasciolosis at Lyantonde Town abattoir. Livest. Res. Rural Dev. 26(9) Available at: http://www.lrrd.org/lrrd26/9/ssim26165.html

Taylor AM, Coop LR, Wall LR (2007). Veterinary Parasitology, 3rd Edition, UK, Wiley-Blackwell prublisher. pp:343-345.

Terefe D, Wondimu A, Dechasa GF (2012). Prevalence, gross pathological lesions and economic losses of bovine fasciolosis at Jimma Municipal Abattoir, Ethiopia. J. Vet. Med. Anim. Health 4:6-11.

Thrustfield M (1995). Veterinary epidemiology, University of Edinburgh, Black well Science. 2:180-188.

Tolosa T, Tigre W (2007). The prevalence and economic significance of bovine fasciolosis at Jimma abattoir, Ethiopia. J. Vet. Med.3(2):1-5.

Troncy PM (1989). Helminthes of livestock and poultry in Tropical Africa. In: Fischer (ed.), Manual of Tropical Veterinary Parasitology.

CAB International, UK. pp. 63-73.
Urquhart GMS, Armour JL, Dunn AM, Jennings FW, Duncan JL (1996). Veterinary Parasitology 2ed. Blackwell Science, London. pp: 87-185.
Yilma JM, Mesifin A (2000). Dry season bovine fasciolosis in Northwestern part of Ethiopia. Rev. Med. Vet. 151:493-5050
Yusuf M, Ibrahim N, Tafese W, Deneke Y (2016). Prevalence of Bovine Fasciolosis in Municipal Abattoir of Haramaya, Ethiopia. Food Sci. Quality Manag. 48:38-43.
Zegeye Y (2003). Challenges and opportunities of livestock marketing in Ethiopia. In: Proc. of the 10th annual conference of Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia. pp. 47-54

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Socio-economic characteristics of dairy production in the selected areas of Ethiopian central highlands

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A study was carried out to assess dairy production practices in eight selected areas of the Ethiopian central highlands. Overall, 320 smallholder farmers (40 from each of 8 study sites) were randomly selected for individual interviews using a semi-structured questionnaire. Dairying (43%) was reported to be a major source of income for farm household. The major feed sources for dairy cattle includes grazing on natural pasture (62%), grass hay (94%), crop residues of barley (57%) and wheat (53%). Mastitis (66%), blackleg (18%) and foot and mouth disease (10%) were the most common dairy cattle health problems. On average, 1,977 Ethiopian birr was estimated for milk disposed from infected udders and cost of medication against various animal diseases per household/year. Artificial insemination and natural mating using genetically improved bulls were the two breeding methods for dairy animals. The average charges of artificial insemination and bull services were estimated to be 29 and 81 birr, respectively. The average milk yield per cow was 10 liters/day. Milking was dominantly done by housewives twice a day. Average calving interval (14 months), age at first calving (31 months), and lactation length (9.4 months) was reported for crossbred cows. The major dairy production constraints identified in this study were shortage of feed, poor nutritional quality, high veterinary cost and shortage of veterinary clinics and veterinarians. Thus it is recommended that there is a need to conserve feed, introduce improved forage species and improve animal health services, which will enhance the productivity and profitability of the dairy sector in the study areas.

Key words: Dairy production, feed, health, reproduction

INTRODUCTION

Ethiopia has the largest cattle population in Africa, estimated at 53.4 million, including 11.4 million milking cows that, in 2012, produced 3.5 billion liters of milk worth $1.2 billion which are mainly kept by smallholder farmers (CSA, 2012). Cattle also provide traction power, produce meat and manure, and serve as insurance or emergency currency in times of drought or household crisis. The country has a favorable climate for keeping high yielding dairy breeds, which has huge potential for feed production as well as an ever increasing demand for

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milk and milk products (Mohammed et al., 2004). Since, the dairy sector is not yet developed to the expected level and its contribution to the national economy is fairly low

In Ethiopia, milk and milk products play an important role in household food security and income for smallholder farmers. Tefera (2010) argued that in the central Ethiopia, households owning larger livestock herds are less affected by food insecurity. The vast majority of smallholder farmers in the Ethiopia use low input production systems that relates to relatively low milk yield per cow/day (Zelalem et al., 2011). In these systems, animals are fed on crop residues and roadside grass, which are relatively low in protein and digestibility (Yoseph et al., 2003) and rarely supplemented with small quantities of agro industrial by products (Ahmed et al., 2010). As a result, productivity is low, animals reach puberty at a late age (often older than 24 months) and calving interval is long (often 18 to 24 months) (Ibrahim et al., 2011).

Herd management practices in nutrition and housing play major roles in predisposing individual animals to diseases (Wanapat and Chanthakhoun, 2011; Juyal et al., 2011). MoA and ILRI (2013) also reported that health-related problems seem to be one of the greatest problems faced by Ethiopian dairy farmers. Hence, improving the herd management systems combined with sustainable veterinary services is critical to optimize production and profitability of the smallholder farmers. With increased demands of dairy products and human population, the continuing importance of the dairy sector in the Ethiopian economy depends on increased productivity through good management practices. To bring this into effect, it is essential to understand the existing dairy production systems to make improvement interventions to the smallholder dairy production system as it is the dominant type of dairy production system in the country.

MATERIALS AND METHODS

The study areas

The study was conducted in eight selected dairy potential areas in the Ethiopian central highlands. Except for Debre Berhan, which is located in the Amhara region, the remaining seven areas, namely; Sheno, Sendafa, Chancho, Fiche, Degem, Debre Zeit and Asella are situated in the Oromia regional state. All the eight target dairy potential areas are located within a radius of 175 km from Addis Ababa. The average minimum and maximum temperatures of the areas range from the lowest 2.4 and 23.3°C at Debre Berhan to the highest 8 and 28°C at Debre Zeit, respectively. The areas are located within altitudes that range from the lowest 1600 m at Debre Zeit to the highest 3000 meter at Fiche, while receiving an annual rainfall that range from the minimum 860 mm for Debre Zeit to the maximum 1200 mm for Fiche.

Data collection and sampling

A semi-structured questionnaire was used to solicit information on socio economic characteristics of dairy production with the major areas being: Household characteristics, herd structure, dairy management practices such as animal feed, breeding and housing practice, record keeping, animal health and related constraints; as well as productive and reproductive performance of cows. From each study sites four representative *Kebeles* were randomly selected. Based on their willingness to provide information, a total of 320 (40 from each of the aforementioned 8 dairy potential areas) that own at least one milking cow were selected and interviewed.

Data analysis

The collected data were analyzed using appropriate quantitative and qualitative statistical procedures of SPSS version 16. Descriptive statistical namely mean and percentage; and standard error were used for the data analysis.

RESULTS AND DISCUSSION

Socio-economic characteristics of households

The age of the respondent household (HH) heads averaged at 42, and on average, holding 1.2 ha of land per HH (Table 1). Similar land holding was reported for other areas such as 1.14 ha in Shashemene - Dilla areas (Sintayehu et al., 2008). Higher land holdings of 2.6 ha reported for Bahir Dar Zuria and Ginchi areas (Getachew, 2002; Asaminew and Eyassu, 2009). Though, land is one of the important pre-requisites for any farming activity, the average land holding/HH (1.2 ha) reported in the current study is lower than the national average value (1.60 ha) reported by FAO (2008). This shows small land holding to be one of the major challenges for dairy producers in current study areas, which is also the case in a number of other parts of the country. To make matters worse, the land size owned is diminishing due to competition for alternative uses such as for crop cultivation and construction works relating to the increasing human population as well as urbanization.

The highest educational level achieved by HH heads was first degree (6.58%), followed by diploma (12%) with the remaining sample respondents having educational backgrounds between secondary and primary school education (Table 1). A minimum of preferably a higher educational level when achieved by farmers apparently facilitates not only a better understanding but also a higher adoption of new technologies/innovations. As confirmed by Lemma et al. (2012), for instance, farmers who have better level of education adopted improved dairy husbandry practices faster than those with low educational level. Other studies such as Gizaw et al. (2012), also revealed the apparent contribution of higher level of education to better husbandry practices.

The overall mean family size reported in study areas was 4.4 persons per HH (Table 1), which is lower than the national average (5.2), as reported by CACC (2003). Larger family sizes of 7.4 and 6 were, however, reported for Shashemene - Dilla (Sintayehu et al., 2008) and

Table 1. Socio economic characteristics of HHs (N=320).

Variable	Study sites								Overall mean
	1	2	3	4	5	6	7	8	
Age (year)	53(1.6)	48.6(1.6)	37(1.6)	40.35(2.1)	38.5(3.6)	39.5(1.9)	41.8(1.7)	41.9(1.7)	42.4(0.6)
Land holding (ha)	0.7(0.2)	0.4(0.1)	2.18(0.1)	0.14(0.02)	1.3(0.1)	1.75(0.2)	0.18(0.02)	1.9(0.2)	1.2(0.06)
Educational status (%)									
First degree	10.0	11.2	0.0	15.0	12.0	0.0	4.5	0.0	6.58
Diploma	10.0	27.5	0.0	20.0	30.0	10.0	1.2	0.0	12.33
Secondary	30.0	37.0	15.0	44.8	18.0	0.0	62.0	37.5	30.54
Primary	45.0	24.3	67.5	15.2	40.0	90.0	32.3	62.5	47.1
Illiterate	5.0	0.0	17.5	5.0	0.0	0.0	0.0	0.0	3.43
Religions (%)									
Orthodox	100	82.5	100	100	100	100	70.0	85.0	92.5
Muslim	0.0	0.0	0.0	0.0	0.0	0.0	12.5	7.5	2.5
Protestant	0.0	17.4	0.0	0.0	0.0	0.0	17.5	7.5	5.3
Family size	5.7(0.3)	4.0(0.4)	3.8(0.3)	4.8(0.4)	4.9(0.2)	3.3(0.2)	4.6(0.3)	4.4(0.3)	4.4(0.1)

1=DebreBerhan, 2=Sheno, 3=Sendafa, 4=Chancho, 5=Fiche, 6=Degem, 7=Debrezeit, 8=Asella; numbers in the bracket indicates the standard error of means.

Table 2. Average (SE) cattle herd size and composition (N=320).

Cattle type	Study sites								Overall mean
	1	2	3	4	5	6	7	8	
Milking cow[a]	2.3(0.26)	2.27(0.22)	4.4(0.3)	3.9(0.5)	1.5(0.6)	2.7(0.2)	1.4(0.2)	1.2(0.1)	2.5(0.1)
Dry cow[a]	0.85(0.25)	0.52(0.12)	0.5(0.08)	1.2(0.0)	0.2(0.06)	0.1(0.1)	0.2(0.1)	0.33(0.7)	0.5(0.3)
Heifers[a]	0.95(0.24)	0.67(0.9)	2.45(0.17)	1.2(0.2)	0.8(0.7)	0.0	0.7(0.6)	0.37(0.1)	0.9(0.1)
Calves[a]	0.05(0.03)	0.3(0.9)	0.0	0.0	0.0	0.1(0.1)	0.2(0.1)	0.3(0.04)	0.1(0.02)
Bull[a]	0.05(0.03)	0.05(0.03)	0.35(0.1)	0.42(0.1)	0.1(0.04)	0.0	0.1(0.1)	1.0(0.2)	0.3(0.1)
Oxen[a]	0.9(0.2)	0.05(0.03)	1.5(0.26)	0.0	0.1(0.4)	0.0	0.15(0.1)	1.1(0.14)	0.5(0.1)
Ave. Crossbred	5.1(0.6)	3.9(0.3)	9.2(0.17)	6.7(0.7)	2.7(0.2)	2.9(0.2)	2.6(0.3)	4.2(0.4)	4.7(0.2)
Ave. local cattle	0.05(0.03)	1.1(0.2)	0.5(0.08)	0.0	0.0	0.4(0.1)	0.3(0.1)	2.1(0.2)	0.5(0.1)
Overall Av. Cattle	5.15(0.6)	5(0.4)	9.7(0.2)	6.7(0.7)	2.7(0.2)	3.3(0.2)	3(0.2)	6.4(0.4)	5.2(0.2)

[a]=crossbreds; 1=Debre Berhan, 2=Sheno, 3=Sendafa, 4=Chancho, 5=Fiche, 6=Degem, 7=Debre Zeit, 8=Asella.

Jimma (Belay et al., 2011) areas, respectively. Family size and age are indicative of household working age groups and family labour situations. The larger family size in Debre Berhan compared to other study sites implies that these HHs have good sources of family labor to utilize for different routine dairy farm activities such as feeding, herding, cleaning, and milking and milk processing. The majority of the respondents (92.2%) are members of Ethiopian Orthodox Tewahido church and the rest are Muslims and Protestants.

Cattle Herd Structure

The mean cattle holding per HH were 5.2 heads (Table 2), which is much lower than HH cattle holding (8) reported by Negussie (2006) in Mekele area. The difference in cattle holding per HH might be associated with the availability of land for grazing and feed production. The overall mean numbers of crossbred milking cows, dry cows, heifers, calves, bulls and oxen per HH were 2.5, 0.5, 0.9, 0.1, 0.3, and 0.5, respectively (Table 2). The average crossbred dairy herd per HH was 4.7 heads which is closer to 4.3 reported in the west Shewa zone of Oromia (Derese, 2008). Higher numbers of crossbred cows/HH were reported (5.4-11) in Sebeta, Bahir Dar and Hawassa (Yitaye, 2008; Haile et al., 2012; Dereje and Yoseph, 2014). In this study, the dairy farmers own higher numbers of crossbred dairy cows than local breed ones. This might be because of availability of promising markets for dairy products and better access to farm inputs such as improved genotype

Table 3. Source of incomes and farmers involved in dairy cooperatives in the study areas (N=320).

Variable (%)	Study sites								Overall mean
	1	2	3	4	5	6	7	8	
Sources of income									
Dairy production	44.5	26.3	61.1	49.8	43.5	38.0	54.0	44.6	43.6
Crop production	19.4	19.1	25.4	0.0	12.0	35.0	0.0	19.6	18.0
Trade	3.0	17.7	8.7	5.7	8.0	10.0	19.3	8.2	10.1
Public organization employment	15.5	23.4	0.0	20.6	12.5	8.0	10.3	4.8	11.8
Private company employment	2.0	6.0	0.0	21.1	6.5	0.0	16.2	0.7	6.5
Other sources	15.6	7.5	4.7	2.6	17.5	9.0	0.0	22.0	9.7
Member of cooperatives	40.0	60.0	0.0	0.0	30.0	0.0	72.5	65.0	33.4
Source of information									
Members	49.6	79.2	-	-	33.3	-	89.7	76.9	65.75
Cooperatives office	50.4	20.8	-	-	66.7	-	10.3	23.1	34.25
Reasons for motivation									
Regular milk market	37.5	75.0	-	-	0.0	-	100	52.2	52.9
Access inputs and regular milk market	62.5	25.0	-	-	100	-	0.0	47.8	47.0

1=Debre Berhan, 2=Sheno, 3=Sendafa, 4=Chancho, 5=Fiche, 6=Degem, 7=Debre Zeit, 8=Asella; other refers daily labour, livestock other than dairy, pension and support from sons and daughters.

and commercial feeds in the study areas.

Milking cows comprised a larger percentage of the dairy herd in the study areas, which shows that crossbred milking cows are playing a significant role in the economy of dairy producers. However, lower numbers of milking cows (0.1 - 1.7 per HH) reported in different parts of the country (Lemma, 2004; Binyam, 2008; Samson et al., 2012). Few numbers of improved bulls used for natural mating were reported in the study areas. The highest average HH holding of replacement heifers was reported from Sendafa (2.45) followed by Chancho (1.2) and Debre Berhan (0.95). The average number of calves estimated was lower compared with other groups of cattle probably because male calves are traditionally viewed as an un-wanted product of the dairy sector. As a result many of the dairy farmers in the study cull male calves at a very early age to reduce rearing cost.

Major income sources and farmers involved in the dairy cooperatives

Dairy cattle owners of the sampled respondents generate income from different sources, however, for the majority of them dairying was the main source of income at varying scale. As observed from the present assessment, the contribution of dairying to the total household income was ranged from 21-61% (Table 3). Similar studies conducted on smallholder farmers in southern Ethiopia indicated that dairying on average contributed about 20-50% to the total income of the farmers (Asrat et al., 2013; Abebe et al., 2014). The discrepancies in contribution of dairying to the total income of the farmers from place to place are due to differences in cattle herd size, income from other sources, land size, productivity of cow and milk market outlets (Sintayehu et al., 2008; Asrat et al., 2013).

Only 33.4% of the sampled dairy farmers found to be a member of dairy cooperative (Table 3). However, the majority of sampled HHs (60-72.5%) in Asella, Debre Zeit and Sheno were members of a dairy cooperative. Dairy farmers who are members of the cooperatives are benefited from easy access to milk market and/or farm input supplies, which would otherwise be difficult at individual farmer level. In this regard, 52.9 and 47% of the sampled dairy farmers in study area were motivated to join dairy cooperatives due to the regular fresh milk market, and supply of farm inputs and availability of regular milk market, respectively. The sampled dairy producers across the study sites got information about the cooperatives from previous members (66%) and cooperative offices (34%) prior to joining. In contrast, none of the surveyed dairy producers in Sendafa, Chancho and Degem were members of the dairy cooperatives. This could be due to the existence of alternative milk market outlets, regular fluctuation of the milk price, and insufficient farm input supplies of the dairy cooperatives.

Dairy cattle management

Dairy cattle feeds

Although grazing land used as a feed source is varying across the study sites, 60% of the surveyed farmers

Table 4. Major feed resources available for dairy animals (N=320).

Parameter (%)	Study sites								Overall mean
	1	2	3	4	5	6	7	8	
Grazing	45.0	54.0	92.0	10.2	100	85.5	7.8	100	61.8
Crop residues									
Barely	48.3	57.7	75.0	50.0	95.0	77.7	0.0	52.6	57.1
Wheat	48.2	47.8	35.0	50.0	50.0	49.96	95.9	45.8	52.8
Teff	0.0	0.0	35.0	0.0	100	0.0	50.0	0.0	23.1
Faba bean	46.7	20.0	67.1	0.0	0.0	0.0	0.0	10.0	17.9
Grass hay	95.1	90.5	100	100	88.0	100	91.0	87.5	94.0
Constraints									
Shortage of feed	36.0	30.0	23.0	40.0	30.0	18.0	45.0	35.0	32.4
Poor quality	20.0	15.0	28.0	27.0	25.0	19.0	18.0	26.0	22.3
High feed cost	23.0	20.0	25.0	25.0	15.0	20.0	32.4	5.0	20.7

1=Debre Berhan, 2=Sheno, 3=Sendafa, 4=Chancho, 5=Fiche, 6=Degem, 7=Debre Zeit, 8=Asella.

reported to use natural pasture as a major source of feed. However, the majority of dairy farmers in Chancho and Debre Zeit had less access to grazing lands for their dairy animals, which might be due to the increasing expansion of urbanization in the areas (Table 4). In contrast, 54-100% of the respondents in Sheno, Sendafa, Fiche, Degem and Asella, depend on grazing land to feed their dairy animals. In Ethiopia, it is estimated that natural pasture provides about 80-90% of the total livestock feed intake with decreasing trends (Alemayehu, 2003). As stated by same author, however, grazing on natural pasture is neither quantitatively nor qualitatively adequate to support profitable dairy production.

Crop residues are the second most important source of livestock feed next to natural pastures in Ethiopia (Berhanu et al., 2009; FAO, 2011) and provides 10 to 15% of the total livestock feed intake (Alemayehu, 2003). Wheat, barley, teff and Faba bean residues reported to be the major crop residues available for dairy animals in study areas. The availability of crop residues were differs across the study areas. For example, teff straw being only available in Fiche and Debre Zeit while the use of Faba bean straw as feed source for dairy animals was reported by larger proportions of HH in Debre Berhan, Sheno and Sendafa. The majority of the respondents (94%) also reported grass hay as a common feed source for dairy animals. Previous reports by Yoseph et al. (2003), in urban and peri-urban dairy farmers around Addis Ababa milk-shed and Sintayehu et al. (2008) in Shashemene - Dilla areas showed that hay is the most common feed resource available for dairy animals.

To alleviate feed shortage, dairy producers across the study sites purchased feeds from markets and/or other famers from the surrounding areas. Among the roughage feedstuffs, grass hay and crop residues of teff, wheat and barley were the major types of feed purchased by producers. Grass hay is usually sold in baled form while crop residues are in a loose form and transported in variety of means: Such as human backs, carts and trucks. According to the respondents, lactating cows were supplemented with small quantities of concentrate feed ingredients of agro-industrial by-products. Feed shortage, high feed cost as well as poor nutritional quality of available feeds were the major constraints of dairy production in the study areas (Table 4). According to the response of 32% of the sampled HHs, feed shortage is the main constraint for dairy cattle production, while the rest about 22 and 20% of them indicated that quality and cost of the feeds, respectively, are the important constraints for dairy production. This is in line with Adugna et al. (2012) and Fekede et al. (2014), who reported that shortages of feed supply, high feed cost and poor nutritional quality of the available feed resource, are the major constraints affecting livestock productivity in the central highlands of Ethiopia.

Sources of water for dairy cattle

The availability of water sources for dairy animals reported to vary across the study sites (Table 5). About half of the interviewed dairy farmers were dependent on tap water followed by river, spring and bore-well water. As noted from the study, the overall average distance to access spring and river watering points were 0.4 and 0.9 km, respectively. As indicated in Table 5 the majority of the respondents had tap water at their homesteads and hence they would not necessarily trek their animals to distant areas. In Debre Berhan and Sheno, and Debre Zeit dairy farmers mostly provide water for dairy animals more than three times a day, whereas the rest provide twice a day.

The majority of the respondents (50-91%) in Sendafa,

Table 5. Source and watering frequency of water and constraints related to water (N=320).

Variable (%)	Study sites								Overall mean
	1	2	3	4	5	6	7	8	
Source of water									
Tap	65.0	67.0	0.0	75.0	80.0	0.0	100	10.0	49.6
River	30.0	25.0	0.0	15.0	15.0	10.0	0.0	87.5	22.8
Spring	5.0	8.0	0.0	10.0	5.0	90.0	0.0	2.5	15.1
Bore-well	0.0	0.0	100	0.0	0.0	0.0	0.0	0.0	12.5
Watering frequency/day									
Thrice and more	65.0	62.1	0.0	20.0	12.5	15.0	60.0	10.0	30.6
Twice	35.0	37.9	87.5	80.0	87.5	85.0	40.0	65.0	64.7
Once	0.0	0.0	12.5	0.0	0.0	0.0	0.0	25.0	4.7
Constraints									
Seasonality	20.0	25.0	91.0	76.0	50.0	88.9	0.0	20.0	46.4
Poor quality	5.0	2.5	9.0	24.0	10.0	11.1	0.0	80.0	17.7
Far watering point	15.0	17.0	0.0	0.0	5.0	0.0	0.0	0.0	4.6
No problem	60.0	55.5	0.0	0.0	35.0	0.0	100	0.0	31.3

1=Debre Berhan, 2=Sheno, 3=Sendafa, 4=Chancho, 5=Fiche, 6=Degem, 7=Debre Zeit, 8=Asella.

Chancho, Fiche and Degem mentioned seasonality of water availability as a major constraint, but water quality problem was more (80%) prominent in Asella. Water from rivers and springs are reported to dry up early during dry seasons, which made the problem of water availability even more critical in these areas. To solve this problem, farmers were digging wells and trekking to long distances to access water for the dairy animals. Trekking of dairy animals for a long distance has been reported to cause considerable energy wastage (Asfaw et al., 2010), and decrease watering frequency which in turn contributes to low dairy cow productivity (Kassahun et al., 2008).

Dairy cattle health

The majority of the respondents (66.4%) encountered udder infection in their dairy herd (Table 6) with the highest rates in Sendafa, Chancho and Degem. Almost all the sampled HHs used veterinary medicines to treat sick animals, as opposite to a few famers (12.5-23%) around Degem and Debre Zeit who used traditional medicines. Eighty percent of the respondents discarded the milk produced from infected udders, while the rest provided it to calves or dogs. The other most common dairy cattle disease reported in Debre Berhan and Degem were blackleg (55-60%), while half of the HHs in Chancho reported both foot and mouth disease (FMD) and lumpy skin disease (LSD). Several earlier studies carried out in different parts of Ethiopia reported that anthrax, FMD, mastitis, pasteurollosis, blackleg and LSD were the leading dairy cattle health problems (Tesfahiwot, 2004; Kuastros, 2007; Gebremedhin, 2007; Azage et al., 2013).

Health of the dairy cows has a great impact on farm profit. As evidenced from the study, the average estimated value of milk disposed per HH/year was 1,146 ETB due to udder infection. This indicates that mastitis is one of the major diseases that cause high economic loss. Moreover, the estimated average cost of medication to treat animals against different diseases was 831 birr per HH/ year. According to the respondents, about 46.7% of the HHs had limited access to veterinary services due to high veterinary cost, and shortage of veterinary clinics and veterinarians.

Breeding practices

It is observed that dairy farmers practiced two breeding methods:natural mating (using genetically improved bulls) and artificial insemination (AI) or a combination of the two methods depending on availability. Forty percent of the HHs solely used AI for breeding the dairy animals, those who used the combination of AI and improved bulls constituted about 53% (Table 7). Because of government subsidies, farmers are charged only 4 birr per AI service in Ethiopia. However, the actual cost of AI service obtained from Debre Berhan (50 birr), Chanacho (83 birr) and Debre Zeit (53 birr) were extremely expensive. This might be due to the fact that the service is mostly provided by private AI technicians.

The use of bulls for natural service is common in Ethiopia, and considered as the best solution in areas where AI service is inadequate and unavailable (MOARD, 2007). The majority of the respondents (89.3%) used

Table 6. Major dairy cattle diseases and treatment methods (N= 320).

Parameter (%)	Study sites								Overall mean
	1	2	3	4	5	6	7	8	
Major diseases									
Mastitis	55.0	65.0	82.5	85.0	53.0	90.0	45.5	55.5	66.4
Blackleg	55.0	0.0	0.0	0.0	10.0	60.0	0.0	20.0	18.1
FMD	0.0	7.5	10.0	50.0	0.0	10.0	0.0	0.0	9.68
LSD	0.0	0.0	15.0	50.0	0.0	0.0	0.0	0.0	8.1
In. parasite	15.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	2.8
Anthrax	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0	2.5
Pasteurollosis	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.0	1.31
Milk from infected udder									
Disposed	100	88.5	100	62.7	100	50.0	53.8	85.0	80.0
For calves	0.0	0.0	0.0	37.3	0.0	50.0	23.1	0.0	13.8
For dog	0.0	11.5	0.0	0.0	0.0	0.0	23.1	15.0	6.2
Methods of treatment									
Veterinary	100	100	100	100	100	87.5	76.9	100	96.0
Traditional	0.0	0.0	0.0	0.0	0.0	12.5	23.1	0.0	4.0

1=DebreBerhan, 2=Sheno, 3=Sendafa, 4=Chancho, 5=Fiche, 6=Degem, 7= DebreZeit, 8=Asella; FMD=Foot and Mouth Disease, LSD=Lumpy Skin Disease

Table 7. Breeding method, source of semen and service charge (N=320).

Variable	Study sites								Overall mean
	1	2	3	4	5	6	7	8	
Breeding methods (%)									
AI	35.0	17.5	17.5	70.0	40.0	20.0	82.5	35.0	39.7
Natural mating	25.0	7.5	0.0	0.0	0.0	10.0	0.0	15.0	7.2
Both	40.0	75.0	82.5	30.0	60.0	70.0	17.5	50.0	53.1
Source of bull (%)									
Neighbor	84.6	100	77.6	80.0	83.3	100	100	88.5	89.3
Own	15.4	0.0	22.4	20.0	16.7	0.0	0.0	11.5	9.7
Price/service mean (SE)									
AI	50(3.8)	4(3.6)	12(3.3)	83(3.3)	12.0(3.8)	6.0(3.5)	53.0(3.3)	18.0(3.8)	29.8(1.2)
Bull	79.3(5)	73.3(4.4)	-	133.0(7.6)	77.5(4.6)	60.0(3.5)	80.0(9.3)	65.0(7.6)	81.2(2.4)
Record keeping (%)	10.0	5.4	6.31	75.0	10.0	60.0	22.5	7.5	24.0

1=Debre Berhan, 2=Sheno, 3=Sendafa, 4=Chancho, 5=Fiche, 6=Degem, 7= Debre Zeit, 8=Asella; SE= standard eror of mean, AI= Artifical Insemination.

breeding bulls not reared in their herd, while only about 14% of them used homebred bulls. The average bull service charge was estimated to be 81 ETB/service, which is expensive when compared to AI service. However, bull service charge was not common in Sendafa which might be associated with cultural taboo in the area.

Record keeping is the basis for proper livestock husbandry. As indicated by Markos (2006), livestock development in Ethiopia has been handicapped to a great extent due to lack of recorded data. The study found that farmers do not keep the necessary farm records pertaining to their dairy animals. However, 24% of the sampled dairy herd owners to some extent tried to keep records on breeding dates until the animals gives calves, and daily milk sales for about 15-30 days using informal sheet. It is therefore essential to provide training on this useful practice to dairy herd owners to make decision for better livestock management, and thereby optimize the utilization of the available resources in the study areas.

Table 8. Dairy animal housing practices in the study areas (N=320).

Variable (%)	Study sites								Overall mean
	1	2	3	4	5	6	7	8	
Roof type									
Corrugated	90.0	85.0	100	100	90.0	80.0	92.5	45.0	85.3
Thatched	10.0	15.0	0.0	0.0	10.0	20.0	7.5	55.0	14.7
Floor type									
Cement	18.5	72.5	82.5	87.5	40.0	30.0	45.0	25.6	50.2
Stone	70.0	20.0	17.5	7.5	33.0	49.0	23.0	51.0	33.9
Earthen	11.5	7.5	0.0	5.0	27.0	21.0	32.0	23.4	15.9
Bedding used	0.0	15.0	17.5	10.0	0.0	0.0	7.5	15	8.1
Cleaning frequency									
Daily	100	87.5	100	100	80.0	100	92.5	100	95.0
Twice/week	0.0	5.0	0.0	0.0	10.0	0.0	0.0	0.0	1.8
Thrice/week	0.0	7.5	0.0	0.0	10.0	0.0	7.5	0.0	3.12

1=Debre Berhan, 2=Sheno, 3=Sendafa, 4=Chancho, 5=Fiche, 6=Degem, 7= Debre Zeit, 8=Asella.

Dairy cattle housing

Animal housing is important to protect animals from predators, theft, unfavorable weather conditions and for ease of undertaking husbandry practices (Sintayehu et al., 2008; Asrat et al., 2013). All sampled dairy herd owners across the study areas housed their animals in separate barns constructed purposefully for dairy cattle. This has advantage to limit the spread of diseases from animals to humans and vice versa. Similar results were reported by Solomon (2010) who indicated that 95.7% of the sample HHs in Arsi zone used separate housing for dairy cows. Asrat et al. (2013), however, reported that 83% of the total respondents in Wolayta zone kept their animals in the same house where the family lives.

The majority of the respondents (85%) constructed dairy cattle barns with corrugated iron roofing material for better durability, while the rest (mainly from Asella) constructed with thatched grass (Table 8). The materials used to make the floor of the barns varied across the study areas. For instance, 72.5-87.5% of the sample HHs in Sheno, Sendafa and Chancho reported using cement flooring. While in Degem, Asella and Debre Berhan, 49-70% of the respondents used stone for flooring. Clean, dry and comfortable bedding material is important to minimize the growth of microorganisms. However, only 8% of the respondents reported to use bedding material (straw) for the dairy animals. The majority of the surveyed HHs (95%) cleaned the barn daily. Housing conditions in many of HHs were unclean, wet and not providing a comfortable setting for the dairy animals. This may have a negative impact on production of clean milk and milk products, in addition to increasing animal health problems. Therefore, cow sheds must be designed in such a way that it gives comfort for the animals, and easy for routine daily activities like cleaning and feeding.

Milking, productive and reproductive performance of dairy cows

As reported by the respondents, cows were milked by hand twice a day (morning and evening). Similarly Azage et al. (2013) reported that hand milking in Ethiopia is the sole milking method and milking frequency was twice a day. Milking was done dominantly by housewives (65.9%) followed by husbands (37%), hired labours (29.7%) and sons (10.6%) (Table 9). Milking in different parts of Ethiopia is primary handled by women, however, in a few areas such as the Fogera area of Amhara region, milking is entirely performed by males (Belete, 2006).

The mean age at first calving (AFC) reported for crossbred heifers were 31 months (ranges from 28.9 to 37 months). AFC in the present study was shorter than 47 months for crossbred cattle Amhara region as reported by Solomon et al. (2009). Age at first calving have an impact on the productive life span of the cows and rearing cost of the dairy animals (Ruiz-Sanchez et al., 2007).

The better-managed and well-fed heifers grew faster, served earlier and resulted in more milk and calves produced during their lifetime as well as low rearing costs (Masama et al., 2003).

The average daily milk yield (DMY) and lactation length (LL) of crossbred cows were 10 liters and 9.4 months, respectively (Table 9). Lower average daily milk (6.5 liters) was recorded in Asella may be attributed to differences in exotic gene level of the crossbred animals and management. The average DMY estimated in the

Table 9. Milking and productive and reproductive performance of crossbred cows (N=320).

Parameter	Study sites								Overall mean
	1	2	3	4	5	6	7	8	
Performance(SE)									
DMY (liter)	9.95(0.5)	9.9 (0.3)	14.8(0.5)	13.3 (1.6)	9.5 (0.5)	11(0.8)	11(0.85)	6.5(0.2)	10(0.24)
LL (month)	9.4(0.17)	9.5(0.14)	9.2(0.17)	8.6(0.24)	9.6(0.29)	9.2(0.12)	8.8(0.17)	11.0(0.6)	9.4(0.1)
CI (month)	14 (0.34)	13.2(0.2)	14.0(0.3)	16.7(1.02)	12.75(0.1)	12.9(0.09)	13.8(0.33)	17.8(0.5)	14.2(0.15)
SPC (number)	1.8 (0.1)	1.7(0.05)	1.8(0.5)	2.0(0.12)	1.2(0.4)	1.6(0.04)	1.5(0.06)	1.5(0.04)	1.6(0.02)
AFC (month)	31(0.39)	29.5(0.4)	30.2(0.7)	29.9(0.12)	37(0.88)	30(0.31)	28.9(0.36)	32.4(0.7)	31.1(0.29)
Who milks (%)									
Housewife	85.0	55.0	50.0	35.0	60.0	80.0	70.0	92.5	65.9
Husband	70.0	15.0	99.0	7.5	60.0	0.0	22.5	22.5	37.1
Hired labor	20.0	42.5	50.0	65.0	30.0	30.0	0.0	0.0	29.7
Son	5.0	0.0	0.0	20.0	0.0	10.0	15.0	35.0	10.6
Daughter	0.0	7.5	0.0	0.0	10.0	10.0	0.0	20.0	5.9

1=DebreBerhan, 2=Sheno, 3=Sendafa, 4=Chancho, 5=Fiche, 6=Degem, 7= DebreZeit, 8=Asella; DMY= Daily Milk Yield, LL=Lactation Length, CI= Calving Interval, SPC=Service per Conception, AFC=Age at First Caving.

current study was comparable with the reports of Solomon (2010) in Arsi zone and Belete (2006) in Amhara region, which was 9.4 L. However, it was higher compared to the values reported for some other parts of the country (Addisu et al., 2012; Mulugeta and Belaynhe, 2013). The average lactation length (LL) reported in current study is nearly similar with the recommended standards for lactation length (10 months), which is usually reported from modern dairy farms (Lobago, 2007). This result is also similar with earlier studies conducted in Sululta and Welmera districts (Mustefa, 2012; Mulugata and Belaynhe, 2013).

The overall mean calving interval (CI) reported for crossbred cow was 14.2 months, which is close to the optimum values (12-13months) recommended for profitable dairy production (Gifawosen et al., 2003). The ideal calving interval would result in a significant increase in the financial returns from milk production and the lifetime productivity of cows. The average CI observed in this study is in consent with the studies of Addisu et al. (2012) who reported 14 months for crossbred cows in Ethiopia. In contrary, longer averages of CI (16-21 months) were reported in Ethiopian highlands (Shiferaw et al., 2003; Belay et al., 2012). Generally, the variation in the average values of CI and LL among the studies conducted in the country could be attributed to the difference in management practices, which brings different responses within the same breed.

The overall estimated average number of service per conception (SPC) for crossbred cows was 1.6 (Table 9). The average number of SPC required in this study nearly matches with the recommended value (1.5) suggested by Radostits et al. (1994), and agreed with the results from central highlands and mid Rift valley of Ethiopia (Shiferaw et al., 2003; Yifat et al., 2009). However, a higher average SPC (2.8) was reported in Harar milk-shed (Mohammed and deWaal, 2009). Feed shortage and poor reproductive management such as lack of proper heat detection and timely insemination might have the most plausible explanation for difference in the number of SPC recorded across the country (Kumar et al., 2014).

Conclusion

Crossbred dairy cattle are dominant in the present study areas as compared to local breeds; and as a result dairy production is the main source of income for smallholder farmers in the study areas. The major feed resource available for dairy animals were natural grazing land, grass hay and crop residues of teff, wheat and barley. Tap, river, spring and bore-well are reported to be the common sources of water for the dairy animals. The entire dairy herd owners constructed separate barns for their dairy animals regardless of the cow comforts. AI and improved dairy bulls (often shared from neighbors) were the common methods for cattle breeding in the study areas. The awareness of the dairy farmers about record keeping is limited; it is not more than keeping information on daily milk sold and breeding dates. Feed shortage, poor quality and high price, seasonal availability of water and limited access to veterinary service were reported to be the major constraints of dairy production in the study areas. Farmer losses about 1,977ETB/year/HH due to milk discarded from infected udder and medication of diseased animals. Therefore, the present study shows that there is a need to improve the dairy cattle management such as feeding, disease preventions as well as record keeping of all necessary farm information to maximize milk production.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Abebe B, Zelalem Y, Ajebu N (2014). Dairy production system and constraints in Ezha districts of the Gurage zone, Southern Ethiopia. Glob. Vet. 12(2):181-186.

Addisu B, Mesfin B, Kindu M, Duncan A (2012). Production aspects of intensification and milk market quality in Amhara region, Ethiopia. Livest. Res. Rural Dev. 24:9. Available at: http://www.lrrd.cipav.org.co/lrrd24/9/bite24154.htm

Adugna T, Alemu Y, Alemayehu M, Dawit A, Diriba G, Getnet A, Lemma G, Seyoum B, Yirdaw W (2012). Livestock Feed Resources in Ethiopia: Challenges, Opportunities and the Need for Transformation. National Feed Committee Report, Ethiopian Animal Feed Industry Association (EAFIA) `and the Ministry of Agriculture and Rural Development (MoARD). Addis Ababa, Ethiopia.

Ahmed H, Abule E, Mohammed YK, Treydte AC (2010). Livestock feed resources utilization and management as influenced by altitude in the Central Highlands of Ethiopia. Livest. Res. Rural Dev. 22(12).Available at: http://lrrd.cipav.org.co/lrrd22/12/hass22229.htm

Alemayehu M (2003). Country pasture/forage resources profiles: Ethiopia. FAO (Food and Agriculture Organization of the United Nations), Rome, Italy.

Asaminew T, Eyassu S (2009). Smallholder dairy production system and emergence of dairy cooperatives in Bahir Dar Zuria and Mecha districts, north western Ethiopia. World J. Dairy Food Sci. 4 (2):185-192.

Asfaw N, Zelealem Y, Aynalem H, Emmanuelle G (2010). Improving smallholders' marketed supply and market access for dairy and dairy products in the Arsi zone. Food and Agriculture Organization of the United Nations, Sub-Regional Office for Eastern Africa (FAO/SFE), Addis Ababa, Ethiopia.

Asrat A, Zelalem Y, AjebuN (2013). Characterization of milk production systems in and around Boditti, South Ethiopia. Livest. Res. Rural Dev. 25 (10).

Azage T, Gebremedhin B, Hoekstra D, Belay B, Mekasha Y (2013). Smallholder dairy production and marketing systems in Ethiopia: IPMS experiences and opportunities for market-oriented development. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working. P 31, ILRI, Nairobi, Kenya.

Belay D, Yisehak K, Janssens G (2012). Productive and reproductive performance of zebu x Holstein-Friesian crossbred dairy cows in Jimma town, Oromia, Ethiopia. Glob. Vet. 8(1):67-72.

Belay D, Yisehak K, Janssens GP (2011). Analysis of constraints facing urban dairy farmers and gender responsibility in animal management in Jimma town. Libyan Agric. Res. Center J. Int. 2(4):155-160.

Belete A (2006). Studies on cattle milk and meat production in Fogera woreda: production systems, constraints and opportunities for development. MSc Thesis, Hawassa University, Hawassa, Ethiopia.

Berhanu GM, Adane H, Kahsay B (2009). Feed marketing in Ethiopia: Results of rapid market appraisal. Improving Productivity and Market Success (IPMS) of Ethiopian farmers project Working Paper 15. ILRI, Addis Ababa, Ethiopia.

Binyam K (2008). Cottage cheese production in Shashemane and the role of Rue (Rutachalepensis) and garlic (Allium sativum) on its quality and shelf life. MSc Thesis, Hawassa University, Hawassa, Ethiopia.

Central Agricultural Census Commission (CACC) 2003. Ethiopian Agricultural sample enumeration, 2001/02. Results for Southern nations, nationalities and peoples regional state.Statistical report on livestock and farm implements. Part IV. Addis Ababa, Ethiopia.

Central Statistical Agency (CSA) (2012). Agricultural sample survey. Vol. II. Report on livestock and livestock characteristics. Statistical Bulletin 582, Addis Ababa.

Dereje S, Yoseph M (2014). Evaluation of crossbred heifer calves rearing practices and growth performance in urban and peri-urban dairy systems of Sebeta woreda, Oromia. Ethiopian J. Anim. Prod. 16(2):121-132.

Derese T (2008). Present situation of urban and peri-urban milk production and quality of raw milk produced in west Shewa zone, Oromia region, Ethiopia. MSc Thesis, Haramaya University, Haramaya, Ethiopia.

FAO (Food and Agriculture Organization of the United Nations) (2008). Country report. FAO (Food and Agriculture Organization of the United Nations). Addis Ababa, Ethiopia.

FAO (Food and Agriculture Organization of the United Nations) (2011). National workshop on Innovations, Actors and Linkage in the dairy value chain in Ethiopia. Proceedings of a National Stalkholder workshop held at Food and Agriculture Organization of the United Nations Sub Regional Office for Eastern Africa, 28 May 2010. Addis Ababa, Ethiopia.

Fekede F, Adugna T, Andnet D, Temesgen A, Diriba G, Alan D (2014). Assessment of livestock feed production and utilization systems and analysis of feed value chain in Jeldu district, Ethiopia. International Livestock Research, Addis Ababa, Ethiopia. Available at: https://cgspace.cgiar.org/handle/10568/56933

Gebremedhin A (2007). Major animal health problems of market oriented livestock development in AtsbiWomberta woreda, Tigray regional state. MSc Thesis, Addis Ababa University, Addis Ababa, Ethiopia.

Getachew E (2002). An assessment of feed resources, their management and impact on livestock productivity in the Ginchi watershed area.MSc Thesis, Haramaya University, Haramaya, Ethiopia.

Gifawosen T, Alemu G/W, Jaya P (2003). Study on reproductive efficiency of Boran and its crosses at Holetta research farm: Effect of genotype, management and environment. Ethiopian J. Anim. Prod. 3(1):1607-3835.

Gizaw K, Habatamu A, Sisay E, Tesfaye M, Tegegn G, Birhanu S(2012). Enhancing the productivity and profitability of crossbred and local cows in urban and peri urban centers of Bako and Nekemt, proceedings of the 19th annual conference of Ethiopian Society of Animal Production, 15-17 December 2011. Addis Ababa, Ethiopia.

Haile W/A, Zelalem Y, Yosef T/G (2012). Challenges and opportunities of milk production under different urban dairy farm sizes in Hawassa City, Southern Ethiopia. Afr. J. Agric. Res. 7(26): 3860-3866.

Ibrahim N, Abraha A, Mulugeta S (2011). Assessment of reproductive performances of crossbred dairy cattle (Holstein Friesian × Zebu) in Gondar town. Glob. Vet. 6:561-566.

Juyal PD, Bal MS, Singla LD (2011). Economic impact, diagnostic investigations and management of protozoal abortions in farm animals. In: All India SMVS' Dairy Business Directory 11:39-46.

Kassahun A, Synman HA, Smit GN (2008). Impact of rangeland degradation on the pastoral production systems, livelihoods and perceptions of the Somali pastoralists in Eastern Ethiopia. J. Arid Environ. 72:1265-1281.

Kuastros M (2007). Major animal health problems of market oriented livestock development in Alaba woreda, southern nation nationalities and peoples region. MSc Thesis, Addis Ababa University, Addis Ababa, Ethiopia.

Kumar N, Eshetie A, Gebrekidan B, Gurmu EB (2014). Reproductive performance of indigenous and Holstein Friesian crossbred dairy cows in Gondar, Ethiopia. IOSR J. Agric. Vet. Sci. 7(1):50-61.

Lemma F (2004). Assessment of butter quality and butter making efficiency of new churns compared to smallholders' butter making techniques in East Shewa Zone of Oromia. MSc Thesis, Harmaya University, Haramaya, Ethiopia.

Lemma F, Trivedi MM, Bekele T (2012). Adoption of improved dairy husbandry practices and its relationship with the socio-economic characteristics of dairy farmers in Ada'a district of Oromia State, Ethiopia. J. Agric. Exten. Rural Dev.4(14):392-395.

Lobago F (2007). Reproductive and lactation performance of dairy cattle in the Oromia central highlands of Ethiopia. PhD Dissertation, Swedish University of Agricultural sciences, Uppsala, Sweden.

Markos T (2006). Productivity and health of indigenous sheep breeds and crossbreds in the central Ethiopian highlands. PhD Dissertation, Swedish University of Agricultural Sciences Uppsala, Seweden.

Masama E, Kusina NT, Sibanda S, Majoni C (2003). Reproductive and lactation performance of cattle in a smallholder dairy system in

Zimbabwe. Trop. Anim. Health Prod. 35:117-129.
MoA and ILRI (Ministry of Agriculture and International Livestock Research Institute) (2013). Dairy value chain vision and strategy for Ethiopia. Addis Ababa, Ethiopia: Ministry of Agriculture and International Livestock Research Institute. Addis Ababa, Ethiopia.
MOARD (Ministry of Agriculture and Rural Development) (2007). Livestock Development Master Plan Study. Phase I Report – Data Collection and Analysis. Addis Ababa, Ethiopia.
Mohammed A, Ehui S, Assefa Y (2004). Dairy Development in Ethiopia EOTD discussion Paper no. 123. International Food Policy Research Institute. Washington D.C.
Mohammed YK, deWaal HO (2009). Herd management, milk production and reproduction of urban dairy farms in Harar milk-shed. Ethiop. J. Anim. Prod. 9(1):57-75.
Mulugeta A, Belayeneh A (2013). Reproductive and lactation performances of dairy cows in Chacha town and nearby selected kebeles, North Shoa Zone, Amhara Region, Ethiopia. World J. Agric. Sci. 1(1):008-017.
Mustefa A (2012). Value chain and quality of milk in Sululta and Welmera woredas, Oromia special zone surrounding Addis Ababa, Ethiopia. MSc Thesis, Addis Ababa University, Addis Ababa, Ethiopia.
Negussie G (2006). Characterization and evaluation of urban dairy production system of Mekele city, Tigray Region, Ethiopia. MSc Thesis, Hawassa University, Hawassa, Ethiopia.
Radostits OM, Leslie KE, Fetrow J (1994). Maintenance of reproductive efficiency of dairy cattle. In: herd health: food animal production Medicine 2nd edition. Philadelphin: W.B. Saundrs Company.
Ruiz-Sanchez R, Blake RW, Castro-Gamez HM, Sanchez F, Montaldo HH, Castillo-Juarez H (2007). Changes in the association with between milk yield and age at first in Holstein cows with herd environment level for milk yield. J. Dairy Sci. 90:4830-4834.
Samson G, Zelalem Y, Sandip B (2012). Assessment of quality and marketing of milk and milk products in the central highlands of Ethiopia. Lambert Academic Publishing. Saarbrucken, Germany.
Shiferaw Y, Tenhagn B, Bekana M, Kassa T (2003). Reproductive performance of crossbred Dairy cows in different production systems in the central Highlands of Ethiopia. Trop. Anim. Health Prod. 25:551-561.
Sintayehu Y, Fekadu B, Azage T, Berhanu G/M (2008). Dairy production, processing and marketing systems of Shashemene – Dilla area, South Ethiopia. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 9. ILRI (International Livestock research Institute), Addis Ababa, Ethiopia. Available at: https://cgspace.cgiar.org/handle/10568/485
Solomon A, Kelay B, Merga B, Fikre L (2009). Milk yield and reproductive performance of dairy cattle under smallholder management system in North Eastern Amhara Region, Ethiopia. Trop. Anim. Health Prod. 41:1597-1604.
Solomon K (2010). Characterization of market oriented small holder dairying and performance evaluation of dairy cooperatives in Tiyo woreda, Arsi zone of Oromia regional state. MSc Thesis, Hawassa University, Hawassa, Ethiopia.
Tefera M (2010). Food security attainment role of urban agriculture: a case study from Adama town, central Ethiopia. J. Sustainable Dev. Afr. 12:223-224.
Tesfahiwot Z (2004). Major Health problem of livestock in the Yerer water shed, Adaliben woreda, South eastern Shewa. MSc Thesis, Addis Ababa University, Addis Ababa, Ethiopia.
Wanapat M, Chanthakhoun V (2011). Food-feed-systems for smallholder livestock farmers. Successes and failures with animal nutrition practices and technologies in developing countries p 69.
Yifat D, Kelay B, Bekana M, Lobago F, Gustafsson H, Kindahl H (2009). Study on reproductive performance of crossbred dairy cattle under smallholder conditions in and around Zeway, Ethiop. Livest. Res. Rural Dev. 21(6).
Yitaye A (2008). Characterization and analysis of urban and peri-urban dairy system in the northern western Ethiopia highlands. Doctoral dissertation, Boku University of Natural Resource and Applied Life Science, Veinna, Austrial.
Yoseph M, Azage T, Alemu Y (2003). Evaluation of the general farm characteristics and dairy herd structure in urban and peri-urban dairy production systems in Addis Ababa Milk Shed. In: Yilma Jobre and Getachew Gebru (Ed.), Proceedings of the 10th annual conference of the Ethiopian society of animal production, 22-24 August 2002, Addis Ababa, Ethiopia.
Zelalem Y, Emannuelle GB, Ameha S (2011). A Review of the Ethiopian Dairy Sector. Ed. Rudolf Fombad, Food and Agriculture Organization of the United Nations, Sub-Regional Office for Eastern Africa (FAO/SFE), Addis Ababa, Ethiopia.

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Composition, prevalence and abundance of Ixodid cattle ticks at Ethio-Kenyan Border, Dillo district of Borana Zone, Southern Ethiopia

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Ixodid ticks are common and a major obstacle to development and utilization of animal resource in tropical countries like Ethiopia. Ethiopia shares long international frontiers with adjacent countries, tick dynamics and influx of ticks across the border are major obstacles of tick control and management. Thus, border-oriented epidemiological surveys are of paramount importance to identify a potential port of cross border diseases, particularly ticks and to formulate complimentary bilateral policies. The current study was therefore, designed with the objectives to assess prevalence, abundance and to identify genera and species of major ixodid tick of cattle circulating at Ethio-Kenyan border. A cross-sectional study was conducted from November 2016 to January 2017 in purposively selected four Pastoral Associations of Dillo district, Southern Ethiopia. A total of 7524 adult ticks were randomly collected from 384 cattle and examined with a stereomicroscope. Logistic regression was used to determine the association of risk factors with positivity for Ixodid ticks. The study revealed an overall prevalence of 98.2% of Ixodid ticks of cattle. Three genera of ticks, *Rhipicephalus* (including the subgenus *Boophilus*), *Amblyomma* and *Hyalomma* and seven species of ticks were identified and found to be abundant with overall mean burdens of 40 ticks/head. The association of age and body condition of animals to tick infestation were statistically significant but there was no significant association between sex and tick infestation (OR=3, P=0.007). Animals in poor body condition were twice more likely to be infested with tick than animals with good body condition (OR=2, P=0.031) and animals with medium body condition were also found more prone to tick infestation than animals in good body condition (OR=1.7, P=0.043). Ixodid ticks that were less abundant in most parts of the country were encountered as well adapted and widely distributed in this area. Uncontrolled animal movement across the border may play a great role in high density and diversification of tick in Dillo district. Therefore, collaborative nationwide studies was done to have the country-wide distribution figures and to identify a potential port of cross border diseases particularly ticks and to formulate complimentary bilateral policies for prevention and control of ticks.

Key words: Ixodid, tick, cattle, Dillo, Borena, cross border disease.

INTRODUCTION

Ethiopia is endowed with a very large and diverse livestock resource, composed of approximately 56.71 million cattle, 29.33 million sheep, 29.11 million goats, 2.03 million horses, 7.43 million donkeys, 0.4 million mules, 1.16 million camels, 56.87 million poultry and 5.88 million bee hives (CSA, 2016). The livestock subsector contributes to 12 and 33% of the total and agricultural GDP, respectively, and accounts for 12 to 15% of the total export earnings, second in order of importance (Ayele et al., 2003; Minjauw and Mcleod, 2003; Argaw, 2014). Nevertheless, cattle productivity is low, with hide represents a major source of foreign exchange earnings for the country that accounts for 14 to 16% of the total export revenue. In addition to a large contribution to the export earnings, hides and skins also contribute much to the domestic leather industry (Argaw, 2014).

Despite the relatively large animal population with a high potential for production, its utilization is far lower than could be expected due to cattle production in Ethiopia is constrained by the compound effects of animal diseases, poor management and low genetic performance (Dabassa et al., 2013; Abdela and Jilo 2016; Jilo and Tegegne 2016; Jilo and Adem 2016; Jilo et al., 2016; Jilo 2016; Jilo et al., 2017; Dabasa et al., 2017). External parasites are common and a major obstacle to development and utilization of animal resources in tropical countries because of the favorable climatic conditions for their development and the poor standards of husbandry practices (Solomon et al., 1998; Mungube et al., 2008; Yalew et al., 2017; Dabassa et al., 2017). In Ethiopia, ticks occupy the first place amongst the external parasites that cause serious economic loss to small holder farmers, the tanning industry and the country as a whole through mortality of animals, decreased production, downgrading and general rejection of skins and hides (Tikit and Addis, 2011; Dabassa et al., 2017).

Beside direct effect of irritation, discomfort, tissue damage, blood loss, toxicosis, allergies and dermatitis ticks are the most important ecto-parasites of the livestock in tropical and sub-tropical areas due to their ability to transmit protozoan, rickettsial and viral diseases of livestock, which are of great economic importance world-wide (Jaswal et al., 2014; Salih et al., 2015; Dabassa et al., 2017). The most economically cover important ixodid ticks of livestock in tropical regions belong to the genera of *Hyalomma*, *Rhipicephalus* and *Amblyomma* (Jongejan and Uilenberg, 2004). Several tick genera are widely distributed in Ethiopia. The major tick genera recorded are *Amblyomma*, *Haemaphysalis*, *Hyalomma* and *Rhipicephalus*. Over 60 tick species are known to exist in Ethiopia and the most economically important and wide spread ticks are *A. variegatum* and *R. pulchellus*. In Ethiopia, more than half of total ticks are confined to arid and semi-arid areas at periphery for advantage of suitable climate condition and abundance of hosts (livestock) while tick densities are usually greater in lowland than highland areas (Pegram et al., 1981). In addition to the climatic advantages and adequacy of host animals, insufficient veterinary extension services combined with extensive management systems have exacerbated tick burdens in arid and semi-arid parts of the country (Jilo et al., 2016). Given the long international borders (mainly covered by lowlands) that Ethiopia shares with adjacent countries, tick dynamics and influx of ticks from neighboring countries are major obstacles of tick control and management.

Although, a number of studies have attempted to know burden, distribution and abundance of tick species in different parts of the country, they were largely restricted to central highlands for accessibility and availability of infrastructures. However, the most infested peripheral lowlands bordering adjacent countries are not yet studied well to have the country wide distribution figures, to identify a potential port of cross border diseases particularly ticks and to formulate complimentary bilateral policies for prevention and control of ticks. Thus, the current study was designed to be conducted at the arid area of Southern lowland at the Ethiopia-Kenya border in Dillo district, possessing a large livestock population and where no single study from any scientific discipline has been conducted before, with the objectives of assessing prevalence and abundance, identifying genera and species of major ixodid tick of cattle circulating at the border and to recommend formulation and implementation of joint policy for prevention and control of tick and tick induced losses.

MATERIALS AND METHODS

Description of study area

The study was conducted in Dillo district located at 695 km at South of Addis Ababa, the capital city of Ethiopia. Dillo district is one of the entirely pastoral areas in Borana zone located at the South most part of the country and bordered on the south and southwest (Kenya), Northwest (Teltelle district), Northeast (Yabello district) and East (Dubluk and Dirre districts). Agroecologically, its characterized by an arid climate with altitude ranging from 521 to 1420 m above sea level and temperatures from 22 to 40°C. The area receives low, erratic and bimodal with a mean annual rainfall about 450 mm. There is considerable spatial and temporal variability in quantities and distribution of rainfall, where about 60% is covered by long rainy season (*Ganna*) extending from mid-March to May and erratic short rain season (*Hagayya*) is received from mid-September through mid-November.

Study design and study population

Cross-sectional study design was used to determine the tickspecies, population dynamics and mean burden of adult tick species in different predilection site, age groups and sex of animal. The study animal was cattle from four purposively selected PAs of

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Dillo district based on distribution of tick as told by woreda animal health experts and indigenous knowledge of the community. Accordingly, lowland areas with reddish brown fragile soil, locally called "*Golbo*" like Arbale and Kadim are relatively free of tick, while Northern and Northeastern part of Dillo covered by dark cracking soil (clay), locally called "*Koticha*" are pointed out for study as severe infestation of ticks is found abundant. Likewise, four PAs from *Koticha* land (Goray, Liso, Kancharo and Magole) were selected and adult ticks were randomly sampled from 384 indigenous cattle by considering age, sex and body condition as risk factors. Body conditions were determined as described previously by Eversole et al. (2005). For convenience, animals <1.5 and ≥1.5 year were considered as young and adult, respectively.

The desired sample size for the study was calculated using the formula given by Thrusfield (2005) with 95% confidence interval and 5% absolute precision. $N = 1.96^{2*}P_{exp}(1\text{-Pexp})/D^2$ Where; n = sample size, Pexp = expect prevalence and D = absolute precision (5%). There was no previously published and documented prevalence in the study area and therefore, sample size was calculated using expected prevalence of 50% by substituting the value, the required sample size was calculated and found to be 384 (Thrusfield, 2005). Study was conducted during short rainy season in November, the collected ticks were transported to Yabello Regional Veterinary Laboratory for acaroscopy. Counting and identification of ticks were done using hand lens and stereomicroscope according to standard taxonomic identification procedure described by (Keirans et al., 1999).

Data management and statistical analysis

All collected data were entered to Micro-Soft Excel sheet 2010 and analyzed by SPSS version 20. Descriptive statistics was used to determine the frequency and percentage of both dependent and independent variables. The prevalence was calculated as percent of infested animals from the total number of animals examined. Logistic regression was applied to assess association of risk factors and strength of the association. For statistical analysis, a confidence level of 95% and a *P*-values less than 5% were judged as significant.

RESULTS

Overall prevalence and distribution of ticks in the different PAs in the study area

From this study, Ixodid ticks of cattle were found highly prevalent in Dillo district with overall prevalence of 98.2% (377/384) and within different PAs of current study area 100, 97.9, 97.7 and 97% prevalence of Ixodid ticks of cattle were recorded in Kancharo, Liso, Magole and Goray, respectively (Table 3). *Rhipicephalus* (including *Rhipicephalus Boophilus*), *Amblyomma*, *Hyalomma* and *Boophilus* were the four important genera of ticks identified with a total prevalence of 98.2, 96.8, 64.3 and 42.4%, respectively. While eight species of ticks with their total prevalence were *Rhipicephalus pulchellus* (68.7%), *Rhipicephalus decoloratus* (42.4%) *Rhipicephalus pravus* (29.4%), *Ambylomma* (65.8%), *Ambylomma lepidum* (30.9%), *Hyalomma truncatum* (19.2%), *Hyalomma* rufipes (25.7) and Hyalomma impeltatum (19.2%) (Table 6 and 7).

Relative abundance of tick genera and species

A total of 7524 adult ixodid ticks were collected from different body regions of 377 cattle that were found to be positive for tick infestation and consequently sampled. Generally, three Ixodidae tick genera and eight species were identified from the study area. The genera *Rhipicephalus* (81.1%, of which 1.1% belonged to the subgenus *Boophilus*), *Ambylomma* (16.5%) and *Hyalomma* (3.2%) were abundant in this study area (96.2%) (Table 2). Regarding tick species distribution, *R. pulchellus* was the most abundant tick species, representing 75.2% of the total ticks in Dillo district, followed by *R. pravus* (35.5%), *Ambylomma gemma* (11.6%) and *A. lepidium* (4.8%), respectively. In contrast, *H. rufipes* (1.8%), *R. decoloratus* (1.1%) and *H. impeltatum* (0.09%) were the least abundant Ixodid species in the study district (Table 4 and 5).

Male to female ratio for tick genera and species

Male to female ratio for tick genera of this result indicates higher number of males for most species except genus *Boophilus* that have higher ratio of female tick. Similarly, at the level of species of ticks higher ratio of male to female was obtained except, *R. decoloratus* (Table 6 and 7).

Tick distribution

The spatial distribution of tick genera and species on the body of the animal was considered in this study. As a result, ticks were found widely distributed in different parts of the hosts' body such as ear, sternum, dewlap, scrotum, udder, anal-vulval area and tail. Ear (13 ticks/head), scrotum (10 ticks/head), udder (10 ticks/head), sternum (8 ticks/head), dewlap (8 ticks/head), anal area (6 ticks/head) and vulvar regions (6 ticks/head) were heavily infested but the tail (3 ticks/head of animal) was lightly infested with ticks (Tables 5 and 6). Among three genera of Ixodid ticks, *Rhipicephalus* was found as the only genus infesting the ear of the animal while the other two genera were spread on different body parts of the animal, except the ear.

Risk factors

Age of the animal was found statistically significant for infestation of Ixodid tick and from two age groups prevalence of tick were relatively higher in adult (100%) than the young (92%) and multivariable logistic regression revealed that adults are about three times more likely to be prone to tick infestation than young animals (OR=3, P =0.007) (Table 1). Regarding sex of animal, the tick prevalence was 98.6 and 96.7% in

Table 1. Logistic regression analysis (univariable and multivariable) output of risk factors associated with Ixodid ticks in cattle in Dillo district.

Risk factor		No. of animal examined	No. of animal positive	Prevalence	Univariable regression		Multivariable	
					COR (95% CI)	P-value	AOR (95% CI)	P-value
Age	<1.5year	87	81	92%	4(11.8-83.21)	0.000	10.23(1.89-55.19)	0.007
	≥1.5year	297	297	100%				
Sex	Male	91	88	96.7%	0.8(0.586-1.578)	0.77	0.34(0.063-1.87)	0.914
	Female	293	289	98.6%				
Body condition	Poor	201	201	100%	3.2(2.82-5.84)		2(2.55-4.67)	0.331
	Medium	149	148	99.3%	2.12(1.27-7.52)	0.032	1.7(1.25-6.73)	0.043
	Good	34	28	82.4%	Ref*		Ref*	

Table 2. Distribution and prevalence of tick genera among age, sex and body conditions of cattle in Dillo district.

Parameters		Tick genera identified, Total animal examined(n=384)									
		Rhipicephallus		*Ambylomma*		*Hyalomma*		*Rhipicephallus (Boophilus)*		Multispecies	
		Examined/+ve animal	% from total	Examined /+ve animal	% from total	Examined /+ve animal	% from total	Examined /+ve animal	% from total	Examined /+ve animal	% from total
Age	<1.5	87/80	20.8	87/76	19.7	87/53	13.8	87/47	12.2	87/76	19.7
	≥1.5	297/297	77.3	297/296	77.0	297/194	50.5	297/116	30.2	297/296	77.0
Sex	M*	91/88	22.9	91/84	21.8	91/64	16.7	91/57	14.8	91/84	21.8
	F	293/289	75.2	293/288	75.0	293/183	47.6	293/106	27.6	293/288	75.0
BCS	P	201/201	52.3	201/200	51.5	201/103	26.8	201/71	18.5	201/198	51.5
	M	149/148	38.5	149/146	37.2	149/118	30.7	149/80	20.8	149/143	37.2
	G	34/28	7.3	34/26	6.7	34/26	6.7	34/12	3.1	34/31	8.0

Table 3. Prevalence of Ixodid tick of cattle among PAs in Dillo district.

PA	Animal examined	Prevalence
Goray	100	97(97%)
Liso	96	94(97.9%)
Kancharo	98	98(100%)
Magole	90	88(97.7%)
Total	384	377(98.2)

Table 4. Distribution of tick genera on the animal.

Genus	No. of animal positive	Prevalence	Mean burden
Rhipicephallus	377	98.2%	31.6
Ambylomma	372	96.8%	6.6
Hyalomma	247	64.3%	2
Rh.(Boophilus)	163	42.4%	1
Multispecies	372	96.2%	6.6

Total animal examined (n=384).

Table 5. Distribution of major Ixodid ticks of cattle on predilection sites of animal body in Dillo district.

Body region	*Rhipicephallus*	*Ambylomma*	*Hyalomma*	*Boophilus*	Total	Mean burden
Ear	2383	0	0	6	2389	13
Sternum/dew	894	555	11	21	1481	8
Scrotum/udder	1488	495	5	24	2012	10
Ano-vulva	714	181	224	3	1122	6
Tip of Tail	477	8	3	32	520	3
Total	5956	1239	243	86	7524	40
Mean burden	31.6	6.6	2	1	40	

Table 6. Male to female ratio and percentages of identified genera of Ixodid ticks of cattle and their predilection site on the animal body in Dillo district, Southern Ethiopia.

Genus	Male : Female (Male/Female)	Percentage of total tick	Predilection sites
Rhipicephallus	2.3:1(4167/1783)	79%(5950/7524)	Ear
Ambylomma	2.6:1(899/346)	16.5%(1245/7524)	Sternum,dew,scrotum,udder, ano-vulva and tail
Hyalomma spp.	3.4:1(188/55)	3.2%(243/7524)	Sternum,dew,scrotum,udder, ano-vulva and tail
Boophilus spp.	0.4:1(24/62)	1.1%(86/7524)	Sternum,dew,scrotum,udder, ano-vulva and tail

female and male. There was no statistical (P=0.914) significance between the two sexes (Table 1). Out of the 384 animals examined, 34 were in good body condition, of which 28 (82.4%) were positive to tick infestation, 149 (38.8%) were in medium body condition and 148 (99.3%) were positive for tick infestation and the remaining 201 animals were of poor body condition and all of them, 201 (100%) were positive to tick infestation. Tick prevalence among body condition of animal varies and it was statistically significant. By multivariable logistic regression analysis animal with poor body condition was twice more likely to be infested with tick than animal with good body condition (OR=2, P=0.031) and animal with medium body condition was also found more prone to tick infestation than the animal in state of good body condition (OR=1.7, P=0.043) (Table 1).

DISCUSSION

A number of researchers have reported that different tick genera are widely distributed in Ethiopia (Solomon et al., 2001). In the present study, a total of 7524 adult ticks were sampled from 384 cattle and overall prevalence of tick infestation was found to be 98.2%. To the best of the authors' knowledge, this finding is the highest report ever reported from Ethiopia. For instance, lower prevalence of 16.0% in Benchi Maji Zone, Southern Ethiopia (Tesfahewet and Simeon, 2013), 33.21% in Haramaya district, Eastern Ethiopia (Kassa and Yalew, 2012), 40.26% in and round Haramaya town, Eastern Ethiopia (Yalew et al., 2017), 81.25% in Dembia district, Northern Ethiopia (Alemu et al., 2014), 82% in Borena province of southern Oromia (Regassa, 2001), 88.8% in Jimma district, Western Ethiopia (Chali *et al.,* 2017), 89.4% from Western Amhara Region, Northern Ethiopia (Nigatu and Teshome, 2012) and 95.2% in Bedelle district, Southwestern Ethiopia (Abera et al., 2010), were reported from different parts of the country. The highest prevalence in the current study area could be largely by presence of wide range of cracking soil that helps larva of ticks to stay long and survive, season of study (wet season), short and sticky grasses used for adherence of adult ticks and their transmission to grazing animals, large livestock population and herd size may also contribute as ticks can easily get access to host and complete their life cycle to perpetuate rapidly. Furthermore, arid agro-ecology, poor veterinary extension service, sedentary management practice employed by herders might also pave the way for the highest tick infestation. Ecto-parasites are common in tropical countries because of the favorable climatic conditions for their development and the poor standards of husbandry practices (Mungube et al., 2008).

Rhipicephalus (including ticks of the subgenus *Boophilus*), *Amblyomma* and *Hyalomma* were the three important genera of ticks identified with a total prevalence of 98.2, 96.8, 64.3 and 42.4%, respectively. While eight species of ticks have total prevalence of: *R. pulchellus* (68.7%), *R. pravus* (29.4%), *R. decoloratus* (42.4%) *A. gemma* (65.8%), *A. lepidium* (30.9%), *H. truncatum* (19.2%), *H. rufipes* (25.7%) and *H. impeltatum* (19.2%). Among the total, *R. pulchellus* (68.7%) was found to be highly prevalent in this area and this finding was higher

Table 7. Male to female ratio, percentages and prevalence of identified species of Ixodid ticks of cattle and their predilection site on the animal body in Dillo district, Southern Ethiopia.

Species	Male : Female	Percentage of tick	N(Prevalence)	Predilection sites
Rhipicephalus pulchellus	2.4:1(3994/1665)	75.2%(5659/7524)	264(68.7%)	Ear
Rhipicephalus pravus	1.46:1(173/118)	35.5%(291/7524)	113(29.4%)	Ear
Ambylomma gemma	2.47: 1(621/251)	11.6%(872/7524)	253(65.8%)	Sternum, dew, scrotum, udder, ano-vulva and tail
Ambylomma lepidium	2.8:1(278/95)	4.8%(373/7524)	119(30.9%)	Sternum, dew, scrotum, udder, ano-vulva and tail
Hyalomma truncatum	4.2:1(75/18)	1.2%(93/7524)	74(19.2)	Sternum, dew, scrotum, udder, ano-vulva and tail
Hyalomma marginatum rufipes	3.25:1(108/34)	1.8%(142/7524)	99(25.7)	Sternum, dew, scrotum, udder, ano-vulva and tail
Hyalomma impeltatum	2:1(5/3)	0.09%(8/7524)	74(19.2%)	Sternum, dew, scrotum, udder, ano-vulva and tail
Boophilus decolaratus	0.38:1(24/62)	1.1%(72/7524)	163(42.4%)	Sternum, dew, scrotum, udder, ano-vulva and tail

than 5.46% in East Hararghe (Bedasso et al., 2014), or 6.4% from East Hararghe (Yalew et al., 2017). This could be due to arid climate condition and savanna and steppe vegetation in thr current study area. *R. pulchellus* is prevalent in the arid and desert climatic regions with savanna and steppe grasses (Pegram et al., 1981; Feseha, 1983).

On the other hand, *A*. *gemma* (65.8%) was the second most prevalent tick species in the present study which was by far more than 2.42% from Jimma high land (Chali et al., 2017) and 8.3% from Mizan Teferi (Tadesse et al., 2012). Higher prevalence of *A. gemma* in Dillo district could be due to the arid climate condition which as reported by many scholars are very suitable for *A. gemma*. Pegram et al. (1981) stated that *A. gemma* is confined to semi-arid lands due to humidity of highland which is not favorable to their survival. As a result, this tick species was collected from restricted area of arid, semi-arid plain and bush land receiving 100 to 800 mm rainfall annually (Morel, 1980). Morel (1980) also stated that *A. gemma* is widely distributed in woodland, bush land, wooded and grassland in arid and semiarid area between altitude 500 and 1750 m above sea level and receiving 350 to 750 mm annual rain fall.

Rhipicephalus (Boophilus) decolaratus was third abundant tick species in the current study area with prevalence of 42.4%. Similar finding has also been reported from Rift Valley (Solomon et al., 2001) and in Girana valley of North Wollo (Zenebe, 2001) and Western Ethiopia (Amante et al., 2014). Contrary to our results, Morel (1980) stated that *R. decoloratus* is often collected in Ethiopia and does not seem really abundant anywhere. Pegram et al. (1981) also added that this tick species is abundant in wetter highlands and sub-highlands receiving more than 800 mm rainfall annually and has similar distribution to *A. variegatum*. *R. (Boophilus) decolaratus* can transmit *Babesia bigemina* and *Anaplasma marginale* to cattle and severe tick infestation can lead to tick problem, anorexia and anemia (Singh et al., 2000; Silashi et al., 2001).

A. lepidium (30.9%), and *R. pravus* (29.4%), was also a prevalent species collected from this study area. Regassa (2001) reported that *R. pravus* (about 8%) is from Southern Ethiopia which disagrees with the current result on *R. pravus*. Wasihun and Doda (2013) reported lower finding of 6.68% *A. lepidum* from Humbo district. It was also reported that *A. lepidum* was common but not abundant in Wolaita zone according to Dessie and Getachew (2006). It is limited by semi-desert conditions (Morel, 1980). It is also known as the “East African bont tick” and is common in many of the semi-arid regions of East Africa (Walker et al., 2003). This is also similar with the findings of Mesele et al. (2010) in Bedelle district. In southwest of Ethiopia including Gambella region and western Oromiya, this tick species was also reported with less abundance by several workers (Pegram et al., 1981) which agrees with the current result. In Gambella region, *A. lepidum* transmits *Rickettsia. ruminantium*, the organism that causes cowdriosis. *A. lepidum* was irregularly dispersed throughout most of the country and was collected from Tigray, Amhara, Oromiya, SNNP and Harare Regional States (Sileshi et al., 2007).

H. rufipes was the sixth most prevalent tick with prevalence of 25.7%. This result was higher than 2.5% report from Asella (Tessema and Gashaw, 2010). This tick species was restricted to warm, moderately dry mid lands areas between altitudes of 1800 and 1950 masl (Tessema and Gashaw, 2010). Hoogstraal (1956) stated that *H. rufipes* is widely distributed in the most arid parts of tropical Africa, receiving 250 to 650 mm annual rainfall and his results concur with the current study findings.

Risk factors (age, sex and body condition) were also involved in the variations of the prevalence of ticks in the study area. Statistically significant association of tick infestation with age and body condition score of study animal was found. However, association of tick infestation and sexes of study animal were not statistically significant. Multivariable logistic regression analysis revealed that adults are about three times more likely to be prone to tick infestation than young animals (OR=3, P =0.007). These results were lined with findings of Bossena and Abdu (2012), Gedilu et al. (2014) and Admassu et al. (2015) but different from that of Kassa and Yalew (2012) and Tesfaheywet and Simeon (2013). This variation could be due to management; animals in different age groups were managed differently. In the current study area, younger animals (<1.5 year) are kept indoor for 1.5 to 2 years in a small separate housing locally called "dokoba" and as a result, unlike adult animals, younger animals have no access to harbor ticks from the field. Young animals are affected less than adult animals due to the less exposure to field grazing with other animals in the field and adults are exposed due to the communal grazing habit (Admassu et al., 2015).

By multivariable logistic regression analysis, animal with poor body condition was twice more likely to be infested with tick than animal with good body condition (OR=2, P=0.031) and animal with medium body condition was also found more prone to tick infestation than the animal in the state of good body condition (OR=1.7, P=0.043). This may due to the fact that ticks have contributed to emaciation of infested animals by causing anemia and stress. Insignificant association obtained between sex of animals and tick infestation concurred with the results of Kassa and Yalew (2012) and this might be due to equal opportunities of oxen and cows to tick infestation since they are kept extensively under similar agro-ecology and management condition.

Concerning predilection sites of ticks on the host body, different tick species were found to be having preference for predilection sites in this study. Accordingly, *R. pulchellus* and *R. pravus* had strong preference for ear, while *Ambylomma, Hyalomma* and the *Boophilus* subgenus were distributed on sternum, dewlap, scrotum, udder, ano-vulva and tail. This result was in line with the results of Stachurski (2000) and Tesgera et al. (2017), who stated that short hypostome ticks like *Rhipicephalus* usually prefer soft tissues like ear while, long hypostome ticks like *Amblyomma* attaches to lower parts of the animal body which is also the case in the current study. Cattle in this study were heavily infested and mean burden of tick was high (mean = 40 ticks/head). This finding was higher that reports of Alemu et al. (2014) from North west Ethiopia with mean = 13.1 tick/head. This variation in mean burden could be justified as tick densities are usually greater in lowland than highland areas (Pelgram, 1981).

The male to female sex ratio of the ticks were higher and similar to previous reports (Solomon et al., 2007; Chali et al., 2017). In all cases, except *R. decoloratus,* males outnumbered females. This is due to fully engorged female ticks drop off on the ground to lay egg while the male tends to remain on the host before dropping off and hence males normally remain on the host longer than females (Solomon et al., 2001).

CONCLUSION AND RECOMMENDATIONS

From this study Ixodid ticks of cattle were found to be highly prevalent in Dillo district with overall prevalence of 98.2%, the highest prevalence ever reported in Ethiopia to the best of the authors' knowledge. Three important genera of ticks, *Rhipicephalus* (including the subgenus *Boophilus*), *Amblyomma* and *Hyalomma* were identified and were found to be highly prevalent and abundant with overall mean burden of 40 ticks/head which was again highest burden of tick in Ethiopia. Eight species of Ixodid tick that were less abundant in most parts of the country were encountered as well as adapted and widely distributed in this area. Climatic advantage and adequacy of host animals for ticks, insufficient veterinary extension service combined with extensive management system may have contributed to the highest tick burden in the current study area. Additionally, Since, Ethiopia shares border of about 600 km with Kenya at this district and animal movement across the border during shortages of pasture and water may play a great role in high density and diversification of tick genera and species circulating around Dillo district. Therefore, both countries need to conduct collaborative nationwide studies to show the country wide distribution figures and to identify a potential port of cross border diseases particularly ticks and to formulate complimentary bilateral policies for prevention and control of ticks. Moreover, researchers in this regard should pay more attention on neglected lowland areas at peripheries that are at risk of tick and tick-borne diseases than any other part of the country.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

REFERENCES

Abdela N, Jilo K (2016). Impact of Climate Change on Livestock Health: A Review. Glob. Vet. 16(5):419-424.

Abera M, Mohammed T, Abebe R, Aragaw K, Bekele J (2010) "Survey of ixodid ticks in domestic ruminants in Bedelle district, Southwestern Ethiopia. Trop. Anim. Health Prod. 42(8):1677-1683.

Admassu B, Yeneneh H, Shite A, Haile B, Mohammed S(2015). Prevalence and identification of major ixodid Tick genera of Ccttle in Dangila District, Awi Zone, North West Ethiopia. Acta Parasitol. Glob. 6(2):129-135.

Alemu G, Chanie M, Mengesha D, Bogale B (2014). Prevalence of ixodid ticks on cattle in Northwest Ethiopia. Acta Parasitol. Glob. *5*(2):139-145.

Amante M, Alelgn Z, Hirpa E (2014) Prevalence of ixodid ticks on cattle in and around Diga Town, West Ethiopia. European J. Biol. Sci. 6(1):25-32.

Argaw D (2014).Marketing chain and quality management of hide and skin in Tiyo and Digelu-Tijo woreda, East Arsi zone, oromia reginal state, Ethiopia, MSc. Thesis, Department of Animal Production Studies, College of Veterinary Medicine and Agriculture, Addis Ababa University, Bishoftu, Ethiopia.

Ayele S, Assegid W, Jabbar M, Ahmed M, Belachew A (2003). A Review of Structure, Performance and Development Initiatives, Working Paper No. 52, Addis Ababa, Ethiopia. pp:1-14.

Bedasso M, Abebe B, Degefu H (2014). Species composition, prevalence and seasonal variations of ixodid cattle ticks in and around Haramaya town, Ethiopia. J. Vet. Med. Anim. Health 6(5):131-137.

Bossena F, Abdu M (2012). Survey on the Distribution of Tick Species in and Around Assosa Town, Ethiopia. Res. J. Vet. Sci. 5:32-41.

Chali E, Melaku M, Negero J (2017). Study on cattle tick species frequency distribution in and around Jimma province of Ethiopia. J. Parasitol. Vect Biol. 9(4):34-38.

Central Statistical Agency (CSA) (2016).Federal democratic republic of Ethiopia. Central statistical agency. Agricultural sample survey, Volume II, Report on livestock and livestock characteristics. Statistical bulletin 583, Addis Ababa, Ethiopia.

Dabassa G, Addis M, Tefera M (2013).Small ruminants Brucellosis: Serological survey in Yabello district. Asian J. Anim. Sci. 7(1):14-21.

Dabassa G, Shanko T, Zewdei W, Jilo K, Gurmesa G, Abdela N (2017). Prevalence of small ruminant gastrointestinal parasites infections and associated risk factors in selected districts of Bale zone, south eastern Ethiopia. J. Parasitol. Vect. Biol. 9(6):81-88.

Dessie S, Getachew A (2006). Cattle tick dynamics in different agro-ecological zones of Wolaita, Southern Ethiopia. Ethiop. Vet. J. 10(2):85-99.

Eversole DE, Browne MF, Hall JB, Dietz RE (2005).Body condition scoring in beef cows. Virginia polytechnic and state university, Verginia, USA.

Feseha G (1983). Notes on tick species and tick borne diseases of domestic animals in Ethiopia, FVM, AAU, Ethiopia. pp: 1-64.

Gedilu M, Mohamed A, Kechero Y (2014).Determination of the Prevalence of Ixodid Ticks of Cattle Breeds, Their Predilection Sites of Variation and Tick Burden Between Different Risk Factors in Bahir Dar, Ethiopia. Jimma University College of Agriculture and Veterinary Medicine, Jimma, Ethiopia. Glob. Vet. **13**(4):520-529.

Hoogstraal H (1956). African Ixodoidea. VoI. I. Ticks of the Sudan (with special reference to Equatoria Province and with Preliminary Reviews of the Genera Boophilus, Margaropus, and Hyalomma). Afr. Ixodoidea. VoI. I. Available at: https://www.cabdirect.org/cabdirect/abstract/19572901469

Jaswal H, Bal MS, Singla LD, Amrita Kaur P, Mukhopadhyay CS, Juyal PD (2014) Application of msp1β PCR and 16S rRNA semi nested PCR-RFLP for detection of persistent anaplasmosis in tick infested cattle. Int. J. Adv. Res. 2(8):188-196.

Jilo K (2016). *Peste Des Petits Ruminants (PPR):* Global and Ethiopian Aspects. A standard review. Glob. Vet.17(2):142-153.

Jilo K, Abdela N, Adem J(2016).Insufficient Veterinary Service as a Major Constrants in Pastoral Area of Ethiopia: A Review, J. Biol. Agric. Healthcare **6**(9):94-101.

Jilo K, Abdela N, Dabasa G, Elias M, (2017). Camel Trypanosomiasis: A Review on Past and Recent Research in Africa and Middle East American-Eurasian J. Sci. Res. 12(1), 13-20

Jilo K, Adem J (2016). Toxoplasmosis and its Current Status in Ethiopia: A Review. Glob. Vet. 17(2):135-141.

Jilo K, Tegegne D, (2016). Chemical composition and medicinal values of camel milk. Intern. J. Res. Stud. Biosci. 4:13-25.

Jongejan F, Uilenberg G (2004).The global importance of ticks. Parasitology 129(S1):S3-S14.

Kassa SA, Yalew A (2012). Identification of Ixodide ticks of cattle in and around Hararamaya district, Eastern Ethiopia. Sci. J. Crop Sci. 1(1):32-38.

Keirans JE, Needham GR, Oliver Jr, JH (1999).The Ixodes ricinus complex worldwide: diagnosis of the species in the complex, hosts and distribution. Acarology IX 2:341-347.

Mesele A, Mohammed T, Abebe R, Aragaw K, Bekele J (2010).Survey of Ixodids ticks in Domestic ruminants in Bedelle district, south western Ethiopia. Trop. Anim. Health Prod. 42:1677-1683.

Minjauw B, Mcheod A (2003). Tick-born disease and poverty. The impact of ticks and tick-borne disease on the live hood of small-scale and marginal livestock owners in India and Eastern and Southern Africa. Research Report, DFID Animal Health Programme, Center for Tropical Veterinary Medicine, University of Edinburgh, UK. pp:1-116.

Morel P (1980). Study on Ethiopia ticks (Argasidae, Ixodidae) Republic of France, Ministry Of foreign affairs, French Vet Mission, Addis. C. J. E. V. T. pp:12: 332.

Mungube E, Bauni S, Tenhagen B, Wamae W, Nzioka M, Mohammed L, Nginyi M (2008). Prevalence of parasites of the local scavenging chickeni selected semi-arid zone of Eastern Kenya. Trop. Anim. Health Prod. Bull. 40:101-109.

Nigatu K, Teshome F (2012). Population dynamics of cattle ectoparasite in western Amhara National Regional State Ethiopia. J. Vet. Med. Anim. Health 4: 22

Pegram RG, Hoogstral H, Wassef HY (1981). Ticks (acarida ixodidae) of Ethiopia. I. Distribution, ecology and host relationship of species infesting livestock. Bull. Entomol. Res. 71:339-359.

Regassa A (2001). Tick infestation of Borana cattle in the Borana Province of Ethiopia. Onderstepoort J. Vet. Res. 68:41-45.

Wasihun P, Doda D (2013). Study on prevalence and identification of ticks in Humbo district, Southern Nations, Nationalities, and People's Region (SNNPR), Ethiopia J. Vet. Med. Anim. Health 5(3):73-80.

Salih DA, Hussein AM El and Singla LD (2015). Diagnostic approaches for tick-borne haemoparasitic diseases in livestock. J. Vet. Med. Anim. Health **7**(2):45-56

Silashi M, Hussein I, Bedane B (2001). The distribution of ixodid ticks in central Ethiopia. On Derstepoort J. Vet. Res. 68(4):243-251.

Singh AP, Singla LD, Singh A (2000). A study on the effects of macroclimatic factors on the seasonal population dynamics of *Boophilus micropus* (Canes, 1888) infesting the cross-bred cattle of Ludhiana district. Int. J. Anim. Sci. 15(1):29-31.

Solomon G, Nigist M, Kassa B (2001). Seasona variation of ticks on calves at Sebeta in western Shewa Zone. Ethiop. Vet. J. 7(1&2):17-30.

Solomon G, Silashi M, Niguist M, Thomas C, Getachew T, Abebe M, Genet B, Demeke S, Ejigu Z (2007). Distribution and seasonal variation of ticks on cattle at Ghibe Tolly in Central Ethiopia. Ethiopian Vet. J. 11:121-139.

Solomon G, Kassaye GP, Feseha G, Teferi G, Getachew T (1998). Ticks and tick borne diseases associated with indigenous cattle in Didtuyura Ranch, southern Ethiopia. Int. J. Trop. Insect Sci. 18(1):59-66.

Stachurski F (2000). Invasion of West African cattle by the tick Amblyomma variegatum. Med. Vet. Entomol. 14(4):391-399.

Tadesse F, Abadfaji G, Girma S, kumsa B ,Jibat T(2012). Identification of tick species and their preferred site on cattle's body in and around Mizan Teferi, Southwestern Ethiopia. J. Vet. Med. Anim. Health 4(1):1-5.

Tesfahewet Z ,Simeon H (2013). Prevalence of ectoparasite infestations of cattle in Bench Maji zone, southwest Ethiopia. Vet. World 6(6):291-294.

Tesgera T, Regassa F, Giro B, Mohammed A (2017). Study on prevalence and identification of ixodid ticks in cattle in Gursum district, East Hararghe Zone of Oromia Regional State, Ethiopia. J. Parasitol. Vect. Biol. 9(4):27-33.

Tessema T, Gashaw A (2010). Prevalence of ticks on local and crossbred cattle in and around Asella town, southeast Ethiopia.

Ethiopian Vet. J. 14(2):79-89.

Thrusfield M (2005).Veterinary Epidemiology. 3rd ed. UK: Black well science ltd. P 233.

Tikit B, Addis M (2011). Distribution of Ixodid Ticks on Cattle in and Around Holeta Town, Ethiopia. Glob. Vet. 7(6):527-531.

Walker AA, Bouatour A, Camicas JL, Estadapena AA, Harok IG, Hatif AA, Pegram RG, Preton PM (2003).Ticks of domestic animals in Africa: A guide to identification species. The University of Edinburgh, UK pp:67-80.

Yalew A, Adugna S, Keffale M (2017). Identification of Major Ixodid Ticks on Cattle in and Around Haramaya Town, Eastern Hararghe,

Ethiopia. Acta Parasitol. Glob. 8(1):09-16.
Zenebe S (2001). Study of ticks and tick borne disease on cattle at Girran valley in the North Wollo Zone. Proceeding of the Ethiopian Veterinary Association, V-15.

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Microbial safety and its public health concern of *E. coli* O157:H7 and *Salmonella* spp. in beef at Dire Dawa administrative city and Haramaya University, Ethiopia

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A cross-sectional study was conducted in Dire Dawa administrative city and Haramaya University (HU) slaughterhouses and retail shops, with the aim to identify *E.coli* O157:H7and *Salmonella,* to assess the microbial safety of beef and identify potential contamination risk factors. A total of 320 samples consisting of beef samples and environmental pooled samples examined for the presence of *E. coli*, *E. coli* O157:H7and *Salmonella* following standard bacteriological techniques and procedures outlined by the International Organization for Standardization. From a total of 290 beef samples collected, *E. coli* was isolated from 36 (12.41%) and out of these, 6 (2.06%) were confirmed on Sorbitol MacConkey Agar to be *E. coli* O157 H7. 8(2.75%) *Salmonella* spp. was identified by means of culture and biochemical test. The difference in prevalence was statistically significant (P≤ 0.01) between slaughterhouses and retail shops in both study areas. There was significant difference in mean Aerobic Plate Counts between Haramaya University slaughterhouse (7.11 log10 cfug^{-1}) and retail shop (2.3 log10 cfug^{-1}). Fecal coliforms counts (FCC) were significantly higher for beef samples from Haramaya University slaughterhouse (7.50 log10 cfug^{-1}) as compared to carcass sample from Haramaya retail shop (4.80 log10 cfug^{-1}). Out of 30 environmental pooled samples, *E. coli*, *E.coli* O157:H7 and *Salmonella* was present in 7(23.33%), 2(6.66%) and 2(6.66%), respectively in both study areas. A significant difference (P≤ 0.01) in the prevalence of *E. coli* between Haramaya University slaughterhouse (35.6%) and Haramaya University retail shop (11.1%) and Dire Dawa slaughterhouse (9%). Visual observations of slaughterhouse design, layout, slaughtering process, hygienic practice employed, sanitary regulatory system and personnel habit were below the minimum standards. Slaughterhouse and all meat contact surfaces might have served as sources of contamination for the product. Therefore, good management practice and good hygienic practice should be introduced in order to enhance the overall safety and hygienic quality of beef and safeguard the consumer from foodborne pathogens.

Key words: Aerobic plate counts (APC), beef, Dire Dawa, *E. coli, E. coli* O157:H7*,* fecal coliforms counts (FCC), Haramaya University (HU)*, Salmonella.*

INTRODUCTION

Foodborne pathogens are one of the leading causes of illness and death in the world. They place heavy burden costing billions of dollars in medical care, social costs and overall economic and infrastructure effects on countries (Fratamico et al., 2005). Centers for Disease Control and Prevention (CDC) reported that of 19,056 people who get sick, more than 4,200 are hospitalized and 80 deaths recorded States of America (USA) (CDC, 2013). It mostly affects developing countries, due to major contributing factors such as from foodborne illness among 48 million (15%) population in United overcrowding, poverty, changes in eating habits, mass catering, complex and lengthy food supply procedures with increased international movement, inadequate sanitary conditions and poor general hygiene practices (Bhandare et al., 2007; Podpecan et al., 2007; Chhabra and Singla, 2009). In developing countries, including Ethiopia, up to 2 million people die per year due to disease of foodborne pathogens (World Health Organization (WHO), 2007).

Over the last 20 years, the emergence of major foodborne pathogens such as *Salmonella* and *Escherichia coli* have persisted as a major public health concerns and provide clear examples of the persistence of foodborne pathogens despite considerable efforts aimed at prevention and control (Diane et al., 2010). For this reason, the basic steps in the control of safety and quality of food include analysis of food products for presence of pathogenic microorganisms that cause the majority of alimentary human diseases. Among them are, *Salmonella* and *E. coli* O157:H7. These foodborne pathogens have frequently been linked to a number of cases of human illness (Brown et al., 2000).

Trends in foodborne illness in the industrialized and developing countries indicate that the incidence of foodborne illness is increasing (WHO, 2005). It has resulted in significant social and economic impact and that it is likely to remain a threat to public health well into the next century. There are however, substantial gaps in our understanding of this problem. In 2005, the World Health Organization (WHO) reported that 1.8 million people died from diarrheal diseases, largely attributable to contaminated food and drinking water (WHO, 2005). This is not just only an underdeveloped world problem. Meat processing at retail level is likely to contribute to the higher levels of contamination in minced beef as compared to carcasses (Tegegne and Ashenafi, 1998). The presence of even small numbers of pathogens in meat and edible offal may lead to heavy contamination of minced meat when it is cut into pieces and the surface area of the meat increases; as more microorganisms are added to the surfaces of exposed tissue (Ejeta et al., 2004). Previous studies conducted in many parts of the country indicated the occurrence of pathogens including *Salmonella* in different food animals, meat and meat products (Haimanot et al., 2010). In addition, outbreaks of infections related with poor hygiene and consumption of contaminated food were reported in Ethiopia (Mache et al., 1997) and some were caused by *Salmonella* and *E. coli* (Alemseged et al., 2009).

In Ethiopia, the widespread habit of raw beef consumption is a potential cause for foodborne illnesses besides the common factors such as overcrowding, poverty, inadequate sanitary conditions and poor general hygiene (Haymanot et al., 2010). Raw meat is available in open-air local retail shops without appropriate temperature control and this is purchased by households and also minced meat (Kitfo) is served as raw, slightly-cooked or well-cooked in Dire Dawa administrative city and Haramaya University. Therefore, the main objectives of this study were to determine the microbial safety of beef through isolation and identification of foodborne bacterial pathogens in beef, to identify potential sources of contamination of beef in slaughterhouse and retail meat shops, to determine the hygiene conditions and practices of slaughterhouse and retail meat shops and to determine the hygienic quality of beef from slaughterhouse and retail meat shops.

MATERIALS AND METHODS

Study area and population

The study was conducted at slaughterhouse and ten retails shop in Dire Dawa administrative city and slaughterhouse and one retail meat shop in Haramaya University from May to November, 2014. Dire Dawa lies in the eastern part of the Ethiopia 515 km away from Addis Ababa with latitude 9° 27′ to 9° 49′ North and longitude 41° 38′ East (Center of Stastical Agency (CSA), 2007). The city has a total area of 1,213 km^2 coverage's and elevation of 226 to 950 m above sea level (Center of Stastical Agency, 2007), and Haramaya University (HU) is located in the Eastern Hararghe Zone of the Oromia Region of Ethiopia, which is about 17 km from the city of Harar and 40 km from Dire Dawa and 5 km from Haramaya town at an altitude of 1980 m above sea level between latitude 9° 26" N and longitude 42° 3" E (Asrat, 2008). The mean annual rainfall is 870 mm with a range of 560 to 1260 mm, and the mean maximum and minimum temperatures are 23.4 and 8.25°C, respectively (Asrat, 2008). The study population represents apparently healthy cattle slaughtered in Dire Dawa and HU slaughterhouse, cattle subjected to slaughter brought from Water, Kersa, Hirna, Chalanko and Kulibi in both study areas and in addition from Issa (Somali) in Dire Dawa. Both local and cross breeds cattle are reared in and around the study areas for meat production mostly. There is one municipal

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slaughterhouse in which different species of animal such as cattle, goat, sheep and camel is slaughtered and both over head rail and horizontal slaughtering system is practiced. Over an average of 70 cattle, 20 camel and 55 goat and sheep are slaughtered daily in Dire Dawa slaughterhouse but one slaughterhouse and one beef retail shop is available inside HU and only horizontal slaughtering system is practiced. Over 17 workers in HU slaughterhouse and 5 workers in HU retail shop are working daily on temporary basis and in range of 5 to 20 cattle are slaughtered every day depending on the needs of student cafeteria (main campus and Harer), staff lounge and the days of the week in HU slaughterhouse. The sample included raw beef and environmental pooled samples from slaughterhouses and retail shops in both study areas. The slaughterhouse structure in Dire Dawa was relatively good like there is a clear division of work, vertical line system and separate room for evisceration as compared with HU slaughterhouse.

Study protocol

A cross-sectional study was conducted to determine the microbial safety and hygienic quality of beef samples drawn from municipal slaughterhouse and retail meat shops. In addition, checklist and interviews were made on food handlers working at food establishment, to determine the hygienic status of the premises and safety practices of meat handlers. In the present study, beef samples and environmental pooled samples were collected from slaughterhouses and retails shops in both study areas. The sample size required for this study to identify the microbial safety of foodborne pathogen from beef was determined according to Thrusfield (2007) by taking expected prevalence of 5.6% for *Salmonella* in Dire Dawa (Bayleyegn et al., 2003) and 3% for *E. coli* O157:H7 in Haramaya University (Taye et al., 2013) with the consideration of slaughter animal coming from the same origin in both study area and confidence interval of 95% and 5% absolute precision.

The sample size of the present study were calculated and 81 beef samples from Dire Dawa slaughterhouse and 81 from 10 randomly selected retails shop and the selection of retail shop were done based on lottery method from 542 retails shop in Dire Dawa, and to increase the precision 19 beef samples for each sample collection centers were added and a total of 200 beef samples were collected from Dire Dawa administrative city and exactly the calculated number of 45 beef samples from HU slaughterhouse and 45 beef samples from retail shop were also collected due to resource limitation. Beside that, to assess the source of contamination level, only 30 environmental pooled samples were taken from equipment, surface, workers hand, vehicles in both study areas due to the vastness of the work and the availability of resource. Therefore, a total of 290 beef samples and 30 environmental pooled samples were collected from both study areas. The microbial safety and hygiene quality were then assayed by using the methods recommended by International Commission on Microbiological Specifications for Foods (ICMSF) (1986). All the samples were investigated with respect to *Salmonella*, *E. coli* and *E. coli* O157:H7 detection and aerobic plate and fecal coliforms counts.

The slaughterhouse and each retail shops were visited once in a week for consecutive weeks, and in each visit, ten beef samples were taken from the slaughterhouse and ten beef samples from ten retails shops in Dire Dawa town and five beef samples from HU slaughterhouse and five beef samples from HU retail shop every week for nine consecutive weeks. Each carcass is represented by meat pieces collected from different locations such as leg, flank, inter costal and neck, and pooled together weighing 200 g. Retail meat samples (200 g) were taken simply from different location under aseptic conditions using sterile blades and sterile containers as described by Gill (2007).

For convenience, before the commencement of the sample collection all the respective samples (meat and environmental swab) were labeled with necessary information including date of sampling, code of sample source (beef) and identification of the shop from which the samples were obtained. The live animals were coded with owners name and the same code were followed for the carcass then the meat and samples were taken from the same carcass from those owner retails shops in Dire Dawa and the same procedure was followed in HU. After completion of sampling, all collected samples from Dire Dawa were placed in nutrient broth or Carry Blair Transport medium (Oxoid Ltd, Basingstoke, Hampshire, England) and immediately transported in cold chain using ice box containing ice pack to Veterinary Microbiology Laboratory of Haramaya University, within an hour and samples from Haramaya University were processed immediately upon arrival. The samples were processed up on arrival or stored overnight in a refrigerator at +4°C and the samples were processed in the next day for identification of pathogenic species, according to the standard set by the International Commission on Microbiological Specification for Food (ICMSF, 1986).

A total of thirty pooled environmental samples were collected from slaughterhouse, retail shop and transport vehicles. The pooled environmental sample collections were conducted two times within three months. On each visit to the slaughter house, a total of four pooled swab samples were taken each from cleaned, disinfected and dry surfaces, others from hooks, knives and aprons, the third from personnel's hands who work flaying, evisceration and carcass cutting before the beginning of the work and the fourth from the surface of transporting vehicles by rubbing thoroughly with a moistened swab. In each visit of each retail shops, a total of three pooled swab samples were taken each from cutting boards and meat grinder, others from hooks, knives and protective cloths and the third from personnel's hands (butcher man) before the beginning of work by rubbing thoroughly with a moistened swab. The samples were then returned to a test tube containing 9 ml sterile buffered peptone water (BPW). All samples were transported to the Veterinary Microbiology Laboratory of Haramaya University in an ice box on ice packs and analyzed upon arrival or within 24 h of sampling. The type and the number of samples processed were presented in Table 1.

For isolation and identification of pathogens from meat, 25 g of sample was weighed, cut into small piece with different sterile scalpel blade and placed into sterile stomacher bags, diluted with 225 ml of sterile BPW and homogenized in a stomacher at 230 R for 2 min (ISO TS 11133-1, 2009). For isolation and identification of pathogens from environmental samples, pooled swab samples were placed into a test tube that contained 9 ml sterile BPW. Subsequently, 10-fold serial dilutions were made to 10^{-6} for spread-plating. Samples were analyzed for the presence of *E. coli* O157:H7 and *Salmonella* spp. according to published methods as follows:

The *E. coli* O157:H7 detection was carried out according to the protocol of ISO 16654 (2001) standard. The pre-enriched beef samples were subsequently subcultured onto MacConkey agar (Oxoid, England) for primary screening of *E. coli* and incubated at 37°C aerobically for 24 h. Suspected colonies of *E. coli* (pinkish color appearance) were then subcultured onto nutrient agar (HiMedia, India) (non-selective media) and confirmed by triple sugar iron (TSI) (Oxoid, England) and indole, methyl red, Voges-Proskauer and citrate (IMViC) tests on tryptone broth (Oxoid, England), MRVP medium (Oxoid, England) and Simon citrate agar

Table 1. Summary of the type and total amount of sample collected

No	Sample type	Sample collected area	Total sample
1	Raw beef meat	45 from HU slaughter house 45 from HU retail shop 100 from DD slaughter house 100 from DD retail shop	290
2	Environmental sample Equipment Workers hand Contact surface balance Vehicle Cutting board and table	2 from each of the four site 2 from each of the four site 2 from HU slaughter house and 2 from DD slaughter house 2 from HU retail shop 2 from HU and 2 from DD slaughter house 2 from HU and 2 from DD retail	30
3	Respondents	22 respondents from HU 28 respondents from DD	50

HU= Haramaya University; DD= Dire Dawa

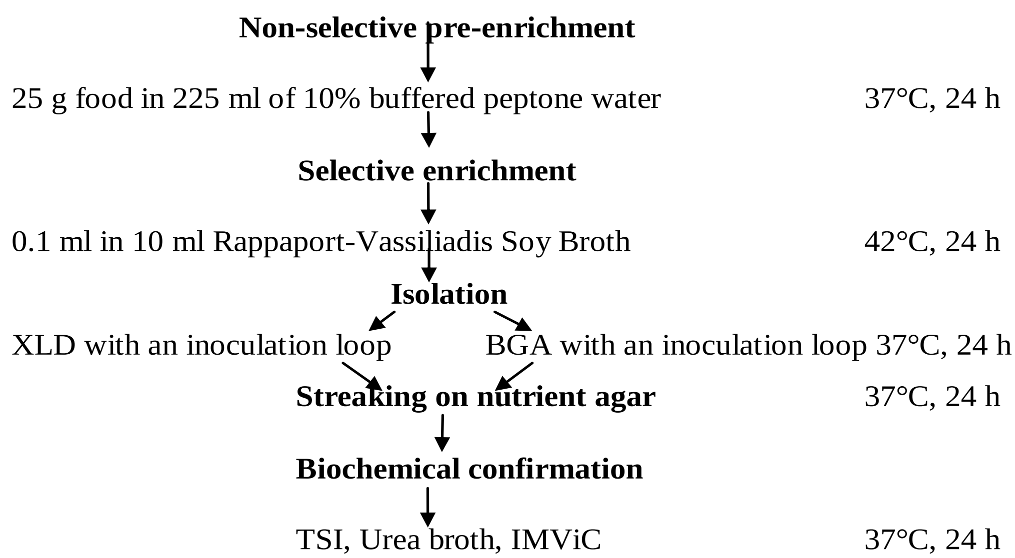

Figure 1. Flow diagram for detection of *Salmonella* (Source, ISO 6579, 2002).

(Oxoid, England), respectively. Then the bacterium that was confirmed as *E. coli* was subcultured onto Sorbitol MacConkey agar (SMA) (Oxoid, England) from nutrient agar (HiMedia, India). SMA (Oxoid, England) plates were incubated at 35°C for 20 to 22 h (Timothy and Smith, 2012). *E. coli* O157:H7 does not ferment sorbitol and therefore, produces colorless colonies. In contrast, most other *E. coli* strains ferment sorbitol and form pink colonies and Latex *E. coli* O157:H7 agglutination test was performed to determine strains.

The procedures for isolation of *Salmonella* from food were based on protocol of the ISO 6579 (2002) standard (Figure 1). To diminish the risk of obtaining false negative results, a non-selective pre-enrichment of large food sample, followed by two selective enrichments, but due to availability of the resource, used one selective enrichment media which is mandatory and plating on two selective media was performed.

Salmonella was isolated from beef sample (25 g) homogenized in 225 ml of 0.1% buffered peptone water (BPW) (HiMedia, India). Aliquot (1 ml) was added to 10 ml of Rappaport Vassiliadis (Oxoid, England). This was incubated at 41 ± 0.5°C over night. After gentle mixing, a loopful of culture from the enrichment broth was streaked parallely onto Xylose lysine desocholate (XLD) agar (Oxoid,

Table 2. Frequency of bacterial isolate of beef samples from Dire Dawa and HU slaughterhouse and retail shops.

Samples source	Number of samples processed	Bacterial isolates (%)		
		E. coli	***E. coli* O157:H7**	***Salmonella* spp.**
HU slaughterhouse	45	16 (35.6)	1 (2.2)	3 (6.7)
HU retail shop	45	5 (11.1)	0 (0)	3 (6.7)
DD slaughterhouse	100	9 (9)	4 (4)	1 (1)
DD retail shops	100	6 (6)	1 (1)	1 (1)
Total	290	36 (12.41)	6 (2.06)	8 (2.75)

$P \leq 0.01$, df= 3 for *E.coli,* $P > 0.05$, df= 3 for *E.coli* O157:H7 and *Salmonella*

England) and Brilliant green agar (BGA) (Oxoid, England) and incubated at 37°C for 24 to 48 h. Typical *Salmonella* colonies which are pink with or without black centers were isolated from XLD and *Salmonella* colonies grow as red-pink, white opaque colonies surrounded by brilliant red zones in the agar are taken from BGA. The colonies were purified on fresh nutrient agar (HiMedia, India) and then streaked and stabbed into the butt of triple sugar iron (TSI) (Oxoid, England) slants and inoculated into tryptone broth (Oxoid, England), MRVP medium (Oxoid, England) and Simon citrate agar (Oxoid, England) for IMViC test from both selective media. These were incubated at 37°C for 24 h. The test tubes that had alkaline (red) slants and acidic (yellow) butts, with the production of H_2S (blackening) were presumed to be *Salmonella* isolates. Moreover, two or more colonies from pure isolates were inoculated on urea broth (SRL, India) and incubated at 37°C for 24 h. All test tubes that were urease negative were treated as suspects of *Salmonella* (FDA, 1992). In addition, isolate that was Gram-negative rod, oxidase negative, methyl red positive, citrate positive, indole negative, Voges-Proskauer negative and lactose and sucrose non-fermenter were accepted putatively as *Salmonella* (Fawole and Oso, 2001).

Aerobic plate count (APC) were enumerated using plate count agar (APC); twenty five grams of beef sample was weighed and homogenized in 225 ml of 0.1% sterile peptone water using a sterile homogenizer. From the 10-fold dilutions of the homogenates, 0.1 ml of 10^{-4}, 10^{-5} and 10^{-6} dilutions of the homogenates were plated by the spread plate method onto the surface of plate count agar (PCA). Plates were incubated at 35°C for 48 h and plates containing between 30 and 300 colonies were counted (ISO/TS 11133-1, 2009). Fecal coliforms were enumerated using violet red bile agar (VRBL); 25 g of beef sample was weighed and homogenized in 225 ml of 0.1% sterile peptone water using a sterile homogenizer. From the 10-fold dilutions of the homogenates, 0.1 ml of 10^{-4}, 10^{-5} and 10^{-6} dilutions of the homogenates were spread onto agar plates. The VRBL was inoculated with 0.1 ml inoculums after the final incubation at 44 ± 1°C for 24 h, typical and atypical colonies were enumerated. Typical colonies on VRBL medium have fuchsia color with a diameter of approximately 0.5 mm and sometimes surrounded by a reddish-fuchsia zone (1 to 2 mm in diameter) of precipitated bile salts, which reveals lactose degradation in acid. On the VRBL medium, pale colonies with greenish zones reflect lactose fermentation by fecal coliforms, which appear slowly (Marshall, 1993).

Statistical analysis

The data collected through questionnaire survey and laboratory results of the collected samples were entered into databases using Micro-Soft Excel computer program and analyzed using SPSS version-19.0 (SPSS, 2012). Descriptive statistics were used to describe the nature and the characteristics of the questionnaire survey result. The aerobic bacterial and fecal coliform counts were expressed as mean using excel and compared by analysis of variance (ANOVA). A Chi-Square test was applied to examine whether the differences between the values and the level of contamination between slaughterhouse and retail shops and associated risk factor were significant. A p-value of less or equal to 0.05 and chi-square value were considered indicative of a statistically significant difference.

RESULTS

Isolation of bacteria from beef slaughtered and marketed at Dire Dawa city and Haramaya University

Out of 90 beef samples from HU (45 beef samples from slaughterhouse and 45 beef samples from retail shop) examined bacteriologically 21 (23.3%), 1 (1.1%) and 6 (6.7%) had *E. coli*, *E. coli* O157:H7 and *Salmonella* spp., respectively. None of the 90 beef samples from HU had mixed bacterial contamination. The prevalence of *E. coli*, *E. coli* O157:H7 and *Salmonella* in HU slaughterhouse and retail shop were presented in Table 2. Out of 200 beef samples from Dire Dawa (100 beef samples from slaughterhouse and 100 from ten randomly selected retail shops) examined bacteriologically, 15 (7.5%), 5 (2.5%) and 2 (1%) had *E. coli, E. coli* O157:H7 and *Salmonella* spp., respectively. One of the 200 samples of beef had yielded both groups of bacteria. The prevalence of *E. coli*, *E. coli* O157:H7 and *Salmonella* in Dire Dawa slaughterhouse and retail shop were presented in Table 2.

Hygienic quality of beef from Dire Dawa and HU slaughterhouses and retail shops

The results of total aerobic bacteria in beef by using detection methods are summarized in Table 3. This study detected total aerobic bacteria in 27/290 (9.31%) of beef

Table 3. Indicator organisms detected from beef sampled from HU and Dire Dawa slaughterhouse and retail shops**.**

Sample source	No of sample	Organisms detected	
		No (%) AB	No (%) FCs
HU slaughter house	45	6 (13.33)	8 (17.77)
HU retail shop	45	8 (17.77)	1 (2.2)
DD slaughter house	100	10 (10)	2 (2)
DD retail shops	100	3 (3)	0 (0)
Total	290	27 (9.31)	11 (3.79)

FCs= Fecal coliforms, AB = Aerobic bacteria, $p > 0.05$, df = 1

Table 4. Microbial loads of indicator organisms on beef in HU and Dire Dawa slaughterhouse and retail shops.

Sample source	No of sample	Bacterial colonies log10 cfug-^{1}					
		APCs			FCCs		
		Mean	Min	Max	Mean	Min	Max
HU slaughter house	45	7.11	4.00	8.80	7.50	3.60	9.20
HU retail shop	45	2.30	4.10	8.80	4.80	0.00	5.70
DD slaughter house	100	5.63	0.30	8.80	1.13	0.33	4.89
DD retail shop	100	3.10	6.72	9.73	0.00	0.00	0.00

FCCs= Fecal coliform counts, APCs= Aerobic plate counts. $P \leq 0.01$**,** df= 1.

samples from slaughter house and retail shops. Results of mean APCs of beef in this study are presented in Table 4. Fecal coliforms count in beef presented in Table 4 indicates the hygienic qualities of meat. In this study, fecal coliforms were detected and enumerated irrespective of pathogencity of the strain to estimate the level of hygiene (Table 3). Out of 290 samples, fecal coliforms were present in 11 (3.79%) samples including HU and Dire Dawa slaughterhouse 8 (17.77%) and 2 (2%), respectively and HU retail shop 1 (2.2%) and Dire Dawa retail shops 0 (0%) (Table 3).

Major source of microbial contamination for beef from slaughterhouse and retail shops

It is generally accepted that microbial loads on surfaces and equipment vary in different food plants depending on the microbial quality of the food (Evans et al., 2004). One of the specific objectives of this study was to examine the sources of microbial contamination of beef intended for human consumption and to determine the acceptability of hygienic levels of slaughterhouse and retail shops. Swab samples were taken from cleaned, disinfected and dry surfaces of slaughterhouse, retail shops facilities and equipment surfaces, and also personnel before the beginning of work by rubbing meat contact surfaces and the hand of meat handler thoroughly with a moistened swab from both sites. All contact surfaces were analyzed for *E. coli* O157:H7 and *Salmonella* spp*.,* detection and enumeration of fecal coliform and aerobic bacteria. Out of 30 environmental pooled samples (8 from HU slaughter house, 8 from HU retail shop, 8 from Dire Dawa slaughterhouse and 6 from Dire Dawa retail shops out of 10 randomly selected retail shops due to the fact that 7 of the selected retail shops could not be voluntary to take swab sample), *E. coli, E. coli* O157:H7 and *Salmonella* was present in 7 (23.33%), 2 (6.66%) and 2 (6.66%) samples. The occurrence of *E. coli*, *E. coli* O157:H7 and *Salmonella* spp. in beef contact surfaces from HU and Dire Dawa slaughterhouse and retail shops are summarized in Table 6. Average microbial load for APCs and FCCs in beef contact surfaces at slaughterhouse and retail shops are shown in Table 5. Total aerobic bacteria in different sample groups in retail shop (knives and hooks, cutting boards and personnel hands) were examined.

Fecal coliforms counts in different sample groups in retail shops and slaughterhouse (knives and hooks, cutting boards, personnel hands and transporting vehicle)

Table 5. Microbial loads of indicator organisms on beef contact surfaces from HU and Dire Dawa slaughterhouse and retail shops**.**

Sources	No of sample	Enumerated organisms log10 cfu /cm^2					
		APCs			FCCs		
		Mean	Min	Max	Mean	Min	Max
HU slaughterhouse							
Equipments	2	3.05	TFC	6.10	TFC	TFC	TFC
Surfaces	2	TFC	TFC	TFC	TFC	TFC	TFC
Workers hands	2	TFC	TFC	TFC	TFC	TFC	TFC
Vehicle	2	TFC	TFC	TFC	TFC	TFC	TFC
HU Retail shops							
Equipments	2	TFC	TFC	TFC	5.38	5.10	5.67
Cutting boards	2	TFC	TFC	TFC	4.78	4.24	5.33
Workers hands	2	TFC	TFC	TFC	5.06	4.50	5.63
Balance	2	TFC	TFC	TFC	TFC	TFC	TFC
DD slaughterhouse							
Equipment	2	TFC	TFC	TFC	4.43	3.11	5.76
Surface	2	TFC	TFC	TFC	4.42	3.20	5.65
Worker hand	2	TFC	TFC	TFC	4.32	3.32	5.32
Vehicle	2	5.73	4.56	6.91	5.87	4.54	7.20
DD retail shops							
Equipment	2	TFC	TFC	TFC	4.96	4.32	5.61
Cutting board	2	TFC	TFC	TFC	6.26	5.65	6.88
Worker hand	2	TFC	TFC	TFC	5.98	4.87	7.1

TFC= Too Few to Count, P≤ 0.01, df=1.

were examined. The result varied from 3.11 $\log_{10}$ cfu/cm^2 to 7.20 $\log_{10}$ cfu/cm^2 in knives and hooks, cutting boards, balance, personnel hand and transport vehicle at slaughterhouse and retail shops. The overall mean of coliforms count in retail shops environment was 5.40 $\log_{10}$ cfu/cm^2 and 2.38 $\log_{10}$ cfu/cm^2 in slaughter house. Furthermore, the result of aerobic plate counts and coliform count were compared by ANOVA and showed that there is significant (P≤ 0.01) variation in the means of fecal coliforms count found in different meat contact surfaces in retail shop and slaughterhouse.

Hygienic practices in Dire Dawa and HU slaughterhouses and retail shops

“Abattoir” in terms of the Republic of South African Meat Safety Act, 2000 (Act 40 of 2000) means a slaughter facility in respect of which a registration certificate has been issued in terms of section 8 (1) and in respect of which a grading has been determined in terms of section 8 (2): (i) A well-designed and constructed structure is needed to systematically process the animal that is slaughtered. According to abattoir, cutting and packing plant standard (ABM, 2008), abattoir wall, floors, ceilings, windows, doors, lighting, air-conditioning/ventilation, services and equipment must be constructed to withstand and facilitate thorough cleaning and minimize contamination of product, either through pests, harboring of dirt or other physical, chemical or microbiological hazards.

In Dire Dawa slaughterhouse except in Muslim slaughter premises, it is a well organized beef slaughter house than Haramaya University slaughter house. In Dire Dawa, slaughterhouse for Christian have clear division of slaughtering process into stunning, bleeding, skinning and evisceration, whereas in Muslim slaughter premises and HU slaughterhouse no clear division existed. In both slaughterhouses, horizontal bleeding on killing floor was conducted, however, only vertical dressing process on

Table 6. Bacterial species detected from beef contact surfaces sampled from HU and Dire Dawa slaughterhouse and retail shops**.**

Sources	No of sample	Bacterial detected		
		No (%) *E. coli*	No (%) *E.coli* O157H7	No (%) *Salmonella*
HU slaughterhouse				
Equipments	2	2(100)	1(50)	0(0)
Surfaces	2	1(50)	0(0)	0(0)
Workers hands	2	1(50)	0(0)	0(0)
Vehicle	2	0(0)	0(0)	0(0)
HU Retail shops				
Equipments	2	0(0)	0(0)	1(50)
Cutting boards	2	1(50)	0(0)	0(0)
Workers hands	2	0(0)	0(0)	0(0)
Balance	2	0(0)	0(0)	0(0)
DD slaughterhouse				
Equipment	2	1(50)	0(0)	1(50)
Surface	2	0(0)	0(0)	0(0)
Worker hand	2	0(0)	0(0)	0(0)
Vehicle	2	1(50)	1(50)	0(0)
DD retail shops				
Equipment	2	0(0)	0(0)	0(0)
Cutting board	2	0(0)	0(0)	0(0)
Worker hand	2	0(0)	0(0)	0(0)
Total	30	7(23.33)	2(6.66)	2(6.66)

$P > 0.05$, df= 3

overhead rail procedure was conducted in Dire Dawa slaughterhouse. The visual observation result in HU slaughterhouses indicated that the animal brought to slaughterhouse without prior ante-mortem inspection was done and without fasting the animal for 12 to 24 h before slaughter, which increases the micro floral load, and sometimes the animal brought to slaughterhouse immediately after arrival from market results in shading of microorganisms. But in Dire Dawa slaughterhouse, the pre-slaughter procedure was done 12 h before the slaughtering process presided. The animal also encountered stressful handling during riding on foot from the HU farm to HU slaughter house in the night, sometimes they even suffered fracture and excitement. Beside these, stunning process was done by kicking, using the back of axe and most of the time the workers could not make stunning by a single kick rather they kick several times which result the animal to suffering from pain. In general, the pre-slaughtering process in HU slaughterhouse brought the animal to stress which facilitate the rapid multiplication and shading of *E. coli* O157:H7 and *Salmonella* spp. This could be one of the sources of contamination of meat.

Hands are rarely free from microorganisms. It is of the utmost importance that soap (preferably in a dispenser) and hot running water are used for this purpose, thus aiming to reduce the microbiological load on hands (Desmarchelier et al., 1999). Van Zyl (1995) suggested that soap and hot water, at 45°C, should always be available at the washing-basins. Desmarchelier et al. (1999) recommend that hand-washing alone has no effect on the reduction of bacteria on hands; it depends on the mechanical action, the duration and the type of soap and sanitizers being used. It was important to know the educational background, type and terms of employment in the abattoir, and how the meat handler acquired their skills to establish their knowledge in handling meat safely. The knowledge and educational level of personnel working in both food establishments are summarized in Table 8.

In this study, personnel practices regarding prohibited habits and actions were also assessed. The visual observations indicated that, fraudulent activity and habits like eating, chewing and smoking in the slaughterhouse by the workers were common practices in both slaughterhouses, especially prominent in Dire Dawa slaughterhouse while they were on duty of meat processing. The overall result regarding habit, personnel cloth and cleanness in both slaughterhouses was summarized in Table 9.

DISCUSSION

Food borne illnesses caused by *Salmonella* spp., and *E. coli* O157:H7 represents a major public health problem worldwide. These pathogens are transmitted mainly through consumption of contaminated food and the presence of these organisms in meat animals and in raw meat products has relevant public health implications (Sousa, 2008). The occurrence of *E. coli* in meat samples from HU slaughterhouse in this study was in close agreement with the result of Taye et al. (2013) who isolated *E. coli* in 30.97% of the meat samples studied in the same slaughterhouse. The present result is much lower than the finding of Mekonnen et al. (2012) who isolated *E. coli* in 91.4% of meat samples from abattoir in Mekelle.

Generally, the high prevalence of *E. coli* in the meat samples from HU slaughterhouse indicated the contamination of meat with intestinal content since evisceration take place in the same place. There was a significant difference in the prevalence of *E. coli* between HU slaughterhouse and Dire Dawa slaughterhouse ($P \leq 0.01$). This difference could be due to difference in hygienic condition and practice in both slaughterhouses. The prevalence of *E. coli* O157:H7 isolated from beef in HU slaughterhouse (2.2%) and Dire Dawa slaughterhouse (4%) in this study was in agreement with the reported prevalence of 2.60% (Mekonnen et al., 2012) and 2.65% (Taye et al., 2013) in Ethiopia. There was no statistically significant difference in the prevalence of *E. coli* O157:H7 between HU slaughterhouse and Dire Dawa slaughterhouse ($P > 0.05$).

In comparison to the present study, a higher prevalence of *E. coli* O157:H7 were reported from different countries; 8% in Debre Zeit and Mojo (Hiko et al., 2008) and 8.1% in Mojo, Ethiopia (Mersha et al., 2009), 9% in India (Luga et al., 2007). In the current study, lower prevalence of *E. coli* O157:H7 was also isolated from Dire Dawa retail shop (1%) which is in agreement with the report from America (0.8%) (Desenclos et al., 1988) and Kenya (0.2%) (Chapman et al., 2000). The frequency of isolation of *Salmonella* spp. in meat samples in this study was 6.7% from both HU slaughter house and retail shop. This result was in agreement with 5.6% prevalence reported from muscle in Addis Ababa, Debre Zeit, Dire Dawa and Jigjiga (Bayleyegn et al., 2003), 8.5% from minced beef in Addis Ababa (Zewdu and Cornelius, 2009) and 4.8% from beef in Bahir Dar (Sefinew and Bayleyegn, 2012).

The detection of 6.7% of *Salmonella* in beef in HU slaughterhouse and retail shop as compared to Dire Dawa slaughterhouse and retail shops (1%) suggests that the process of evisceration could be the main source of carcass contamination in addition to carrier state. Cross-contamination can also occur during the skinning process as a result of poor hygienic conditions. The other probable source of contamination is infected abattoir personnel. When comparing with the present study, a relatively high prevalence of *Salmonella* (14.4%) was reported by Ejeta et al. (2004) from minced beef in Addis Ababa. It was also lower than the 40% prevalence reported by Molla et al. (2000). Similarly, Tegegne and Ashenafi (1998) reported *Salmonella* contamination rate of 42% from minced meat (locally known as «kitfo») samples collected from different hotels, bars and restaurants in Addis Ababa.

The lower prevalence was also revealed in this study from Dire Dawa slaughterhouse (1%) and Dire Dawa retail shops (1%). This result was in agreement with prevalence report of Sibhat et al. (2011) who reported 2% from carcass in Debre Zeit, Ethiopia and Fegan et al. (2004) also reported carcass contamination of 2% from slaughterhouse in Australia. There was no statistically significant difference in the prevalence of *Salmonella* spp. between Haramaya University and Dire Dawa administrative city ($P > 0.05$). This could be due to unhygienic slaughtering practice in HU slaughterhouse and Dire Dawa halal slaughter house.

Presence of microbes in high numbers (APC > 5 log cfu/cm^2 or g^{-1}) fast tracks the spoilage of the meat. According to the international standard organization (ISO 4833, 2003), APC of 80% of analyzed samples must not exceed 5 log cfug^{-1}or cm^2, whereas 20% of the samples may have counts of up to 5 log cfug^{-1} or cm^2 (Mukhopadhyay et al., 2009). In this study 5.8% of samples had APCs more than 5.00 log$_{10}$ cfug^{-1}, the condition was unacceptable. Lower level of aerobic plate count in this study was much lower than previous studies (Alvarez-Astorga et al., 2002; Bhandare et al., 2007; Haque et al., 2008; Hassan et al., 2010). However, the microbial contamination level of slaughterhouse and retail shops were higher as compared to reports from developed countries and our results do not conform to EU specifications (Gill et al., 2000; Duffy et al., 2001).

The higher aerobic plate count enumerated from HU slaughterhouse (7.11 $\log_{10}$ $cfug^{-1}$) suggests an unusual high level of contamination and/or growth which was similar with Gill (2007) report, given the hygienic status of the slaughterhouse and meat processing observed in the slaughterhouse. The result of this study was much lower than the presence of fecal coliforms in meat and meat studied by many researchers (Doyle, 2007; Adu-Gyamfi et al., 2012). Other study results have also been reported for retail chicken (50% incidence of *E. coli*) in Australia (Pointon et al., 2008) which was much higher than the present study. Mean fecal coliforms counts were higher for beef samples from HU slaughterhouse (7.50 $\log_{10}$ $cfug^{-1}$) as compared to carcass sample from HU retail shop (4.80 $\log_{10}$ $cfug^{-1}$) and also higher for beef samples from Dire Dawa slaughterhouse (1.13 $\log_{10}$ $cfug^{-1}$) but there was no fecal coliforms in Dire Dawa retail shops. This difference was statistically significant between both slaughterhouses and retail shops ($p \leq 0.01$).

The prevalence of coliforms was much lower than that of any other microorganism studied. Of the 290 beef samples tested, 11 (3.79%) were positive for FCCs and the microorganism were detected at both processing stage. The concentration of fecal coliforms enumerated from beef (3.57 $\log_{10}$ $cfug^{-1}$) was higher than established limits (10 to 100 $cfug^{-1}$) in guidelines (Alvarez-Astorga et al., 2002) which is assumed to be an indicator of fecal contamination. The result showed that only one sample from HU retail shop had count of 6.10 $\log_{10}$ cfu/cm^2 in knives and hooks, while too few to count in cutting boards, balance and personnel hands and 6.91 $\log_{10}$ cfu/cm^2 in vehicle from Dire Dawa slaughterhouse. The overall mean of total aerobic bacteria count in retail shops environment was 3.05 $\log_{10}$ cfu/cm^2 and 5.73 $\log_{10}$ cfu/cm^2 in Dire Dawa slaughterhouse. Furthermore, the result showed that there was significant ($P \leq 0.01$) variation in the means of total aerobic bacteria found in knives and hooks and different meat contact surfaces in retail shops and slaughterhouse.

From the data of retail meats it was evident that the highest FCCs (6.26 $\log_{10}$ cfu/cm^2) levels were found in the cutting boards at Dire Dawa retail shop. Cutting board from HU retail shop got the smallest values of FCCs (4.78 $\log_{10}$ cfu/cm^2) and in HU slaughterhouse was too few to count from knives and hooks, surface, vehicle and workers' hands (Table 5). Based on the data, the highest FCCs (5.87 $\log_{10}$ cfu/cm^2) and APCs (5.73 $\log_{10}$ cfu/cm^2) levels found in the transporting vehicle from Dire Dawa slaughterhouse while the smallest values of FCCs (4.32 $\log_{10}$ cfu/cm^2) found in workers hand in Dire Dawa slaughterhouse and APCs was found too few to count in both slaughterhouses (Table 5). The findings of this study indicated that meat contact surfaces might be real risks associated with the persistence of hazardous organisms. Similar findings were reported by Gill and McGinnis (2004) and Temelli et al. (2006). Based on European commission standards used in the food processing industry; a standard of less than 1.3 $\log_{10}$ cfu was used for aerobic plate count, less than 1.0 $\log_{10}$ cfu for Enterobacteriaceae count. According to this standard, the results of average mean of APCs and FCCs in our study for food contact surfaces were 4.39 and 5.29 $\log_{10}$ cfu, respectively, which was unacceptable (Sneed et al., 2004).

In the present study, it was found that all of the meat establishments had pathogenic and indicator bacteria. The findings showed the magnitude of contamination at slaughterhouses and retail shops was high. This may contribute to the incidence of food associated illnesses. In this study, the identification of thermo-tolerant *E. coli* showed the presence of recent fecal contamination (Collee and Mackie, 1999). Hence, basic failures occur in the sanitization procedures applied to these utensils, since the establishments were found not to apply the cleaning process on a daily basis. The knives used for filleting and cutting were not sanitized at any of the retail houses visited. Neither the slaughterhouse, nor any of the platforms (bleeding, evisceration and inspection line) adopted the practice of immersing knives in hot water.

In both slaughterhouses, personnel interviewed to assess the hygienic conditions in the slaughterhouse responded that there was adequate potable water supply in the slaughterhouse. However, there is no hot water supply in all meat processing facilities. In both slaughterhouses, there were no facilities for knife sterilization and no rooms for retention of conditionally approved carcasses. Regarding latrine facility, both slaughterhouses had communal latrine which was properly placed but with poor management. There were no enough water supplies as a result, flies infestation of the facilities were observed. Hand washing is an essential component of infection control (Larson et al., 2003). In general, both abattoirs have no mechanism of ensuring sanitation standards, proper waste disposal mechanism and vermin's and scavenger's protection mechanisms. Therefore, there are opportunities of contamination of slaughter facilities which in turn contaminate the exposed tissues of the carcass with microorganisms.

The adequacy of a cleaning program is judged on the basis of the adherence to specified standard operating procedures during the cleaning and disinfection process and the inspection of cleaned facilities and equipment (Gill et al., 1999). Gill et al. (1999) further reports that improperly cleaned equipment have been implicated in outbreaks of foodborne diseases and it is therefore apparent that cleaning and disinfecting processes should fully comply with regulations. Gill and McGinnis (2000) reported that a primary source of *E. coli* deposited on meat during processing appears to be the detritus in equipment which was not removed during daily cleaning.

Assessment on the procedures and frequency of cleaning and disinfection of the equipment in both slaughterhouses are important and the result indicated that, the procedures of cleaning and disinfection of the surface, a notably low percentage (35.7%) in Dire Dawa slaughterhouse and high percentage in HU slaughterhouse (68.2%) of respondents indicated that running water and detergent was used to clean the surfaces. whereas majority of them cleaned their knives whenever they were excessively and visibly soiled with fat or blood before the commencement of work each day. About seventy eight percent of the respondents in Dire Dawa slaughterhouse and ninety five percent in HU slaughterhouse practiced washing their knife with soap and water. The respondents were also questioned on the frequency of cleaning and disinfection of the working surfaces. All (100%) respondents in Dire Dawa and 90.9% in HU slaughterhouse reported that the surfaces were cleaned before the commencement of work each day.

Upon visual observation, the knives used for filleting and cutting were not sanitized at any of the meat retail establishments visited in both study areas. In the slaughterhouse, any of the platforms (bleeding, evisceration and inspection line) did not adopt the practice of immersing knives in hot water. As for the meat hooks for hanging carcasses, most of them were splashing with water and some were not cleaned prior to use and most importantly the floor and surface of transporting vehicles were regularly cleaned with detergent and water but re-contaminated with workers gum boot and in contact with the meat during loading. In both slaughterhouses interview showed that washing of the hand before starting slaughter is not common but after the end of processing hand washing were conducted without the use of hot water and soap. In addition to the frequency, the procedure of hand-washing is also considered important. The proportion of individuals that indicated following the correct procedure of using detergents and water for lathering and rinsing was 96.4% in Dire Dawa slaughterhouse and 77.3% in HU slaughterhouse. Regarding the availability of soap, all of the respondents indicated that soap was not always available.

In the current study, 92.9% of the interviewees in Dire Dawa slaughterhouse and all (100%) of the interviewees in HU slaughterhouse responded that no sanitary regulation system was in place in the slaughterhouse in Table 7. Therefore, effective food safety and quality control programs are essential. The behavior of worker and hygienic practices of retail shop in HU was relatively good as compared to Dire Dawa retails shop, and meat handlers do not have close contact with money and they do so only when cutting and weighing the meat. To get rid of germs and dirt, it is important to wash hands properly and frequently with detergents and warm water. Hands that have long nails are more difficult to clean thoroughly and can collect small pieces of debris and bacteria that do not wash off easily (Trickett, 1997).

All the respondents in both slaughterhouses were employed on a temporary basis which makes it difficult to train the staffs. When assessment on the literacy level, the personnel working on food establishment in both areas, 98% of butcher men attend school and 14% of respondent are obtained their skills from their parents, while 80% of the respondents taught themselves through visual observation and 10.7% of respondent in Dire Dawa gained skill through formal training. Training and education of food handlers regarding the basic concepts and requirements of personal hygiene plays an integral part in ensuring a safe product to the consumer (Adams and Moss, 1997). To ensure this, there should be some form of induction training with regular updating and refresher courses for the food handlers. Meat handlers should furthermore understand the risks associated with contamination of food by microbial agents, and should be trained to avoid the contamination of the meat. A formal employee training and assistance program that describes all the training activities should be made attractive to the meat handlers (CFIA, 1990). Ryser and Marth (1991) conclude that the training and education should be directed towards a thorough understanding of food hygiene, which includes aspects of sanitation.

The result from meat handler indicated that 46.4% in Dire Dawa and 13.6% in HU smoke cigarette when they carry out their task. Smoking inside the slaughterhouse or whenever meat is handled should be prohibited, because whenever a cigarette is handled the fingers come into contact with the lips and saliva, together with microorganisms, may consequently be transferred from the hands to the food (Burton, 1996). Smoking may furthermore cause coughing, thus transferring aerosols containing microorganisms to the food (Gordon-Davis, 1998). Moreover 42% of the respondent in both slaughterhouses had worn jewelry materials. Jewelry is a potential source of microorganisms, because the skin under the jewelry provides a favorable habitat for contaminating microorganisms to proliferate (Trickett, 1997).

Regarding protective cloth, the personnel observation and assessment result in both slaughterhouses indicated that, almost all of the food handlers had a uniform protective cloth. However; minimal personal hygiene was practiced during food preparation. Van Zyl (1995) gave emphasis to protective clothing which should not only be on protection, but also on cleanliness, thus he proposed that the overalls, hairnets (beard nets if applicable), hard hats, gum boots and aprons should at all times be worn by meat handlers. Because the purpose of wearing overalls is to protect both the food product and the meat

Table 7. Hygienic and sanitation practices employed at Dire Dawa and HU slaughterhouses and retail shops.

Practices	Dire Dawa (%)	HU (%)
Cleaning and disinfection of knives and hooks		
Before the commencement of work	28(100)	21(95.5)
When excessively and visibly soiled	-	1(4.5)
Manner of cleaning and disinfection		
Using detergents and water	22(78.6)	21(95.5)
Rinsing with water only	6(21.4)	1 (4.5)
Floor Surface cleaning and disinfection		
Before commencement of work	28(100)	20(90.9)
When excessively and visibly soiled	-	1(4.55)
After commencement of work	-	1(4.55)
Manner of cleaning and disinfection of surface		
Using detergents and water	10(35.7)	15(68.2)
Rinsing with water only	18(64.3)	7(31.8)
Hand washing before starting handling raw meat		
Yes	28(100)	22(100)
Manner of hand washing		
Using detergents and water	27(96.4)	17(77.3)
Rinsing with water only	1(3.6)	5(22.7)
Presence of sanitary regulatory system		
Yes	2(7.1)	0
No	26(92.9)	22(100)

$p \leq 0.01$, df= 1

Table 8. Educational status of meat handler's

Skills	DD slaughterhouse frequency (%)	HU slaughterhouse frequency (%)
Educational status		
None	0	1(4.55)
Elementary/junior	11(39.3)	13(59.1)
High school	12(42.9)	7(31.8)
College	4(14.3)	1(4.55)
Graduate	1(3.6)	
Sources of meat processing skills		
Observation	21(75)	19(86.4)
Parents	4(14.3)	3(13.6)
Formal training	3(10.7)	0

$P \leq 0.001$, df= 4

Table 9. Practices of the meat handlers regarding prohibited habits and actions.

Prohibited habits	Dire Dawa (%)	HU (%)
Jewelry		
Worn	19(67.9)	2(9.1)
Not worn	9(32.1)	20(90.9)
Finger nails		
Short and polished	22(78.6)	15(68.2)
Short/ not polished	6(21.4)	5(22.7)
Long and polished		2(9.1)
Smoking in meat processing plants		
Yes	13(46.4)	3(13.6)
No	15(53.6)	19(86.4)
Hair cover		
Used	24(85.7)	14(63.6)
Not covered	4(14.3)	8(36.4)
Gum boots		
Used	18(64.3)	22(100)
Not used	10(35.7)	0

$P \leq 0.01$, df= 1

handler from cross-contamination, overalls should be suitable to wear over other clothing (CFIA, 1990).

The clean gum boots are just as important as clean overalls, because they may also be a source of contamination. Gum boots should therefore be washed at the facility provided (washing-basins supplied with hot and cold water, liquid soap and a brush) before entering the processing room (Van Zyl, 1995). The purpose of hairnets and beard nets is twofold: to prevent loose hairs and dandruff from falling into the food and also to discourage the workers from running their fingers through their hair or scratching their scalps (Educational Foundation, 1992; Pelczar et al., 1993).

CONCLUSION AND RECOMMENDATIONS

The results obtained from this study showed that contamination sources of beef are more likely to be associated with insufficient hygienic practices and improper handling of meat in the slaughterhouse and retail shops. Floor surface, cutting boards, hooks and knives, workers hands and transporting vehicle in slaughterhouses as well as, in retail shops, are potential sources of beef contamination.

The overall prevalence of *E. coli*, *E. coli* O157:H7 and *Salmonella* were 36 (12.4%), 6 (2.06%) and 8 (2.75%) which indicated that slaughterhouses and retail shops in HU and Dire Dawa could be the source of contamination of beef. HU and Dire Dawa slaughterhouses and retail shops are not well structured and the working habits in the slaughterhouse are not good enough to satisfy an acceptable hygienic standard practice for slaughtering and processing of beef for human consumption. The study suggested that beef could be a significant source of foodborne pathogens for people in the study areas.

Based on the findings of the present study, the following recommendations are forwarded in order to guarantee the microbial quality of beef and minimize the risk of *E. coli* O157:H7 and *Salmonellosis* outbreak in Dire Dawa and Haramaya University and its surrounding areas.

1. Haramaya University should open the newly constructed slaughterhouses that can improve slaughtering and processing of beef for human consumption and Dire Dawa administrative city authorities should improve their supervision of slaughterhouse workers.
2. Periodic sanitary-hygienic evaluation and inspection of

abattoirs and beef meat retail establishments should be implemented and Health authorities need to enforce legislative requirements and periodic monitoring aimed at insuring the proper slaughtering process and sanitary-hygienic standards. Failure to meet these requirements should result in enforcement action against premises, and this should ultimately lead to prosecution and suspension and/or revocation of their license to operate.

3. Good manufacturing practice and good hygienic practice, together with stringent control of all aspects of meat production, preparation, storage and distribution should be put in place in food establishment in order to reduce contamination of *Salmonella* and other foodborne pathogens to acceptable limit.

4. Training to meat handlers regarding stunning process, food safety and good hygienic practices should be given especially in Haramaya University slaughter house as all workers who had no formal trainings.

CONFLICT OF INTERESTS

The author has not declared any conflict of interest.

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REFERENCES

Activity Based Management (ABM) (2008). Standards for Abattoir, Cutting and Packing Plant. Version 4.0 January, 2008 Northern Ireland.

Adams MR, Moss MO (1997). Food Microbiol. Cambridge: The R Soc Chem. pp. 200-213.

Adu-Gyamfi A, Torgby-Tetteh W and Appiah V (2012). Microbiological quality of chicken sold in Accra and determination of D10-Value of *E. coli*. Food Nutr. Sci. 3(5):693-698.

Alemseged F, Yami A, Birke W, S/Mariam Z and Worku K (2009). Investigation of Dysentery outbreak and Its causes, Jimma City South west, Ethiopia. Ethiop. J. Health Sci. 19(3):147-154.

Alvarez-Astorga M, Capita R, Alonso-Calleja C, Moreno B, Del M and Garcia-Fernandez C (2002). Microbiological quality of retail chicken by-products in Spain. Meat Sci. 62(1):45-50.

Asrat GT, Berhan T, Solomon M (2008). Inclusion of Different Proportions of Poultry Litter in the Rations of Yearling Hararghe Highland goats. Livest. Res. Rural Dev. 20:48.

Bayleyegn M, Daniel A, Woubit S (2003). Sources and distribution of *Salmonella* serotypes isolated from food animals, slaughterhouse personnel and retail meat products in Ethiopia. Ethiop J. Health Dev. 17:63-70.

Bhandare S, Sherikarv A, Paturkar A, Waskar V, Zende R (2007). A comparison of microbial contamination on sheep/goat carcasses in a modern Indian abattoir and traditional meat shops. Food Control 18: 854-868.

Brown MH, Gill CO, Hollingsworth J, Nickelson R, Seward S, Sheridan JJ (2000). The role of microbiological testing in systems for assuring the safety of beef. Int. J. Food Microbiol. 62:7-16.

Burton GR (1996). Microbiology for the health sciences (4th ed.). New York: Lippencott. pp. 234-239.

Canadian Food Inspection Agency (CFIA) (1990). Meat hygiene manual of procedures, Canada. Available at: http://www.inspection.gc.ca/food/meat-and-poultry-products/manual-of-procedures/eng/1300125426052/1300125482318.

Centers for Disease Control and Prevention (CDC) (2013). FoodNet: Incidence and Trends in Foodborne Illness.

Central of Statistics Agency (CSA) (2007). Agricultural sample survey 2006/07(1999 EC). Report on livestock and livestock characteristics (private peasant holdings), CSA, Addis Ababa, Ethiopia.

Chapman PA, Siddons CA, Cerdan Malo AT, Harkin MA (2000). A one year study of *E. coli* O157 in raw beef and lamb products. Epidemiol. Infect. 124:207-213.

Chhabra MB, Singla LD (2009). Food-borne parasitic zoonoses in India: Review of recent reports of human infections. J. Vet. Parasitol. 23(2):103-110.

Collee JG, Mackie TJ (1999). *Practical Medical Microbiology*. 14th ed Churchill living stone. pp 883-884, 898-907.

Desenclos JC, Zergabachew A, Desmoulins B, Chouteau L, Desve G (1988). Clinical, microbiological and antibiotic susceptibility patterns of diarrhoea in Korem, Ethiopia. J. Trop. Med. Hyg. 91:296-301.

Desmarchelier PM, Higgs GM, Mills L, Sullivan AM, Vanderlinde PB (1999). Incidence of coagulase positive *Staphylococcus* on beef carcasses in three Australian abattoirs. Int. J. Food Microbiol. 47:221-229.

Diane GN, Marion K, Linda V, Erwin D, Awa AK, Hein S, Marieke O, Merel L, John T, Flemming S, Koke V-DG, Hild K (2010). Foodborne diseases. Int. J. Food Microbiol. 139:s3-s15.

Doyle ME (2007). Microbial food spoilage – Losses and control strategies, (A brief review of the Literature), FRI Briefings. Available at: www.wisc.edu/fri/

Duffy EA, Belk KE, Sofos JN, LeValley SB, Kain ML, Tatum JD, Smith GC, Kimberling CV (2001). Microbial contamination occurring on lamb carcasses processed in the United States. J. Food Prot. 64 (4):503-508.

Educational Foundation of the National Restaurant Association (1992). Applied food service sanitation (4th ed.). Canada: John Wiley and Sons. pp: 44-45.

Ejeta G, Molla B, Alemayehu D, Muckle A (2004). *Salmonella* serotypes isolated from minced meat beef, mutton and pork in Addis Ababa, Ethiopia. Revue Méd. Vét. 11:547-551.

Evans JA, Russell SL, James C, Corry JE (2004). Microbiological contamination of food refrigeration equipment. J. Food Eng. 62:225-232.

Fawole MO, Oso BA (2001). *Laboratory manual of microbiology*: Revised edition. Ibadan: Spectrum books Ltd. P 127.

FDA (Food and Drug Authority) (1992). Bacteriological Analytical Manual. 7th Ed. AOAC international 2200 Wilson Blvd, Suite 400, Arlington, VA. Available at: ttp://www.fda.gov/Food/FoodScienceResearch/LaboratoryMethods/ucm2006949.htm.

Fegan N, Vanderlinde P, Higgs G, Desmarchelier P (2004). Quantification and prevalence of *Salmonella* in beef cattle presenting at slaughter, J. Appl. Microbiol. 97:892-898.

Fratamico PA, Bhunia AK, Smith JL (2005). Foodborne Pathogens: Microbiology and Molecular Biology, Caister Academic Press, Wymondham, Norfolk, UK. P 273.

Gill CO (2007). Sampling of red meat. In Microbiological Analysis of red meat, poultry and egg, Mead, G.C. (editor). Cambridge, England; Woodhead Publishing Limited. pp. 132-135.

Gill CO, Mcginnis JC (2004). Microbiological conditions of air knives before and after maintenance at a beef packing plant. Meat Sci. 68:333-337.

Gill CO, Badoni M, McGinnis JC (1999). Assessment of the adequacy of cleaning of equipment used for breaking beef carcasses. Int. J. Food

Microbiol. 46:18.
Gill CO, Bryant J, Brereton DA (2000). Microbiological conditions of sheep carcasses from conventional or inverted dressing processes. J. Food Prot. 63(9):1291-1294.
Gordon-Davis L (1998). The hospitality industry handbook on hygiene and safety: for South African students and practitioners. Kenwyn: Juta publication. pp. 49-65
Haque MA, Siddique MP, Habib MA, Sarkar V, Chou KA (2008). Evaluation of sanitary quality of goat meat obtained from slaughter yards and meat stalls at late market hours. Bangl. J. Vet. Med. 6(1):87-92.
Hassan AN, Farooqui A, Khan A, Khan Y, Kazmi SU (2010). Microbial contamination of raw meat and its environment in retail shops in Karachi, Pakistan. J. Infect. Dev. Ctries. 4(6):382-388.
Haymanot T, Alemseged A, Getenet B, Solomon GS (2010). Microbial flora and foodborne pathogens on minced meat and their susceptibility to antimicrobial agents Jimma city, Ethiopia. Ethiop. J. Health Sci. 20(3):137-143.
Hiko A, Asrat D, Zewde G (2008). Occurrence of *E. coli* O157:H7 in retail raw meat products in Ethiopia. J. Infect Dev. Ctries. 2:389-393.
ICMSF (International Commission on Microbiological Specifications for Foods) (1986). Microorganisms in Foods 2. Sampling for microbiological analysis: Principle and specific application, (2nd ed.) Blackwell Scientific Publications. UK. pp. 132-136.
ISO (International Organization for Standardization)/TS 11133-1 (2009). Microbiology of food and animal feeding stuffs. *Guidelines on preparation and production of culture media*. Part 1: General guidelines on quality assurance for the preparation of culture media in the laboratory.
ISO (International Organization for Standardization)-16654 (2001). Microbiology of food and animal feeding stuffs. Horizontal method for the detection of *E. coli* O157:H7.
ISO (International Organization for Standardization)-4333 (2003). A horizontal method for the enumeration of microorganisms by counting the colonies growing in solid medium after aerobic culturing of aerobic bacteria.
ISO (International Organization for Standardization)-6579 (2002). Microbiology-General guidance on methods for the detection of *Salmonella,* 4rd ed International Organization for Standardization, Geneva.
Larson E, Aiello A, Lee LV, Della-Latta P, Gomez-Duarte C, Lin S (2003). Short and long term effects of hand washing with antimicrobial or plain soap in the community. J. Commun. Health 28(2):139-150.
Luga I, Akombo PM, Kwaga JKP, Umoh VJ and Ajogi I (2007). Sero-prevalence of Faecal Shedding of *E. coli* O157:H7 from Exotic Dairy Cattle in North-Western Nigeria. Niger. Vet. J. 28:6-11.
Mache A, Mengistu Y, Cowley S (1997). *Salmonella* sero groups identified from adult diarrheal out-patients in Addis Ababa, Ethiopia: Antibiotic resistance and plasmid profile analysis. East Afr. Med. J. 74:183-187.
Mekonnen H, Habtamu T, Kelali A, Shewit K (2012). Food safety knowledge and practices of abattoir and butchery shops and the microbial profile of meat in Mekelle City, Ethiopia. Asian Pac. J. Trop. Biomed. 12:952-957.
Mersha G, Asrat D, Zewde BM, Kyule M (2009). Occurrence of *E. coli* O157:H7 in faeces, skin and carcasses from sheep and goats in Ethiopia. Lett. Appl. Microbiol. 50:71-76.
Molla B, Kleer J, Sinell HJ (2000). Occurrence, distribution and level of *Salmonella* in selected food items in Addis Ababa, Ethiopia. Fleischwirt Int. 4:37-39.
Mukhopadhyay HK, Pillai RM, Pal UK, Kumar VJA (2009). Microbial quality of fresh chevon and beef in retail Outlets of pondicherry. Tamilnadu J. Vet. Anim. Sci. 5 (1):33-36.
Pelczar MJ, Chan ECS, Krieg NR (1993). *Microbiology, concepts and applications*. New York: McGraw-Hill. pp. 80-100, 158-161, 370.
Podpecan B, Pengov A, Vadnjal S (2007). The source of contamination of ground meat for production of meat products with bacteria *Staphylococcus aureus*. Slov. Vet. Res. 44:25-30.
Pointon A, Sexton M, Dowsett P, Saputra T, Kiermeier A, Lorimer M, Holds G, Arnold G, Davos D, Combs B, Fabiansson S, Raven G, McKenzie H, Chapman A, Sumner J (2008). A baseline survey of the microbiological quality of chicken portions and carcasses at retail in two Australian states (2005 to 2006). J. Food Prot. 71(6):1123-1134.
Ryser ET, Marth EH (1991). Listeria, Listeriosis, and food safety. New York: Marcel Dekker. pp. 183-189.
Sefinew A, Bayleyegn M (2012). Prevalence and antimicrobial resistance profiles of *Salmonella* enteric serovars isolated from slaughtered cattle in Bahir Dar, Ethiopia. Trop. Anim. Health Prod. 44:595-600.
Sibhat B, Molla B, Zerihun A, Muckle A, Cole L, Boerlin P, Wilkie E, Perets A, Mistry K, Gebreyes WA (2011). *Salmonella* serovars and antimicrobial resistance profiles in beef cattle, slaughterhouse personnel and slaughterhouse environment in Ethiopia. Zoonoses Public Health 58:102-109.
Sneed J, Strohbehn C, Gilmore AS, Mendonca A (2004). Microbiological evaluation of food service contact surfaces in Iowa assisted living facilities. J. Am. Diet. Assoc. 104:1722-1724.
Sousa CP (2008). The Impact of Food Manufacturing Practices on Foodborne Diseases. Braz. Arch. Biol. Technol. 51(4):815-823.
Taye M, Berhanu T, Berhanu Y, Tamiru F, Terefe D (2013). Study on carcass contaminating *E. coli* in apparently healthy slaughtered cattle in Haramaya University slaughter house with special emphasis on *E. coli* O157:H7, Ethiopia. J. Vet. Sci. Technol. 4:132.
Tegegne M, Ashenafi M (1998). Microbial load and incidence of *Salmonella* species in kitfo", traditional Ethiopian spiced, minced meat dish. Ethiop. J. Health Dev. 12:135-140.
Temelli S, Dokuzlu C, Cemsen MK (2006). Determination of microbiological contamination sources during frozen snail meat processing stages. Food Control 17:22-29.
Thrusfield M (2007). Veterinary Epidemiology, 3rd Edition. Blackwell Science, UK. P 332.
Timothy M, Smith JR (2012). Isolation, Identification, and Enumeration of Pathogenic *Salmonella* Serovars from Environmental Waters. J. Food Prot. 76(7):2-251.
Trickett J (1997). Food hygiene for food handlers. London: Macmillan Press. pp. 19-27.
Van Zyl AP (1995). Manual for the abattoir industry (1st ed.). Pretoria: Red Meat Abattoir Association. pp. 123-156.
WHO (World Health Organization) (2007). Food safety and foodborne diseases and value chain management for food safety. "Forging links between Agriculture and Health" CGIAR on Agriculture and Health Meeting in WHO/HQ.
Wilson I (2002). *Salmonella* and *Campylobacter* contamination of raw retail chickens from different producers: a six year survey. Epidemiol. Infect. 129:635-645.
Zewdu E, Cornelius P (2009). Antimicrobial resistance pattern of *Salmonella* serotypes isolated from food items and personnel in Addis Ababa, Ethiopia. Trop. Anim. Health Prod 41:241-249.

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Prevalence and risk factors associated to skin diseases in small ruminants in Gamo Gofa zone, south-Western Ethiopia

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A cross-sectional study was employed to estimate the prevalence of skin diseases in small ruminant and risk factors associated to its occurrence in Gamo Gofa zone from July, 2012 to April, 2014. The study areas were clustered into two agro-ecological zones; lowland and highland area. A total of nine hundred (450 sheep and 450 goats) were examined. Detailed physical examinations and systemic examinations, followed by skin scraping and laboratory tests were carried out to diagnose skin diseases. The Pearson's chi-square (χ^2) test was used to assess the degree of association between skin diseases and risk factors. The overall prevalence was found to be 42.33% (381/900). Significantly higher prevalence (p<0.05) of small ruminant skin disease was observed in goats (52.22%) than sheep (38.66%). Furthermore, the study also revealed significantly higher prevalence (p<0.05) in unvaccinated (42.92%) than vaccinated (29.52%) group of animals. The occurrence of skin diseases was statistically significantly associated with age and sex of animals. The prevalence was higher in males (30.38%) than females (22.49%), and in young age groups as compared to adults. The external parasites identified include manges (Sarcoptic, Chorioptic, Psoroptic and Demodectic), ticks (*Ambyloma varigatum, Rhipicephalus evertisi evertisi* and *Boophilus decloratus*), lice (*Bovicola* species and *Linognathus* species) and sheep ked (*Melophagus ovinus*). Viral infections, predominantly of pox virus infection were noted in sheep (10.44%) and goat (13.11%) and contagious ecthyma 2.44% on sheep and 2.00% on goats. The overall prevalence of viral disease showed significant association (p<0.05) with vaccination history and age of the study animals. The high prevalence of skin disease on small ruminant has shown there is urgent need for its strategic prevention and control, as skin and hides represent the second major export commodity of the country. It is recommended that external parasite control should be strategically designed and technologically verified in local context.

Key words: Ethiopia, external parasites, Gamo Gofa, goat, sheep, prevalence.

INTRODUCTION

Small ruminants contribute 35 and 14% of meat and milk consumption, respectively in Ethiopia (Kebede, 2013).

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Hide and skin export has got the largest share of animal products next to live animal export and skin is the most important item in generating foreign currency, next to coffee (Kumsa et al., 2012). Ethiopia supplies a wide range of both processed and semi-processed sheep and goat skins to the world market (Kebede, 2013). Whereas hides and skins account for 12 to 16% of the total value exports in Ethiopia (Tefera, 2012). The current utilization of hides and skins is estimated to be 48% for cattle hide, 75% for goat skin and 97% for sheep skin with the expected off take rate of 33% and 75% for sheep, goat and cattle, respectively (Berhe, 2009; Yacob et al., 2008 and Tefera, 2012). In Ethiopia, hides, skins, leather and leather products are the most widely traded agro-based livestock commodities with an estimated value of over US$100 billion/year and continues to conspicuously exhibit a huge unexplored potential (Mekonnen et al., 2013). Even though small ruminants are important components of Ethiopian farming system, their contribution to food production, rural income and export income are far below the expected potential (Mekonnen et al., 2013). This is because small ruminant production not only in Ethiopia but in most of the developing countries is constrained by complemented effects of prevailing diseases, subclinical parasitism, poor feeding and managements (Abadi, 2000; Singla, 1995; Tefera, 2012; Yacob et al., 2008; Yacob, 2013). Over the last 10 years, there are indications that the quality of raw material has deteriorated with an increasing number of reject grades and the appearance of skin diseases like "*Ekek or cockle*" that is mainly due to sheep ked and lice infestation (Assefa et al., 2011). The low quality of skins undermines the competitiveness of the industry, as it leads to low factor inputs productivity especially in the tanning process (Mekonnen et al., 2013).

Among the diseases of small ruminant skins, infestations by mange mites, ticks and infections by pox disease and dermatophilosis possess considerable economic losses, particularly to the skin export due to various defects (Dessie et al., 2010). Losses from these diseases and other skin abnormalities are leading to downgrading and rejections of skins; unfitness to the leather industries (Kebede, 2013; Kumsa et al., 2012). Skin diseases in small ruminants were reported from different parts in Ethiopia. Kumsa et al. (2012) reported the prevalence of 48.1% in central Ethiopia, Dessie et al. (2010) reported a mange mites prevalence in Wolaita area of southern Ethiopia 1.98 and 3.85% in sheep and goats, respectively. A study of tick infestation in small ruminants in Bedelle district, Western Ethiopia, revealed prevalence of 66.12 and 80.7% in goats and sheep, respectively reported by Fufa et al. (2012). Many other studies and reviews conducted at different regions of the country reported the importance of small ruminant's skin diseases (Kebede, 2013; Yacob, 2013; Assefa et al., 2012; Tewodros et al., 2012; Dessie et al., 2010; Yacob et al., 2008; Tefera, 2012; Haffiz, 2001; Abadi, 2000). Despite various study on the prevalence and associated risk factors in different parts of the country, it is not known in Gamo Gofa zone of Southern Ethiopia. Furthermore, this area is known to border with the major pastoral livestock production area of South Omo zone, and serving as a route of market from the lowland pastoral production areas to the highland meat value chain areas of highland markets. In due concern to the above facts, and to seek as whether there is need and/or serve as baseline information, this study was initiated. The objectives were to estimate the prevalence and assess associated risk factors of skin diseases, and to determine the etiological agents of skin diseases in small ruminants.

MATERIALS AND METHODS

Study area

The study was conducted on three districts, categorized into two agro-ecological zones, namely Demba Gofa and Zala district, representing lowland, and Geze Gofa district for highland. Lowland categories were areas ranging from 800 to 1500 meter above sea level (masl) but those ranging from 1500 to 2800 masl were considered as highland. The average annual rainfall of the study areas were varying from 950 to 1150 mm, characterized by a bi-modal type of distribution. The mean annual minimum and maximum temperature were 15.4°C and 37.2°C in the highland and lowland, respectively.

Study animals

The study population animals were extensively managed, almost all are reared in mixed species herd type as an individually owned herd or a group based. A total of 900 small ruminants (450 goats and 450 sheep) were sampled with systematic random sampling. Ages of animals were addressed in two category, young (below 2 years) and adult (above 2 years) of age according to (Bersisa et al., 2013; Gatenby, 1999). The body condition score (BCS) was considered in three categories, poor (BCS of 1 and 2), medium (BCS of 3) and good (BCS of 4 and 5) according to Desta et al. (2001) and Tefera (2012).

Sampling method and sample size

Study districts were selected purposively to represent different agro-ecology and accessibility whereas study Peasant Associations (PA) was randomly selected. 10% of shoat herds were selected from each PA's and individual animals were selected from the population by systematic random sampling approach. The sample size was determined according to Thrusfield, 1995, with expected prevalence of 50%, as there were no such study in the area and 95% confidence interval was considered. Despite this, the calculated sample size was 380, it was increased to 450 from each species and a total of 900 animals were included in the study.

Study designs

A cross-sectional study design was employed to estimate the prevalence of skin diseases and identify the causal factors for different skin diseases of small ruminants. The age, sex, species, body condition scoring, geographical location, season of the year and vaccination were considered as test variables to see if these were risk factors associated with disease occurrence or not. Animals with visible skin problems suspected for bacterial and fungal infections were subjected to skin scrapings. Both skin scrapings and visible external parasites such as ticks, sheep ked and lice were shifted to universal sampling bottle, labelled, preserved and transported to Gofa Universal college department of animal health for species identifications and subsequent laboratory confirmation. 70% ethyl alcohol or 10% formalin were used to preserve adult external parasites recovered and 10% potassium hydroxide (KOH) was used as a cleaning agent for skin scrapings. Species identification and laboratory test on skin scraping was conducted according to Soulsby (1982) and Urquhart et al. (1996).

Sample collection and identification of etiological agents

Physical inspection was conducted to assess the presence of external parasites and gross skin lesions, followed by palpation of all parts of the body. External parasites, sheep keds, ticks and lice were manually collected using tissue forceps and identified under stereomicroscope according to the morphological keys described by (Soulsby, 1982; Urquhart et al., 1996; Taylor et al., 2007). Skin scrapings were collected when suspected for mange mites, fungal and bacteriological lesions. This was done by clipping the hair around the lesion, scrapping the edges of lesions with scalpel blade until capillary oozing was evident (Bersisa et al., 2013; Urquhart et al., 1996). The scrapped materials were either directly shifted to clean microscopic slide or container for laboratory examination. A few drops of 10% potassium hydroxide (KOH) was added to skin scrapings and allowed to stand to 24 h until the time of examination under 4x, 10x, and 40x magnifications of light microscope (Bersisa et al., 2013). Laboratory tests were limited only to bacteriological, fungal and parasitological examinations (arachino-entomology). Skin scrapings suspected for bacterial infections were handled aseptically in clean and disinfected sampling bottles and test tubes. Gram staining was the principal bacteriological test conducted for samples suspected for Dermatophilosis and Giemsa staining was used to test fungal pathogens suspected. Viral diseases like sheep and goat pox (SGP) and contagious ecthyma were tentatively diagnosed on the bases of field level physical clinical examinations.

Data management and statistical analysis

The data entered into Microsoft excel spreadsheet, imported to statistical software for social science (SPSS) version 20.0 for windows. Descriptive statics such as tables, graphics, averages and percentages were used to summarize and present the results of the collected data. The Pearson's chi-square (χ^2) test was used to assess the degree of association between skin diseases with the various risk factors. In all cases, 95% confidence interval (CI) and 5% absolute precision was used for statistical analysis.For all conditions, a p-value of less than 0.05 ($p < 0.05$) was taken as significant association.

RESULTS

Prevalence of skin diseases

Animal was classified as positive to skin disease if it has at least one of the clinical abnormalities associated to skin disease or is infested with an external parasite. The overall prevalence of skin diseases in small ruminants was found to be 42.33% (381/900). On species bases, the prevalence was 52.22 and 38.66% in goats and sheep, respectively. Small ruminants from lowland agro-ecology revealed higher prevalence (43.43%) of skin diseases than the highland (37.85%) (Tables 1 and 2).

On species bases, statistically significant (p=0.026) variation in prevalence of skin disease was observed on goats 235 (52.22%) than sheep population 174 (38.66%). Except at Geze Gofa district, in which comparatively larger sheep populations manifested skin disease 52 (48.6%). In the rest two districts, higher prevalence was seen on goat population than sheep populations (Table 2).

On age bases, there is statistically significant (p=0.003) difference on prevalence of skin diseases in young and adult small ruminants. Greater prevalence was recorded in young age groups as compared to adults (Table 3). Whereas, there were no statistically significant difference in the occurrence of skin diseases in small ruminants on sex bases (Table 4), body condition scores and season of the year (Table 6). On the bases of vaccination history, there was statistically significant difference (p=0.000) on occurrence of skin diseases in the study area. The study revealed higher prevalence of skin diseases, 61.45% in unvaccinated small ruminants as compared to vaccinated ones, 23.96 % (Table 5).

Prevalence of external parasites

The study revealed significantly higher prevalence of external parasites ($p<0.05$) in goat population than sheep population. Furthermore, the study also revealed significantly higher prevalence ($p<0.05$) of external parasite infestation in males (30.38%) than in females (22.49%). When external parasite infestation was calculated, in goats: 78 (43.33%), 57 (28.50%) and 9 (12.85%) were infested at Demba Gofa, Zala and Geze Gofa Woredas, respectively. However, the prevalence of external parasites in goats was not showing statistically significant difference ($P>0.05$) among the three Woredas (Table 7). The current study also revealed the external parasite prevalence of 34 (17.62%), 27 (18.00%) and 32 (29.90%), respectively on sheep population from Demba Gofa, Zala and Geze Gofa Woredas. However, there was no statistically significant difference ($P>0.05$) in prevalence of external parasites of sheep among the three Woredas of Gamo Gofa zone (Table 8). In infested goats, the predominant external parasite identified was tick species (*Ambyloma varigatum*, *Boophilus decoloratus* and *Rhipicephalus evertisi evertisi*) accounted to be 23 (12.77%), 22 (11.00%) and 2 (2.85%), respectively at Demba Gofa, Zala and Geze Gofa Woredas. However the variation in prevalence of ticks was not statistically significant ($P>0.05$) with respect to agro-ecological zones, age, sex and body condition scoring. In goats, the other external parasite identified next to ticks was pediculosis (lice infestation) occurring with the prevalence of 13.33, 7.5 and 2.85% at Demba Gofa, Zala and Geze

Table 1. Prevalence of small ruminant skin diseases on agro-ecology bases in Gamo Gofa zone.

Agro-ecology	Total examined	Total infected	Prevalence (%)
Lowland Woredas	723	314	43.43
Highland Woredas	177	67	37.85
Total	900	381	42.33

P-value = 0.121, Chi-square (χ^2_{cal}) = 2.399.

Table 2. Prevalence of small ruminant skin diseases on to species bases in Gamo Gofa zone.

Agro-ecology	Total examined		Total infected		Prevalence (%)	
	Goats	Sheep	Goats	Sheep	Goats	Sheep
Lowland Woredas	380	343	220	122	57.95	35.57
Highland	70	107	15	52	21.42	48.60
Total	450	450	235	174	52.22	38.66

P-value=0.026, Chi-square (χ^2_{cal}) = 4.929.

Table 3. Prevalence of small ruminant's skin diseases on age bases in GamoGofa zone.

Agro-ecology	Total examined		Total infected		Prevalence (%)	
	Adults	Youngs	Adults	Youngs	Adults	Youngs
Demba Gofa	258	115	125	63	48.44	54.78
Zala Woreda	295	55	118	28	40.00	50.90
Geze Gofa	140	37	50	17	35.71	45.94
Total	693	207	293	108	42.27	52.17

DF: 1, p-value = 0.003, and Chi-square (χ^2_{cal}) = 8.651.

Table 4. Prevalence of skin diseases on sex and body condition bases in Gamo Gofa zone.

Woreda	Sex		Body condition scoring		
	Male (%)	Female (%)	Poor (%)	Medium (%)	Good (%)
Demba Gofa	87 (48.87)	101 (51.59)	19 (42.22)	51 (39.84)	118 (59.00)
Zala Woreda	49 (49.00)	77 (30.80)	26 (44.10)	66 (36.67)	34 (30.63)
Geze Gofa	30 (33.33)	37 (42.53)	9 (45.00)	26 (32.91)	32 (41.02)
Total	166 (45.10)	215 (40.41)	54 (43.54)	143 (36.95)	184 (47.30)

DF: 1, χ^2_{cal} = 1.709, p-value = 0.191 for sex. DF: 2, χ^2_{cal} = 2.519 and p-value: 0.284 for body condition score.

Table 5. Prevalence of skin diseases on the bases vaccination history in Gamo Gofa zone.

Agro-ecology	Total examined		Total infected		Prevalence (%)	
	Vaccinated	Unvaccinated	Vaccinated	Unvaccinated	Vaccinated	Unvaccinated
Demba Gofa	194	179	70	118	36.08	65.92
Zala Woreda	195	155	28	98	14.35	63.22
Geze GofaWoreda	70	107	12	55	17.14	51.40
Overall	459	441	110	271	23.96	61.45

DF: 1, χ^2_{cal} = 17.302 and p-value: 0.000.

Table 6. Prevalence of skin diseases on the bases of season of the year in Gamo Gofa zone.

Agro-ecology	Total examined		Total infected		Prevalence (%)	
	Dry	Wet	Dry	Wet	Dry	Wet
Demba Gofa	200	173	116	72	58.00	41.61
Zala Woreda	221	129	100	26	45.21	20.15
Geze Gofa Woreda	101	76	48	19	47.52	25.00
Overall	522	378	264	117	50.57	30.95

DF: 1, χ^2_{cal} = 0.015, and p-value: 0.903.

Table 7. Prevalence of external parasites and skin disorders in goats in three Woredas of Gamo Gofa zone.

Skin diseases	Demba Gofa n (%)	Zala Woreda n (%)	Geze Gofa n (%)
External parasites	***78 (43.33)***	***57 (28.5)***	***9 (12.85)***
Sarcoptes scabies	10 (5.55)	9 (4.50)	2 (2.85)
Chorioptes spp	3 (2.77)	5 (2.50)	0 (0.00)
Demodex caprae	18 (10.00)	6 (3.00)	3 (4.28)
Ticks	23 (12.77)	22 (11.00)	2 (2.85)
Pediculosis	24 (13.33)	15 (7.50)	2 (2.85)
Skin disorders	***46 (25.55)***	***42 (21.00)***	***6 (8.57)***
Goat pox	26 (14.14)	28 (14.00)	5 (7.14)
Contagious ecthyma	6 (3.33)	3 (1.50)	0 (0.00)
Dermatophilosis	3 (2.77)	1 (0.50)	0 (0.00)
Dermatophytosis	7 (3.88)	4 (2.00)	0 (0.00)
Wounds and scratches	4 (2.22)	5 (2.50)	1 (1.14)
Photosensitization	2 (1.11)	1 (0.50)	0 (0.00)
Overall	124 (68.89%)	99 (49.50)	15 (21.42)

Table 8. Prevalence of external parasites and skin disorders in sheep in three Woredas of GamoGofa zone.

Skin diseases	Demba Gofa (n = 193)	Zala Woreda (n = 150)	Geze Gofa (n = 107)
External parasites	**34 (17.62)**	**27 (18.00)**	**32 (29.90)**
Sarcoptes scabies	7 (3.62)	4 (2.66)	5 (4.67)
Chorioptes ovis	2 (1.04)	0 (0)	3 (2.80)
Psorptes ovis	0 (0)	3 (2.00)	1 (0.93)
Demodex ovis	3 (1.55)	9 (6.00)	3 (2.80)
Ticks	13 (6.74)	4 (2.66)	9 (8.41)
Pediculosis	9 (4.66)	7 (4.66)	14 (13.08)
Skin disorders	**41 (21.24)**	**20 (13.33)**	**20 (18.69)**
Sheep pox	21 (10.88)	12(8.00)	14 (13.08)
Contagious ecthyma	7 (3.63)	3(2.00)	1 (0.93)
Dermatophilosis	4 (2.07)	1 (0.50)	3 (2.80)
Dermatophytosis	7 (3.63)	2 (1.33)	2 (1.87)
Wounds and scratches	2 (1.04)	2 (1.33)	0 (0.00)
Overall	75 (38.86%)	47 (31.33)	52 (48.60)

Gofa Woredas, respectively. The prevailing lice species identified were Linognathus species and Bovicola species from sucking and biting groups of lice (Table 7 and 8). As far as mange mite infestation in goat population was concerned, Sarcoptic mite was occurring at the prevalence of 5.55, 4.5 and 2.85% in Demba Gofa, Zala and Geze Gofa Woredas, respectively. Chorioptic mite (2.77, 2.50, and 0%), and *Demodex caprae* (10.00, 3.00, and 4.28%) were also recorded in the three respective Woredas above (Table 7 and 8). External parasites identified on the sheep was lice infestation, accounted to be 13.08, 4.66, and 4.66%, respectively at Geze Gofa, Zala and Demba Gofa Woredas. Similar species of lice as recovered in goats. Prevalence of pediculosis was not statistically significantly different (P > 0.05) among sheep of the three Woredas of Gamo Gofa Zone (Table 8). Ticks were the other dominant external parasites observed even though the prevalence was not showing statistically significant difference (P > 0.05) among small ruminants of the 3 Woredas of Gamo Gofa zone, Southern Ethiopia. Sarcoptic mite, Chorioptic mite, Psoroptic mite and *Demodex ovis* were also identified in sheep population, but their prevalence was at very low rate.

Prevalence of bacterial, fungal and viral infections

The predominant viral infection on small ruminants was caused by pox disease, prevalence of 14.44, 11.00, and 7.14% in goats and, 10.88, 10.66 and 9.35% in sheep at Demba Gofa, Zala and Geze Gofa Woredas, respectively. Occurrence of pox disease was not statistically significantly associated (P>0.05) with agro-ecology, species, sex and body condition scores, whereas, there was statistically significant variation (p<0.05) on age group base; higher in young as compared to adult (Table 8). The occurrence of pox disease in both sheep and goat was limited only to unvaccinated small ruminants.

DISCUSSION

The current study revealed the overall prevalence of 42.33% for small ruminant skin diseases. The record of significantly higher skin disease prevalence from goat species than sheep was suggested as due to variation in animal husbandry system. Traditionally, sheep and sheep products like skin are relatively expensive than goat and goat products in all three Woredas of the study areas and this finding is in agreement with the explanation underlined by Tekle et al. (2009) and Yacob (2013). So, the underlying reason for increased exposure of goats to skin disease was lack of care in terms of veterinary service, feeding, vaccination and housing. The finding of current study is in agreement with Rahmeto et al., (2011) who had reported an overall skin disease prevalence of 51.7% on sheep and 59.60% on goats at Tigri Regional State of Ethiopia and, a 48.1% overall skin disease prevalence reported by Yalew (2014) at Wolita-Sodo, Southern Ethiopia.

However, the current result is higher than that of previous works conducted by Dessie et al. (2010), on small ruminant mange mite; 1.98% on sheep and 5.85% on goats at three ecological zones of Wolita-Sodo, Southern Ethiopia. The variations could be attributed due to seasonal variation, variation in animal husbandry system and/or geographical location of the study areas. Relatively higher overall prevalence in current study (42.33%) could be due to very limited intervention for external parasite prevention and control in the area and overall poor veterinary facility in the area. The sharing of different flocks of animals to communal watering and grazing sites could have facilitated the establishment and spread of external parasite infestation and contagious skin infections in the area. This finding is also in agreement to Yacob et al. (2013). Statistically significant difference in prevalence (p<0.05) was observed from unvaccinated small ruminants than vaccinated groups. The finding suggests that immunizing the animals is an important strategy to prevent skin diseases especially those originated from bacterial and viral groups. Furthermore, the study revealed significantly higher overall small ruminant skin disease prevalence in young animals than adults, which could be because of their low acquired resistance compared to adults. Many previous works agrees with the finding of this research (Yacob et al., 2013; Fufa et al., 2012). The finding of higher prevalence of external parasite in goats than sheep in current report is in agreement with previous reports by Dessie et al. (2010), Kebede (2013), Yacob (2013) and Zenaw and Mekonnen (2012). The higher prevalence of external parasite in male small ruminants of both species could be due to the fact that anatomically the skins of male goats and sheep have heavy course grain nature that lacks tensile strength, while female skins have better strength in nature (Tekle, 2009), not favourable for external parasite infestation. The tick species identified by this study were *Ambyloma varigatum*, *Rhipcephalus evertisi evertisi* and *Boophilus decoloratus* in agreement to Yacob et al. (2008); reported the presence of these three tick genera in Ethiopia. The occurrence of small ruminants infested by ticks by current study is comparatively lower than the previous reports; 66.12% in goats and 80.7% in sheep by Fufa et al. (2012) around Bedelle district of Oromia regional state, Ethiopia. The current study revealed both burrowing (Sarcoptic mange, Demodectic mange) and non-burrowing mites (Chorioptic and Psoroptic mange) in both species of the study animals. These findings are in agreement to the reports of Dessie et al. (2010), Yacob et al. (2008) and Haffiz (2001), whereas, relatively larger prevalence of mange mites in sheep (69.3%) and goat (57.3%) was reported Kassa et al. (2013).

CONCLUSION AND RECOMMENDATIONS

Ethiopia has a huge small ruminant population, endowed with great potential of attractive global market for skin. However, the contribution of skin in the national export income and enhancing the earnings from the skin to its producers are disproportionately small as a result of various skin diseases. The causes of deteriorated quality of skin were external parasites infestation, bacterial, viral and fungal diseases, and the poor animal husbandry practices such as poor nutrition and improper slaughter and flying operations. Moreover, poor veterinary infrastructure, lack of awareness and absence of a designed strategy in prevention and control of skin diseases continued to be a problem of deterioration of skin quality.

1. Therefore, awareness creation among farmers about the impacts of skin diseases and improving livestock extension system was recommended.
2. Control of external parasites through combination rotational grazing, sound husbandry practices and application of acaricides should also be encouraged.
3. More importantly, vaccinating both sheep and goat population against pox diseases and bacterial pathogens across the study Woredas was also suggested.
4. Further study should be conducted in designing integrated skin diseases prevention and control regimen on the bases of species dynamicity and seasonal occurrence.

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CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Abadi Y (2000). Current problems of leather industry: The opportunities and challenges of enhancing goat production in East Africa: Proceedings of Conference held at Debub University, Hawassa, Ethiopia. *E(kika) de la Garza* institute for Goat research. OK: Langston pp. 139-143.

Assefa M, Tesfaye D, Taye M (2011). A study on the prevalence of sheep and goat skin defects in Bahir Dar tannery, Ethiopia. Onl. J. Anim. Feed Res. 2(4):384-387.

Berhe A (2009). Assessment of hides and skin marketing in Tigri region. The case of Atsbi Wemberta Woreda, Eastern Tigri: *Msc thesis*: Addis Ababa University School of Graduate Studies College of Development Studies, pp. 1-37.

Bersisa M, Jemberu A, Tamirat M (2013). Skin defects of small ruminants in Africa. Ethiop. Vet. J. 321-322.

Dessie S, Hailu D, Dereje B (2010). Epidemiological study of small ruminant mange mites in three agro-ecological zones of Wolita, Southern Ethiopia. Ethiop. Vet. J. 14(1)31-38.

Desta H, Girma A, Alemu Y (2001). Body condition scoring of sheep and goat. Technical Bulletin Number 8. Ethiopian Sheep and Goat Productivity Improvement Program (ESGPIP), Addis Ababa, Ethiopia, 2:109-134.

Fufa A, Josen T, Alemayehu R (2012). Status of tick infestation in small ruminants of Bedelle district: Oromia region, Ethiopia. Glob. Vet. 8(5):459-462.

Gatenby R (1999). Sheep major health in tropical production system. In: The Tropical Agriculturalist, Macmillan Education. London: UK pp. 7-8.

Haffiz M (2001). Study on skin disease of small ruminants in central Ethiopia. *DVM thesis:* Faculty of Veterinary Medicine, Addis Ababa University, DebreZeit, Ethiopia, pp. 12-32.

Kassa B, Asegid S (2013). Enhancing economic growth through control of livestock skin diseases in Ethiopia. 27th EVA Annual Conference Proceedings, Addis Ababa, Ethiopia. Ethiop. Vet. J. pp. 85-93.

Kebede M (2013). Effects of small ruminant ecto-parasites in tanning industry in Ethiopia: *O Revion.* J. Anim. Sci. Adv. 3(9)424-430.

Kumsa B, Beyecha K, Goleye M (2012). Ectoparasites of sheep in three -agro-ecological zones in central Oromia region, Ethiopia. J. Vet. Res. pp. 1-8.

Mekonnen H, Nicholas M, Mwinyikione M (2013). Unlocking the potential of Ethiopian leather value chain: Livestock based extension role. COMESA Leather and Leather Products Proceedings (LLPI): 27th Ethiopian Veterinary Association Proceedings, Addis Ababa, Ethiopia. Ethiop. Vet. J. pp. 51-66.

Rahmeto A, Dessie S, Mekalash T, Bekele M, (2011). Prevalence of small ruminant external parasites and associated risk factors in selected districts of Tigri region, Ethiopia. Glob. Vet. 7(5)433-437.

Singla D (1995). A note on sub-clinical gastro-intestinal parasitism in sheep and goats in Ludhiana and Faridkot districts of Punjab. Indian Vet. Med. J. 19:61-62.

Soulsby E (1982). Helminthes, arthropods and protozoa of Domesticated animals London: Bailliere Tindal. pp. 92-106, 136-166.

Taylor M, Coop R, Wall R (2007). Veterinary Parasitology. 3rded . Oxford, UK: Blackwell Publishing, pp. 459-475.

Tefera S (2012). Investigations on external parasites of small ruminants in selected sites of Amhara regional state and their impact on tanning industry. MSC thesis, Faculty of Veterinary Medicine, Addis Ababa University, Ethiopia, pp. 1-37.

Tekle Z, Alemu Y, Merkel R (2009). Common defects of sheep and goat skins in Ethiopia and their causes: *Technical Bulletin* at Addis Ababa, Ethiopia, pp. 1-59.

Tewodros F, Tsegedingle Y, Mersha C (2012). Bovine demodicosis: Threat to leather industry in Ethiopia. Asian J. Agric. Sci. 4(5)314-318.

Thrusfield M (1995). Veterinary Epidemiology. 2 nd ed, Blackwell Science.

Urquhart M, Armor J, Duncan L, Dunn A, Jennings F (1996). Veterinary Parasitology. 2nd ed. London: Blackwell Science, pp. 123-192.

Yacob H (2013). Skin defects in small ruminants and their nature and economic importance: The case of Ethiopia. Glob. Vet. 11(5):552-559.

Yacob H, Nesanet B, Dinka A (2008). Prevalence of major skin diseases in cattle, sheep and goats at Adama Veterinary Clinic, Oromia Regional State, Ethiopia. Rev. Med. Vet. 159:8-9.

Yalew T (2014). Study on the prevalence of ecto-parasites in small ruminants in and around Wolita Sodo, Southern Ethiopia. Trop. Anim. Health Prod. 47:27-35.

Zenaw Z, Mekonnen A (2012). Assessment of major factors that cause skin defects at Bahir Dar Tannery, Ethiopia. Adv. Biol. Res. 6(5)177-181.


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