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Charnley AK (1992). Mechanisms of fungal pathogenesis in insects with particular reference to locusts. In: Lomer CJ, Prior C (eds), Pharmaceutical Controls of Locusts and Grasshoppers: Proceedings of an international workshop held at Cotonou, Benin. Oxford: CAB International. pp 181-190.

Jake OO (2002). Pharmaceutical Interactions between *Striga hermonthica* (Del.) Benth. and fluorescent rhizosphere bacteria Of *Zea mays*, L. and *Sorghum bicolor* L. Moench for Striga suicidal germination In *Vigna unguiculata*. PhD dissertation, Tehran University, Iran.

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Full Length Research Paper

Prevalence and economic significance of bovine fasciolosis in Nekemte Municipal abattoir

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A cross-sectional study was carried out from November, 2011 to March, 2012 at Nekemte municipal abattoir to assess prevalence and economic significance of bovine fasciolosis. Out of 384 cattle examined at post mortem, 21.9% (84) were positive for fasciolosis. The prevalence of bovine fasciolosis was found to be significantly affected ($P < 0.05$) by the age of animal, in which young animals were affected than adult animals. The prevalence of bovine fasciolosis was also higher ($P < 0.05$) in poor body conditioned animals than medium and good body conditioned animals. Sex of the animal was not found as a significant factor ($p > 0.05$) affecting the prevalence of disease. The prevalence of *Fasciola hepatica* was 14.1% (54), which was predominant among *Fasciola* species, causing bovine fasciolosis in the study areas. Whereas, the prevalence of *Fasciola gigantica* was 5.2% (20), and 2.6% (10) animals were mixed infected. The economic significance of bovine fasciolosis was also assessed based on condemned livers. Thus, based on retail value of bovine liver, the direct economic loss from fasciolosis during the study time was estimated to be 63072 ETB annually.

Key words: Cattle, economic significance, *Fasciola gigantica*, *Fasciola hepatica*, prevalence, post mortem examination.

INTRODUCTION

Ethiopia owns huge number of ruminants having high contribution for meat consumption and generates cash income from export of live animals, meat, edible organs and skin. In spite of the presence of huge ruminant population, Ethiopia fails to optimally exploit these resources due to a number of factors such as recurrent drought, infrastructures problem, rampant animal diseases, poor nutrition, poor husbandry practices, shortage of trained man power and lack of government policies for disease prevention and control (International Livestock Research Institute (ILRI), 2009).

Among the animal diseases that hinder the animal health, parasitic infections have a great economic impact, especially in developing countries. Fasciolosis is one of the most common economically important parasitic diseases of domestic livestock, particularly in cattle and sheep. The disease is caused by digenean trematodes of

the genus *Fasciola*, commonly referred to as liver flukes. The two species most commonly implicated as the etiological agents of fasciolosis are *Fasciola hepatica* and *Fasciola gigantica*. *F. hepatica* has a worldwide distribution but predominates in temperate zones while *F. gigantica* is found on most continents, primarily in tropical regions (Andrews, 1999). The presence of fasciolosis due to *F. hepatica* and *F. gigantica* in Ethiopia has long been known and its prevalence and economic significance has been reported by several workers (Graber, 1978; Bahiru, 1979; Yilma and, 2000; Rahmeto et al., 2009).

A review of available literature strongly suggests that fasciolosis exists in almost all parts of the country. It is regarded as one of the major setbacks to livestock productivity, incurring huge direct and indirect losses in the country. Nekemte is one of the areas where the environmental conditions and altitude is conducive for the

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occurrence of fasciolosis. However, little information is available about its prevalence and economic significance in the study area. Therefore, the objective of this study was to determine the prevalence of bovine fasciolosis and to assess the direct economic loss due to liver condemnation in Nekemte municipal abattoir during November, 2011 to March, 2012.

MATERIALS AND METHODS

Description of the study area

The study was conducted in Nekemte Municipal abattoir from November, 2011 to May, 2012. Nekemte is found in East Wollega zone, Oromia regional state, Ethiopia. It is located at 331 km west of Addis Ababa at latitude and longitude of 9° 5' N and 36° 33' E, respectively with an elevation of 2,088 meters above sea level. The minimum and maximum annual rain fall and daily temperature ranges are between 1450 to 2150 mm and 15 to 27°C, respectively.

Study animals

The study animals comprised of cattle slaughtered at Nekemte municipal abattoir. A total of 384 cattle were inspected during ante mortem and post mortem inspection with their identification numbers, and recorded accordingly on a format prepared for this purpose.

Sample size and sampling method

The sample size was determined by simple random sampling method using 95% confidence interval and calculated by using the formula given by Thrusfield (1995), with 5% absolute precision and at 50% expected prevalence.

$$N = \frac{1.96^2 (P_{exp}) (1 - P_{exp})}{d^2}$$

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

= 384 cattle

Where N = sample size, P = expected prevalence, d = desired level of precision.

Study design

Active abattoir survey was conducted based on cross sectional study during routine meat inspection on randomly selected cattle slaughtered at Nekemte municipal abattoir from November, 2010 to March, 2011.

Study methodology

The liver of each study animal was carefully examined for presence of lesions suggestive 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. Each mature fluke was identified to species level according to its shape and size. Investigation and identification of *Fasciola* was done according to their distinct morphological characteristics following the standard guidelines given by Urquhart et al. (1996).

Economic loss assessments

Generally, all infected livers with fasciolosis were considered to be unfit for human consumption and if any liver was infected by *Fasciola* at the Nekemte municipal abattoir, it was totally condemned. Economic losses were calculated based on condemned livers due to fasciolosis. In the study abattoir, the average annual cattle slaughtered rate was estimated to be 7,200, while mean retail price of bovine liver in Nekemte town was 40ETB. The prevalence of bovine fasciolosis in Nekemte municipal abattoir was estimated as 21.9%. The estimated annual loss from organ condemnation is calculated according to mathematical computation using the formula set by Ogunrinade and Adegoke (1982):

$$ALC = CSR \times LC \times P$$

Where ALC = Annual loss from liver condemnation, CSR = mean annual cattle slaughtered at Nekemte municipal abattoir, LC = mean cost of one liver in Nekemte town, P = prevalence of bovine fasciolosis at Nekemte abattoir

Data management and statistical analysis

The data which were recorded during the study period were entered into Microsoft excel sheet. Data were summarized and analyzed using statistical package for social sciences (SPSS) version 16 computer program. The Pearsons chi-square (X²) test at a significance level of 5 and 95% CI was used to determine the differences in the prevalence of fasciolosis infection among different species, between ages and among body conditions of cattle, sheep and goats. A 5% significant level was used to determine the differences in the prevalence of fasciolosis infection among different species of ruminants, between ages and among body conditions. The difference was considered as statistically significant if the p-value was less than 0.05.

RESULT

Post mortem examination

A total of 384 indigenous cattle breeds that were slaughtered at Nekemte municipal abattoir were examined for the presence of fasciolosis. Among the examined animals, 84 (21.9%) were positive for fasciolosis. Out of 84 livers positive for fasciolosis, 54 livers (14.1%) harbored *F. hepatica*, 20 (5.2%) harbored *F. gigantica* and the remaining 10 livers (2.6%) harbored mixed infection of *Fasciola* (Table 1). There was a statistically significant difference (p < 0.05) in the prevalence of bovine fasciolosis in different age groups considered. The highest (31.78%) prevalence was in young animals and the lowest (18.05%) was found in adult animals. Among five different origins, no significant difference (p > 0.05) in the prevalence of bovine fasciolosis was observed.

Table 1. Prevalence of fasciolosis in considered risk factors.

Factors	No. of animals examined	Number of positive cases	Percentage (%)
Age			
Adult	277	50	18.05
Young	107	34	31.78
Origin of the cattle			
Nekemt	106	24	22.64
Amoma	61	13	21.31
Diga	89	15	16.85
Uke	59	14	23.73
Bandira	69	18	26.09
Body Condition			
Poor	97	36	37.11
Medium	170	35	20.58
Good	117	13	11.11
Sex			
Male	375	82	21.87
Female	9	2	22.2

However, the prevalence of fasciolosis was highest (26.09%) in Bandira area and the lowest (16.85%) prevalence was observed in Diga. There was a significant difference ($p < 0.05$) in the prevalence of bovine fasciolosis within different body conditions. The highest prevalence (37.11%) was found in animals with poor body condition and the lowest prevalence was found in poor body conditioned animals. Among 384 cattle examined at Nekemte municipal abattoir, 375 were male, from these, 82 (21.87%) were positive for fasciolosis and 9 of them were females which showed 22.22% (2) prevalence of fasciolosis.

Economic loss assessments

The annual loss from liver condemnation in Nekemte was estimated to be 63072 ETB (\$1,182,600).

DISCUSSION

The overall prevalence of bovine fasciolosis (21.9%) observed in this study is in close agreement with the report of Berhe et al. (2009) from northern Ethiopia, who reported a 24.3% prevalence. However, it is much lower than that of many other studies from different abattoirs in the country and elsewhere in Africa. Yilma and Mesfin (2000) reported a 90.7% prevalence of fasciolosis in cattle slaughtered at Gondar abattoir, while Tolosa and Tigre (2007) recorded a prevalence of 46.2% at Jimma abattoir. Phiri et al. (2005) from Zambia and Pfukenyi and

Mukaratirwa (2004) from Zimbabwe reported 53.9 and 31.7% prevalence, respectively. On the other hand, a lower prevalence of fasciolosis (14.0%) has been observed in slaughtered cattle at Wolaita Soddo abattoir (Abunna et al., 2009). However, the prevalence of fasciolosis recorded in this study is higher than that reported in Diredawa municipal abattoir (14.4%) (Daniel, 1995). 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.

The result of present study revealed that the sex of the animal has no significant effect ($p > 0.05$) on the occurrence of bovine fasciolosis. This agrees with the report of Rahamato et al. (2009) who concluded that sex has no impact on the infection rate and hence both male and female are equally susceptible and exposed to fasciolosis. But this contradicts with the work of Balock and Arthur (1985) who reported that the effect of sex on the prevalence of bovine fasciolosis might be attributed to management system, with longer exposure of male outdoor when females are kept indoor at beginning of lactation.

The result of present study showed that age has significant effect on the prevalence of bovine fasciolosis; being higher in young animals than the adult ($p < 0.05$). There was a decrease in infection rate (prevalence) as age increased. This may be due to the result of acquired immunity with age which is manifested by humoral immune response and tissue reaction in bovine liver due

to previous challenge. There are some additional reports confirming that the increased resistance against fasciolosis (low prevalence) with age is most likely related to the high level of tissue reaction seen in bovine liver. Liver fibrosis which impedes the passage of immature flukes acquired thickening, stenosis and calcification of bile ducts, assumed unfavorable site for adult parasites and consequently fasten their expulsion. These are in agreement with experimental study conducted by Radostits et al. (1994) which confirmed the occurrence of higher infection rate in younger animals. The results of the present study indicated that body condition of the animal has significant association with the occurrence of fasciolosis. The prevalence was higher in poor body conditioned animals than that of medium and good body conditioned animals. The prevalence of fasciolosis was higher in the animals with poor body condition because this body condition in cattle is manifested when fasciolosis reaches at its chronic stage.

Post mortem examination on the 84 *Fasciola* infected livers of current results indicated that the prevalence of *F. hepatica* (14.1%) was higher than that of *F. gigantica* (5.2%). The high prevalence of *F. hepatica* may be associated with the presence of favorable ecological biotypes for its snail vector *Lymnaea truncatula*.

The total annual economic losses encountered due to condemnation of infected liver in Nekemte town were calculated as 63072 ETB (\$1,182,600). The present finding is by far lower than the results reported by Abdul (1992) and Daniel (1995) who reported a total economic loss of 154,188 and 215,000 ETB (\$2,891,025 and \$4,031,250, respectively) annually in cattle due fasciolosis at Ziway and Dire Dawa municipal abattoir, respectively. These higher values may be due to higher number of animals slaughtered at the Diredawa and Ziway abattoirs. The ecological conditions and the number of intermediate host found around the area may also be another factor contributing to the decrement of the economic loss.

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Full Length Research Paper

Disruption of estrus and conception in the acute phase of *Fasciola gigantica* infections in Yankasa ewes

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The effect of the hepatic migratory phase of *Fasciola gigantica* infections on estrus response to synchronization, conception rates, serum enzyme and biochemical changes in Yankasa ewes was investigated. Twelve adult Yankasa ewes were randomly assigned to one of two groups of 6 animals each. The ewes in Group 1 were each infected with 1,200 metacercaria of *F. gigantica* each while Group 2 served as non infected controls for the study. The ewes in both groups were then synchronized for estrus at 7 weeks post infection (WPI), and intact rams were introduced for heat detection and breeding. Pregnancy was confirmed by progesterone levels and non-return to estrus 21 days post breeding. Estrus response was 66.6 and 100% in infected and controls, respectively, but all infected animals returned to estrus by 42 days post breeding, indicating conception failure or an early embryonic death. Pathophysiological signs included anorexia, progressive anemia, emaciation and significant hypoproteinemia. Hepatic dysfunction was indicated by the significant increases in liver enzymes; aspartate amino transferase, alanine amino transferase and alkaline phosphatase levels in infected ewes and at post mortem hepatic fibrosis of the liver with intra-hepatic hemorrhage was observed. It is concluded that fasciolosis has an adverse effect on conception and establishment of the fetus in the acute migratory phase.

Key words: *Fasciola gigantica*, estrus, conception, ewes, productivity, Nigeria.

INTRODUCTION

Fasciolosis caused by *Fasciola hepatica* and/or *Fasciola gigantica*, is an economically important helminth infection of ruminants affecting animal health and production (Mulcahy and Dalton, 2001), with worldwide monetary losses at over US \$3.2 billion per annum (Spithill et al., 1999). It is also recognized as an emerging human disease with approximately 2.4 million people infected, and 180 million are at risk of infection (Mas-Coma et al., 2005). This has been connected with increased building of dams and irrigation canals to boost energy and food

production, especially in Sub Saharan Africa (Food and Agriculture Organisation, 2005). Irrigated agriculture increases the number of potential snail habitats and with them the risk and incidence of fasciolosis (Esteban et al., 2002).

Fasciolosis caused by *F. gigantica* is a significant constraint on livestock production in Nigeria (Schillhorn van Veen et al., 1980; Fabiyi, 1987; Okewole et al., 2000). A number of studies have been undertaken on the disease but these have been mostly on abattoir based

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prevalence rates and evaluation of diagnostic methods for early detection of infection (Ogunriade and Ogunrinade, 1980; Nwosu and Strivastava, 1993; Guobardia, 1998; Okewole et al., 2000). Most of the studies have been on done cattle, but the fluke affects bovines and ovines in Nigeria and is endemic in most parts of the country (Schilhorn van Veen, 1980). Peak prevalence is in the dry seasons, when only wetlands around irrigation canals, marshy areas and stagnant water bodies are likely to have fresh grass, and animals congregate to graze in such areas. The wet areas also favour the multiplication of the snail intermediate host of *Fasciola*, and the communal grazing in those areas allow the *Fasciola* to complete its life cycle by passing from the snail to the final animal hosts (Iqbal et al., 2007).

Fasciolosis may manifest clinically either as acute or chronic disease depending on the amount of metacercariae ingested (Behm and Sangster, 1999). Chronic infection manifests as anaemia, reduced feed efficiency, weight gains, milk production, reproductive performance, carcass quality and culminates in a chronic wasting syndrome (Ogunrinade et al., 1981; Vassilev and Jooste, 1991).

Acute phase of the disease is usually caused by the immature flukes as they tunnel through the liver causing haemorrhage, disruption of liver structure, and a number of other biochemical and haematological changes which are more serious in sheep than cattle (Chauvin et al., 2001; Wiedosari et al., 2006). Reported effects of these changes in animals include decrease in conception rate and fecundity (Hope, 1976), high barren rates, low twinning rates, abortions during all stages of gestation and still births (Wamae and Ihiga, 1999).

Hope (1972) had therapeutically eliminated immature flukes before mating and provided circumstantial evidence from improved fertility rates that parasitic invasion of the bile ducts coinciding with mating affected establishment of the foetus in ewes. This study seeks to directly evaluate this theory. Poor reproductive efficiency is the most important obstacle for increasing animal productivity. The farmer or extension worker wishing to institute a program on control must have reliable information on the benefits of control.

MATERIALS AND METHODS

Study area

The study was conducted at the National Animal production Research Institute, Shika, Zaria, Nigeria. Shika lies between latitude 11 and 12° north and between longitude 7 and 8° east. Mean annual rainfall in the area is 1100 mm, lasting from May to October. Mean relative humidity is about 72%, while the average daily temperature is about 25°C. The wet season is followed by a period of cool dry weather known as harmattan, lasting until

February. This is followed by hot weather when temperatures fluctuate during the day (14 to 34°) and relative humidity is between 10 to 20% (Osinowo et al., 1993).

Animal management

Twelve adult Yankasa ewes weighing between 15 to 20 kg were used for the study. Animals were housed in concrete floor pens throughout the experiment, and were fed with hay and sun dried grass. In addition, ewes received concentrate feed of 300 g each per day (Akinbamijo et al., 1993). Hay, water and salt lick were given *ad libitum*. Health care of the animals consisted of an annual immunization with *pests des petit* ruminant vaccine, weekly dipping to control ectoparasites and initial deworming to eliminate all gastrointestinal parasites. Thin and thick blood films were made to exclude cases with blood parasites. Animals were weighed at weekly intervals until they were bred at 7 weeks post infection (PI). Baseline pre-infection data were collected and the ewes were ranked on the basis of live weight and body condition score (Ahmed et al., 2006), and randomly assigned to two treatment groups.

Preparation of metacercaria for infection

The metacercaria cysts for infection were obtained from naturally infected *Lymnaea natalensis* snails collected at permanent streams around Ahmadu Bello University Zaria, over a period of 2 months. Collected snails were crushed and the cercariae recovered were allowed to encyst on cellophane and stored in water at 4°C, and frequently wet with water until use. For infections, the metacercariae comprising each dose were scraped from the celluloid membrane on which they had been allowed to encyst, examined with a low-power dissecting microscope to identify the penetration glands (an indicator of viability), counted and placed in 1.0 ml of water in individual test tubes (Ajanusi, 1987). For infection of each ewe, the metacercariae in the tubes were sucked into a 1 ml syringe and delivered to the esopharyngeal region of the animal and flushed down with several rinses with water.

Experimental protocol

Twelve adult Yankasa ewes were randomly assigned into one of two groups of 6 animals each. The ewes in Group 1 were each infected orally with 1,200 metacercaria of *F. gigantica* while Group 2 served as non infected controls for the study. Seven weeks PI ewes of both groups were synchronized for estrus using prostaglandin (PGF₂α) (Dinoprost tromethamine) at a dose of 2.5 ml per ewe. Proven intact rams were introduced to the ewes for heat detection and breeding. The animals were visually observed for estrus twice daily at 07:00 to 09:00 a.m, and those ewes that stood to be mounted by rams were noted. Ewes that did not show estrus and were not bred were given a second treatment with 2.5 ml of PGF₂α, ten days after the first treatment, and observed for an additional five days. Pregnancy was confirmed in the ewes by progesterone (P₄) levels greater than 5 ng/ml 18 days post breeding and non-return to estrus 21 days post breeding (Osinowo et al., 1993).

Reproduction parameters

The primary sign of estrus observed was the ewe standing to be

Table 1. Response to estrus synchronization and breeding in in *Fasciola*-infected and control ewes.

Parameter	Infected ewes	Control ewes
Number of animals in estrus after 1 st treatment with PGF2 α	2 (33.3%)	4 (66.7%)
Number of animals in estrus after 2 nd treatment with PGF2 α	2 (33.3%)	2 (33.3%)
Total estrus response rates	4 (66.6%)	6(100%)
Total number of animals bred	4	6
Mean mating frequency	4.3 \pm 0.58	10.5 \pm 4.4
Pregnancy/Lambing rate	0%	50%

mounted by the ram. The parameters calculated were:

1. Estrus response rate was determined by dividing the number of animals which came into estrus by the number of animals that were synchronized and expressed as a percentage.
2. Conception rate was determined by dividing the number of animals that became pregnant by the number of animals that came into estrus expressed as a percentage.
3. Pregnancy rate was determined by dividing the number of animals which became pregnant by the number of animals that were synchronized and expressed as a percentage

Parasitological examination

Faecal samples were collected directly from the rectum of animals every week as from week 1 post infection. Fluke egg count was performed using the sedimentation technique as described by Urquhart et al. (1996).

Haematological investigations

Blood samples with and without anticoagulants were collected via jugular vein puncture weekly for 16 weeks post infection. Standard methods of haematology (Jain, 1986) were used for determination of red blood cell count (RBC) and packed cell volume (PCV). Serum was harvested and assayed spectrophotometrically for liver enzymes: Aspartate amino transferase (AST), alanine amino transferase (ALT) and alkaline phosphatase (ALP) levels, spectrophotometrically using (Bayer Express Plus Clinical Chemistry Analyzer). Levels are expressed as international units per litre (IU/l). The rest of the serum was stored at -20°C until assayed for progesterone using a human enzyme linked immunosorbent assay (ELISA) commercial kit. Total serum proteins were determined by the biuret method while serum albumin fraction was determined by the bromocresol green method using commercial test kits (Bayer diagnostics).

Post-mortem examination

Post mortem examination was carried out on all dead ewes. The livers, bile ducts and gall bladders were collected and examined for the presence of *F. gigantica* parasites as described by Egualé et al. (2009). Briefly, capsules were stripped from the livers which were then crushed manually. Crushed livers were washed onto 1 mm mesh sieves and the residue was suspended in water in black trays and screened for parasites. The total count was the number of intact parasites plus the larger of the number of heads or tails

recovered. The intact worms were randomly picked from each of the dead ewes and their length and width were measured with a transparent ruler. Sections of livers were taken for further histological studies.

Statistical analysis

Statistical analysis was carried out using SAS (2002). Data were expressed as mean \pm standard error (SE) of the mean. Values of $p < 0.05$ were considered significant.

RESULTS

All ewes infected with metacercariae developed a liver-fluke infection. Clinical signs were observed 9 weeks post infection. No *Fasciola* eggs were detected in the faecal samples until 12 weeks PI. Mean egg count per gram of faeces was 530 \pm 96. Observed clinical signs were anorexia, progressive anaemia, emaciation and then sudden death of infected ewes between the 10th and 12th weeks PI. Due to this mortality, a salvage treatment with anthelmintics had to be carried out on the surviving animals at the 13th week PI. The surviving animals were left to run with rams and their next conception dates were recorded.

In Table 1, the estrus response rate, breeding and pregnancy outcomes were shown in infected and control ewes. Frequency of mating was lower in the infected than the control ewes. Of the 6 infected ewes that were synchronized for estrus at week 7 PI, three stood to be mounted by rams but no ewe became pregnant in this group. Three out of six control ewes were similarly synchronized, became pregnant and eventually lambed. Ovarian activity as shown by progesterone profiles (Figure 1) showed estrus in infected and non infected control groups. The control animals that conceived after synchronization and mating showed P4 levels > 5 mg/ml, these animals carried their pregnancies to term and lambed. All infected animals returned to estrus by 42 days post breeding. Three control animals also returned to estrus 22 days post breeding.

In infected ewes, serum albumin and total protein

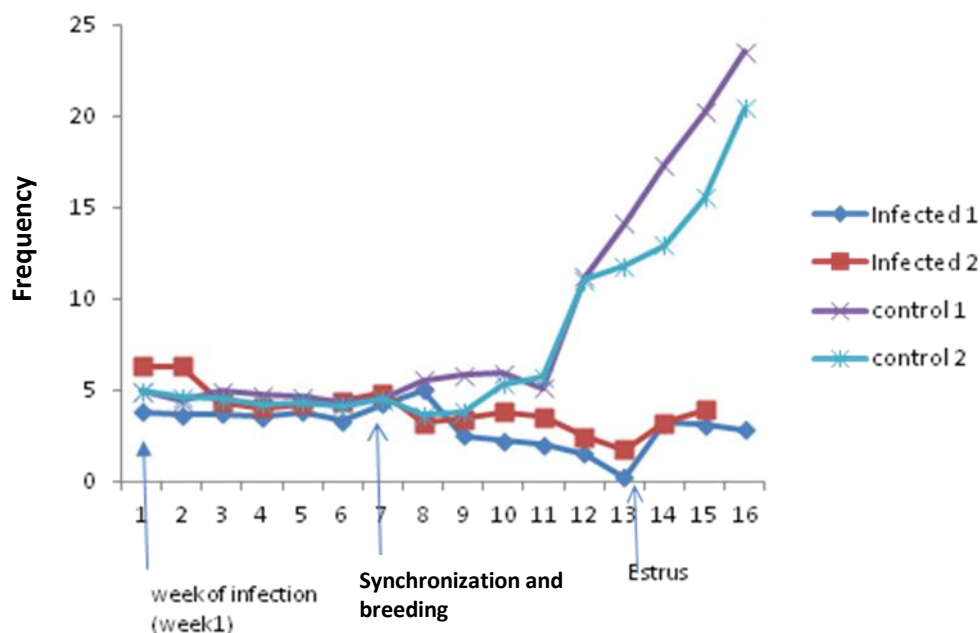


Figure 1. Progesterone profiles of two non-pregnant infected and two pregnant control animals

values were significantly reduced when compared to the values in control animals. Urea levels showed insignificant ($P > 0.05$) changes in both groups (Table 2). Hepatic dysfunction was indicated by the significant increases in AST, ALT and ALP activities (Table 2), in infected ewes. At necropsy, the carcasses were pale with blood-tinged fluid in the peritoneal cavity. The gall bladder was also grossly distended (Figure 2), there was hepatomegaly and massive hepatic fibrosis of the entire liver (Figure 4) with intrahepatic hemorrhage (Figure 5), and in one animal the liver capsules was completely ruptured and flukes could be seen crawling on the liver surface (Figure 3). Biomass of flukes as assessed from parasite length and width increased with duration of infection with maximum length at patency of the parasite.

DISCUSSION

The findings of abnormal hepatic function, anaemia, weight loss and high mortality in this study are characteristic features of ovine fascioliasis as has been reported elsewhere (Matanovic et al., 2007). Anaemia is due to adult flukes feeding on the blood of the host while observed hypoalbuminaemia is due to a reduction in albumin synthesis by the damaged (Dargie, 1987). Sewell (1966) estimated that each fluke reduced the potential annual gain by about 200 g, with infected animals achieving only about half the annual weight gain

Table 2. Mean serum biochemical variables in *Fasciola* infected and control ewes.

Serum parameter	Infected ewes	Control ewes
ALT (IU/l)	13.2±2.4 ^a	10.8±1.4 ^b
AST (IU/l)	89.5±8.9 ^a	73.2±7.2 ^b
ALP (IU/l)	28.7±4.8 ^a	20.6±5.8 ^b
Albumin (g/L)	2.8±0.4 ^a	3.3±0.5 ^b
Total Protein (g/L)	5.6±0.4 ^a	7.1±0.4 ^b
Urea (M/mol)	24.5±5.0	24.1±3.2

Data expressed as Mean± SEM. Means within the same row are significantly different ($P < 0.05$).

of that shown by control animals. Poor estrus response and conception rates will add up to long lambing intervals, low productivity and low off takes of animals in *Fasciola* endemic areas. This observation also directly confirms the speculation of Hope (1972) that establishment of the fetus in ewes was affected if parasitic invasion of the bile ducts coincides with mating. Khallaayoune and Stromberg (1992) also reported increased lambing rates and lower number of services per conception in albendazole treated sheep since in the presence of *Fasciola* infection, pregnancy rate was decreased by 50% when compared to non infected animals. Other investigators have reported prolonged anoestrus period as well as cessation of ovarian function

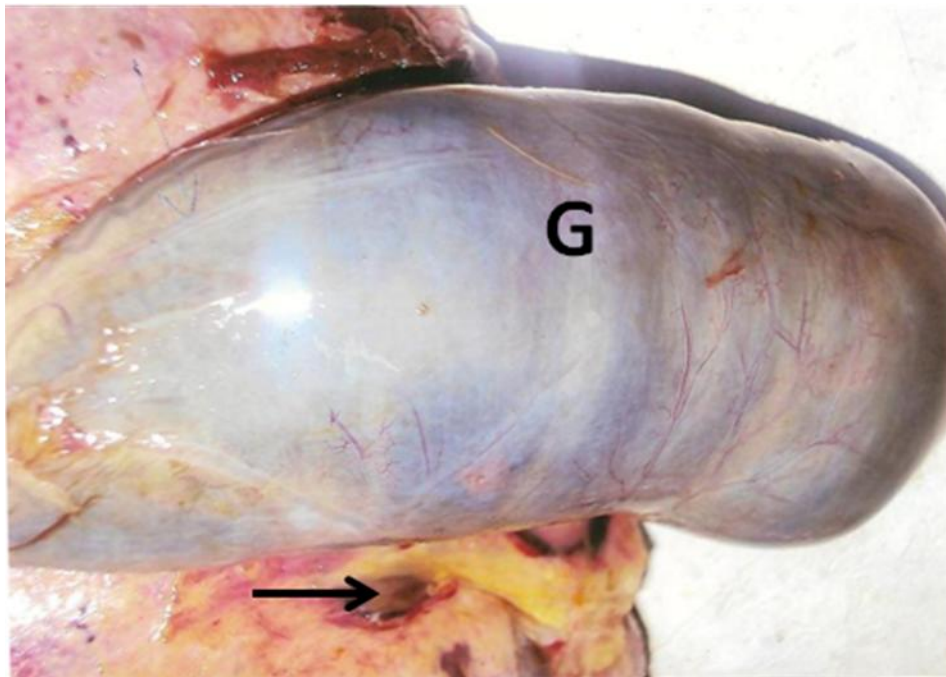


Figure 2. Photograph of liver from *Fasciola gigantica* infected Yankasa ewes at 12th week PI. showing distended gall bladder (G) and enlarged hepatic lymph node (arrow).

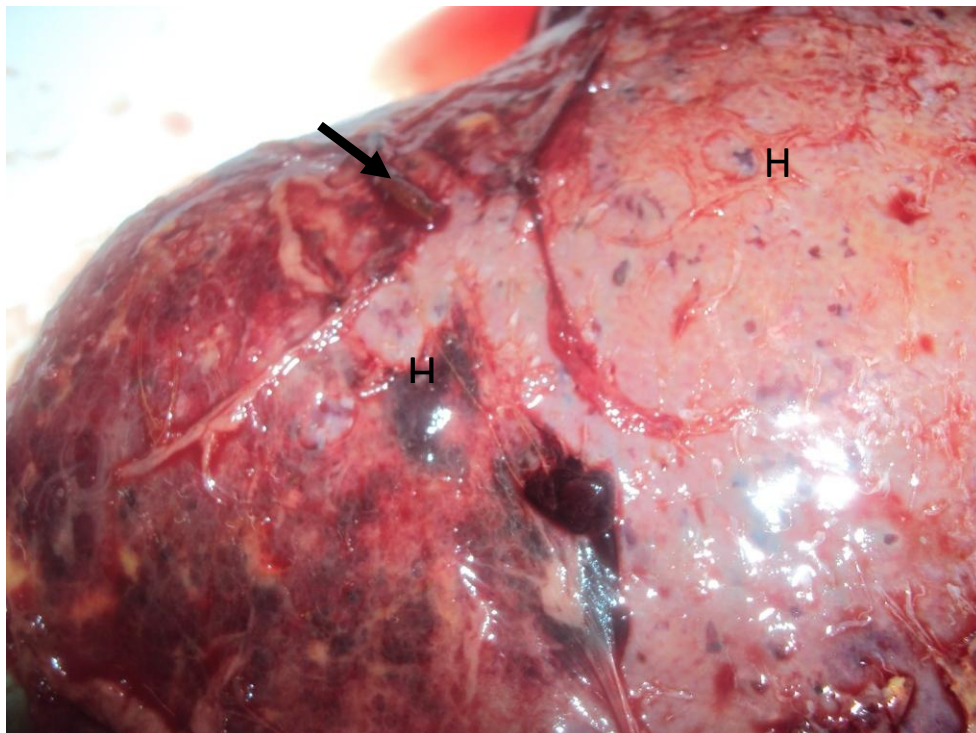


Figure 3. Photograph of liver from *Fasciola gigantica* infected Yankasa ewes at 12th week PI. showing fluke on surface of the liver (arrow) as well as the haemorrhages (H) in the liver as a result of fluke migration.

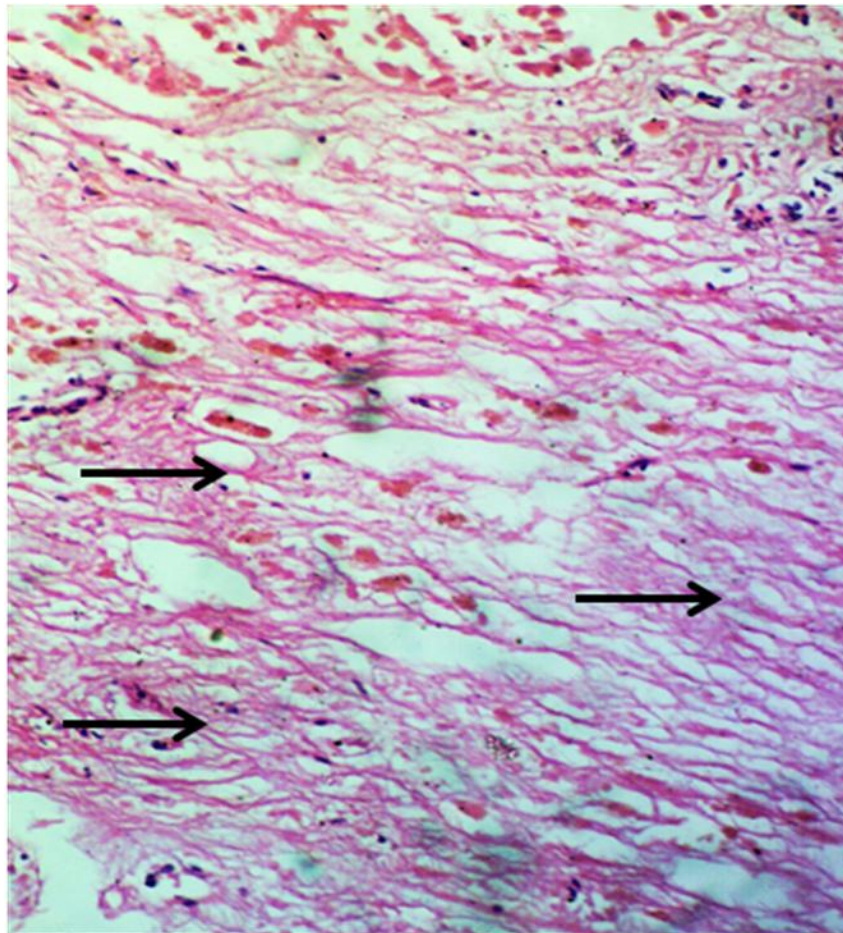


Figure 4. Photomicrograph of liver from *Fasciola gigantica* infected Yankasa sheep at 12th week PI. Note the massive hepatic fibrosis (arrow). H & E stain x 400.

in *Fasciola* infected mature animals (Ahmed, 2006).

In this study, the surviving animals did not conceive again until six months post treatment even though they were continuously exposed to rams. However, the animals should have been monitored for estrus activity or ovarian function. A reduction in ovulation rate and ovarian activity in infected ewes has also been reported with other helminth parasites (Jeffcoate et al., 1988; Fernandez-Abella et al., 2006). This reduction was attributed to a secondary effect associated with live weight loss induced by nematode challenge. The return to estrus after 42 days post breeding in this experiment could be attributed to early embryonic loss in infected ewes. This is similar to other reports (Behm, 1999; Fernandez et al., 2006). In cattle, a link has been observed between infection with *Fasciola*, anaemia and fertility (Simsek et al., 2007). Suhardono (2001) reported that 58.4% of repeat breeder cows were seropositive to *F. hepatica* and that there were significantly longer inter-calving intervals

and a lower packed cell volume in infected cows than in those treated with triclabendazole.

In this study, apart from the effect of weight loss, reproductive disruption may have resulted mainly from hormonal imbalances due to liver destruction induced by the flukes. This may produce lower response to synchronization and impaired fertility. Increased serum enzyme concentrations as seen in this study has also been reported in other studies (Shaikh et al., 2007; Pal and Dasgupta, 2006) and have been associated with the migratory phase of infection and resultant parenchymal damage and liver trauma. In fasciolosis, even when only small liver areas are damaged, significant disturbances in liver function including mitochondrial bioenergetic metabolism, carbohydrate, protein, lipid and steroid metabolisms as well as bile flow and bile composition have been reported (Calléja et al., 2000). Increased biomass of flukes which was found to increase with duration of infection must have been reflected in increased liver

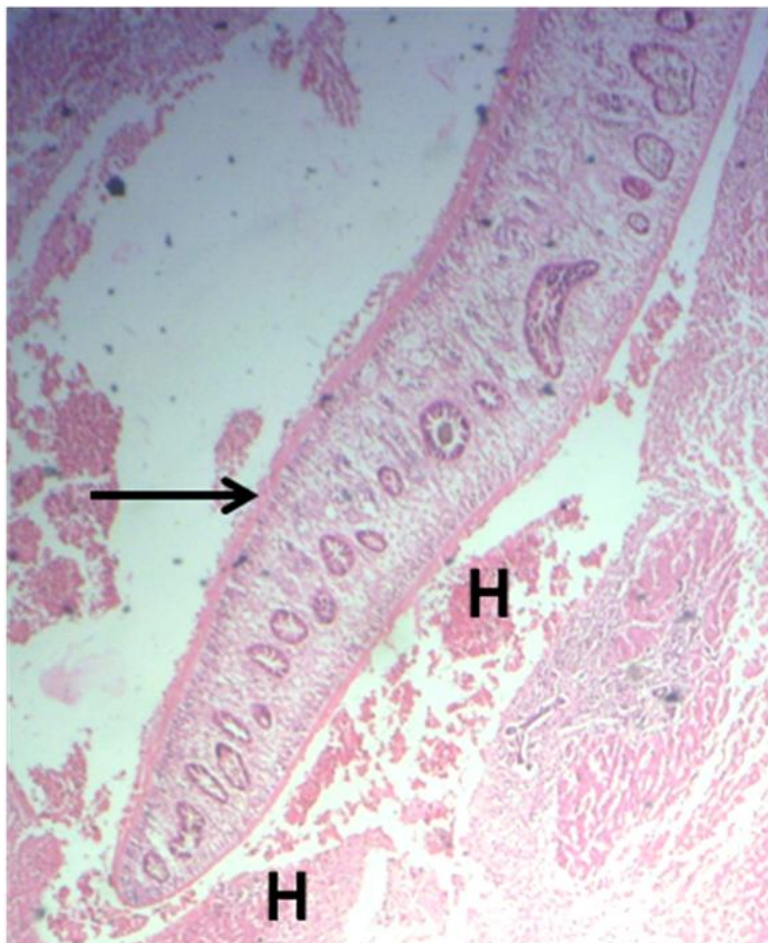


Figure 5. Photomicrograph of liver from *Fasciola gigantica* infected Yankasa sheep at 11th week PI. Note the intrahepatic (arrow) hemorrhage (H). H & E stain $\times 400$.

pathology.

Coprological diagnosis of clinical fasciolosis was not possible until 12 weeks after infection. This indicates that if fasciolosis is suspected to be the cause of production losses, the damage will have already been done. This patency period is shorter than the 14 weeks reported for *F. gigantica* by Behm and Sangster (1999) and Spithill et al. (1999). The maturation time of juvenile flukes in the bile duct and the initiation of egg laying have been found to depend on the infection dose (Valero et al., 2006). In heavy infections, a crowding effect manifested through a delayed fluke migration time from the liver parenchyma into the common bile duct occurs. A delayed prepatent period was not observed in this study but low egg production relative to number of flukes present, as well as presence of immature flukes and mature flukes present on the surface of the liver up to 13 weeks post infection may be indications of a crowding effect.

Diagnosis of infection by ELISA is possible as early as 2 weeks post infection with 95% sensitivity (El-Ridi et al., 2007; Tarek et al., 2011). Early detection enables livestock to be treated prior to the development of liver pathology, thus minimizing morbidity due to this disease. This combined with a history of grazing on wet pastures, weight loss and anaemia can give a confirmatory diagnosis and intervention undertaken. Weight loss and anaemia in infected animals closely reflected the pathology of infection and indicated that these are useful parameters for prognosis in fasciolosis.

Conclusion

Infection with *F. gigantica* adversely affects reproduction sequel to anorexia, asthenia, liver destruction, anaemia and eventually loss of weight. Reduced productivity due

to both low fertility, low lambing rates and ewe deaths would seriously increase the financial loss due to fasciolosis. This further emphasizes the need for effective planned control measures against this parasite. ELISA for early detection of infections would also be a useful laboratory diagnostic tool in fluke endemic areas.

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Full Length Research Paper

Study on bovine mastitis and its effect on chemical composition of milk in and around Gondar Town, Ethiopia

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A cross sectional study was undertaken from October, 2010 to June, 2011 to estimate prevalence of mastitis, to identify potential risk factors, and to assess impact of mastitis on chemical composition of bovine milk in and around Gondar town, Ethiopia. The study was conducted using California Mastitis Test for screening of subclinical mastitis, clinical examination and ultramilk to analyze chemical composition of milk. A total of 1,097 quarter milk samples collected from 290 local zebu and Holstein-zebu cross breed cows were examined; and overall prevalence of 46.9 and 24.3% was observed at cow and quarter level, respectively. Clinical and subclinical mastitis were detected with prevalence of 9.7 and 37.2%, respectively. From observed risk factors breed, milk yield, housing and feeding show statistically significance difference ($p < 0.05$) in prevalence of mastitis. Of all parameters, chemical composition of milk, statistically significant difference ($P < 0.05$) was observed in the mean fat composition among different mastitic milk. In conclusion, prevalent occurrence of mastitis accompanied with different potential risk factors was an important problem affecting dairy production; therefore, integrated control measures and monitoring were suggested.

Key words: Gondar, mastitis, milk composition, risk factors, prevalence.

INTRODUCTION

Milk is one of the most important foods of human beings. It is universally recognized as a complete diet due to its essential components (Battaglia, 2007; Javaid et al., 2009). In recent years, the demand for liquid milk is increased tremendously worldwide due to increased population growth (Klaas, 2000). However, production of milk has been affected by various factors like mastitis (Payne and Wilson, 1999).

Mastitis is inflammation of mammary gland and costly

production disease affecting dairy cattle industry worldwide (Wallenberg et al., 2002; Seegers et al., 2003). It is often classified as subclinical or clinical depending on the severity of the disease or contagious and environmental based on the causative agents (Andrews et al., 2003). The occurrence of mastitis depends on the interaction between microbial agent, host and environmental factors. The changes in composition of milk are one of the consequences of mastitis in dairy cows (Giannechini et

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al., 2002). It leads to a reduction of yield, lactose and butter fat. Milk protein levels will increase slightly with mastitis, but the protein is of lower quality, with increased levels of globulin and decreased casein (Andrews et al., 2003).

In Ethiopia, cows are the main source of milk and 42% of the total cattle herds for private holdings are milking cows (Food and Agriculture Organization (FAO), 1990). Ethiopia's increasing human population and urbanization trends are leading to a substantial increase in the demand for milk and meat (Azage et al., 2001). The activities of Ethiopia for self-sufficiency together with increase in milk demand leads to having a significant percentage of improved breeds of dairy cattle in the years to come, which are susceptible to most diseases including mastitis (Lemma et al., 2001).

In North Gondar zone, the Integrated Livestock Development Project (ILDP), Austrian funded project, provided crossbred heifers for poor farmers to improve their livelihood, as part of the activity of self-sufficiency. According to Almaw et al. (2009), these crossbred cattle are suffering from subclinical mastitis. However, the level of different types of mastitis, potential risk factors and impact of mastitis on chemical composition of the milk were not well studied. Therefore, the present study was undertaken to estimate prevalence of mastitis, to identify potential risk factors, and to assess impact of mastitis on chemical composition of bovine milk in and around Gondar town, Ethiopia.

MATERIALS AND METHODS

Study design, mastitis examination and sample collection

It was a cross-sectional study conducted on 290 lactating local zebu and Holstein-Zebu crossbred cows from October, 2010 to June, 2011 in and around Gondar town of North Gondar zone, Ethiopia. Breed, age, stage of lactation, parity, milk yield, tick infestation, housing and feeding of study animals were considered as risk factors to be tested for occurrence of mastitis.

History about the udder and quarters was asked. The udder (including its symmetry, size, consistency and hotness) and milk (including its consistency and color change) were physically examined. Clinical mastitis was diagnosed on the basis of manifestation of visible signs of inflammation. A warm and swollen quarter which had pain upon palpation was considered to have acute clinical mastitis otherwise chronic mastitis when misshaped, atrophied, hard and fibrotic quarters were examined (International Dairy Federation (IDF), 1987). A quarter was considered subclinically affected when clinical signs were not present and become positive by California Mastitis Test (CMT). A cow which had one or more positive quarters by CMT was considered positive for subclinical mastitis (Quinn et al., 1994).

Milk samples were collected from clinically and subclinically affected non-blind quarters and additionally, normal quarters. For comparative study of chemical composition of milk, pooled sample was collected from normal quarters of non-mastitic cows; however, milk from cross and local breed cows were collected into separate

bottles. After milking out and discarding the first two drops of milk, the milk was examined both for clinical and subclinical mastitis. Then, about 50 ml from each quarter was aseptically collected using sterile universal bottle.

Finally, samples were transported in ice box to University of Gondar Veterinary Microbiology and Public Health laboratory for analysis. Samples will be kept at 4°C not for more than 18 h if immediate analysis is not convenient.

Milk analysis

Milk samples of both mastitic and non-mastitic quarters were analyzed separately according to their collection using ultramilkner (Hangzhou Ultrasun Technologies Co Ltd., 2010). Samples had been warmed at 30°C if they were preserved at 4°C, and fat, solid not-fat (SNF), protein, lactose and ash were analyzed according to description of Hangzhou Ultrasun Technologies Co Ltd. (2010).

Data analysis

The data was entered and managed in Microsoft Excel spread sheet. Presence of difference in prevalence of mastitis between different groups of risk factors was tested by using chi-square test; Fisher's exact test was used when the numbers within categories were too small for the Chi-square test. Analysis of variance (ANOVA) was used to evaluate presence of significant difference in means of a specific milk composition of more than two means. Student t-test was used for two means and to identify categories of leading significant difference when it was found statistically significant by ANOVA. Multiple regression analysis was applied to see the confounding effects of breed and mastitis on chemical composition of milk. P-value less than 5% was considered statistically significant.

RESULTS

Prevalence study

An overall prevalence of 46.9% (136 of 290 cattle) was observed. Of these 136 cows which were positive for mastitis, 108 (79.4%) was due to subclinical while the rest 28 (20.6%) was due to clinical mastitis (Table 1). When the prevalence of clinical and subclinical mastitis compared between local and cross breed cows, higher prevalence was observed in cross breed cows in both cases with prevalence of 12.9% ($\chi^2 = 6.2728$, $P < 0.05$) and 47.3% ($\chi^2 = 22.5048$, $P < 0.05$), respectively (Table 2).

Risk factors

Breed, stage of lactation, milk yield, housing, feed, tick infestation, age and parity were evaluated as risk factors for prevalence of mastitis; of which breed, milk yield, housing and feeding show statistically significance difference ($P < 0.05$) in prevalence (Table 3).

Table 1. Prevalence of clinical and subclinical mastitis in cattle at cow and quarter level in and around Gondar.

Type of mastitis	No. of animals/quarters examined	Positive (%)
Cow level		
Subclinical	290	108 (37.2)
Clinical		28 (9.7)
Total		136 (46.9)
Quarter level		
Subclinical	1097	236 (21.5)
Clinical		31 (2.8)
Total		267 (24.3)

Table 2. Prevalence of clinical and subclinical mastitis between local and cross breed cattle.

Type of mastitis	Breed		Total (%)	χ^2 or Fisher's exact	p-value
	Cross (%)	Local (%)			
Total no. of animals examined	186	104	290	-	-
Clinical	24 (12.9)	4 (3.8)	28 (9.7)	6.2728	0.012
Subclinical	88 (47.3)	20 (19.2)	108 (37.2)	22.5048	0.000
Total	112 (60.2)	24 (23.1)	136 (46.9)	-	-

Chemical composition of milk

Table 4 shows results of milk composition of clinical, subclinical and normal milk of cross and local breeds. The calculated means of types of mastitis was analyzed and statistically significant difference was observed between types of mastitis in bringing effects on fat in cross breeds ($F = 19.45$, $P < 0.05$). The mean of the fat showed significant difference between normal (non-mastitic) and clinical mastitis ($t = 3.9644$, $P < 0.05$) and between subclinical and clinical mastitis ($t = 4.3891$, $P < 0.05$). There were also some alteration in chemical composition of milk and this showed different degrees of increment or decrement with respect to types of mastitis from the normal (non-mastitic) cows in the study area. Breed was not found as confounding factor affecting fat composition.

DISCUSSION

Prevalence study

The prevalence of mastitis at cow and quarter level was observed. At cow level, overall prevalence of 46.9% (136 of 290 cows) mastitis was observed. The observed

prevalence in this study was in agreement with work of Workineh et al. (2002) who reported mastitis with prevalence of 45.4% in their study on prevalence and etiology of mastitis in cows from two major Ethiopian dairies. It was higher than previous reports of mastitis in some parts of Ethiopia. Getahun et al. (2008) and Bitew et al. (2010) reported mastitis with prevalence of 24.9 and 28.2% in their respective studies in Selalle, and Bahir Dar, respectively. Similarly, Klastrup and Halliwell (1997) in Malawi reported bovine mastitis with prevalence of 17.19%. However, it was lower than the works of Sori et al. (2005), Lakew et al. (2009), and Mekibeb et al. (2010) who reported mastitis with prevalence of 52.78, 65.6 and 71.0% in their respective studies. The observed difference in the prevalence of mastitis among these studies could be due to difference in managemental system (Almaw et al., 2008).

At quarter level, overall prevalence of 24.3% was observed. It was in close agreement with the work of Almaw et al. (2008) in their study of bovine mastitis on smallholder dairy farms (22.8%) in Bahir Dar, and Fadlelmoula et al. (2007a) in large scale dairy farms (27.57%) in Thuringia-Germany. The quarter level mastitis observed in this study was higher than the work of Getahun et al. (2008) from their study (10.61%) in Selalle. According to Quinn et al. (1994), occurrence of

Table 3. Prevalence of mastitis compared between/among risk factors.

Risk factor	Animals examined	Positive (%)	χ^2 or Fisher's exact	P-value
Breed				
Cross	186	112 (60.2)	36.9424	0.000
Local	104	24 (23.1)		
Stage of lactation				
Early	91	41 (45.1)	0.1958	0.907
Middle	137	65 (47.4)		
Late	62	30 (48.4)		
Milk yield				
Low	91	28 (30.7)	14.4892	0.001
Medium	101	52 (51.5)		
High	98	56 (57.1)		
Housing				
Poor	121	40 (33.1)	29.17	0.000
Fair	69	34 (49.3)		
Good	72	37 (51.4)		
Very good	27	24 (88.9)		
Feed				
Mixed	219	115 (52.5)	11.3240	0.001
Pasture	71	21 (29.6)		
Tick infestation				
Absent	260	118 (45.4)	2.3070	0.129
Present	30	18 (60)		
Age				
Young	16	4 (25)	0.214	0.214
Adult	223	108 (48.4)		
Old	51	24 (47.1)		
Parity				
1 and 2	132	53 (40.2)	0.023	0.310
3 and 4	112	65 (58)		
5 and 6	41	16 (39)		
7 and 8	5	2 (40)		
Total for each	290	136		

mastitis depends on the interaction between microbial agent, host and environmental factors. Therefore, the difference in the prevalence of mastitis both at cow and quarter level might be associated with difference in interaction among host, agent and environment in the different study areas.

Clinical mastitis was observed at prevalence of 9.7 and

2.8% at cow and quarter level, respectively. Prevalence of clinical mastitis at cow and quarter level in the current study was higher than work of Getahun et al. (2008) who reported clinical mastitis with prevalence of 1.8 and 0.51% at cow and quarter level, respectively. The cow level prevalence observed in this study was higher than prevalence of 4.4, 3.6 and 3% reported by respective

Table 4. Milk composition of clinical, subclinical and normal milk of cross and local breeds.

Component of milk (%)	Cross breed					Local breed			
	No. of observations = 74					No. of observations = 24			
	N	C	S	P-value	F-test	N	S	P-value	F-test
Fat	6.024615	2.53375	6.0665	0.0000	19.45	5.676	5.377143	0.7458	0.11
SNF	9.274615	8.64875	8.99225	0.5475	0.61	9.493	9.195	0.7413	0.11
Protein	3.510769	6.59875	3.3135	0.1441	1.99	3.514	3.742857	0.8161	0.06
Lactose	5.173077	4.76125	4.91175	0.8396	0.18	5.297	4.981429	0.9542	0.00
Ash	0.6984	0.6425	0.6535	0.4013	0.92	0.713	.6871429	0.8301	0.05

N = Non-mastitic, C = clinical mastitis, S = subclinical.

studies of Bishi (1998), Mungube (2001) and Bitew et al. (2010) in different study areas. However, it was lower than the work of Lakew et al. (2009) and Mekibeb et al. (2010) who reported clinical mastitis with prevalence of 26.5 and 22.4%, respectively.

Subclinical mastitis was observed with prevalence of 37.2% at cow level. It was in close agreement with prevalence of 34.6, 36.7 and 38.1% reported by Abaineh and Sintayehu (2001), Sori et al. (2005), and Lakew et al. (2009), respectively. Almaw et al. (2008) and Getahun et al. (2008) also reported subclinical mastitis but with prevalence of 25.22 and 22.3%, respectively. At quarter level, subclinical mastitis was observed with prevalence of 21.5% in the present study. The result of current study was in line of agreement with the work of Almaw et al. (2008) who reported quarter level subclinical mastitis with prevalence of 22.8%. Bachaya et al. (2005) reported quarter level subclinical mastitis with prevalence of 44.17% from Pakistan; therefore, this was lower when compared with the report from Pakistan. However, it was more than two fold when compared with work of Getahun et al. (2008) who reported subclinical mastitis with prevalence of 10.1% at quarter level. The higher prevalence of subclinical mastitis both at cow and quarter level in Ethiopia is due to the little attention given for subclinical form of mastitis than clinical mastitis, and efforts have been concentrated on the treatment of clinical cases (Hussein et al., 1997) while the high economic loss could come from subclinical mastitis.

Risk factors

Breed

The higher prevalence of mastitis (60.2%) observed in cross breed cows than in local breeds (23.1%) was in line with the report of Almaw et al. (2008) which might be due to difference in anatomical structure of the teats and difference in genetic resistance to disease (Radostits et

al., 2007). When prevalence of clinical mastitis was compared between cross and local breed cows, the prevalence was 12.9 and 3.8% in cross and local breeds, respectively. In line with prevalence of mastitis between breeds in the current study, Almaw et al. (2008) reported occurrence of clinical mastitis in cross breed cows (3.9%) but none in the local breed cows. This can also be associated with difference in milk yield as cows with high milk yield have gene which makes them more susceptible to mastitis (Radostits et al., 2007).

Stage of lactation

Highest prevalence of mastitis (48.4%) was observed in cows at later stage of lactation. It was in agreement with work of Nesru (1999), and Kerro and Tareke (2003) who reported higher prevalence of sub-clinical mastitis for cows in mid and late stage of lactation. However, Mungube et al. (2004) and Biffa et al. (2005) reported higher prevalence of mastitis in early stage of lactation. The variations in the effect of stages of lactation among different studies could be related probably to disparities in age, parity and breed of the sampled animals as indicated by Getahun et al. (2008).

Milk yield

Mastitis was observed at highest prevalence (57.14%) in high yielding cows followed by medium yielding (51.49%) and less prevalent in low yielding (30.77%). The result in the current study was in agreement with the work of Sori et al. (2005) and Lakew et al. (2009) who reported highest prevalence of mastitis in high milk-yielding cows in Asella. The similarity in prevalence of mastitis taking milk yield as a risk factor might be associated with the fact that higher-yielding cows have been found more susceptible to mastitis owing to position of teat and udder and anatomy of teat canal, and such cows have more

susceptible genes making them prone to mastitis (Radostits et al., 2007), and due to less efficacy of phagocytic cells in higher yielding cows associated to dilution (Schalm et al., 1971).

Housing and feeding

The current study indicated that housing system had significant effect on prevalence of mastitis. The highest prevalence (88.9%) was observed in cows kept in very good housing condition and prevalence decreases when the housing condition was getting poor. It was in line with the work of Fadlelmoula et al. (2007b) who reported higher prevalence of mastitis in tie-stall housed cows in Thuringia, Germany. However, Getahun et al. (2008) reported higher prevalence in cows living in poor housing system. Feed had also got significant effect on prevalence of mastitis with more prevalence in cows fed with mixed feeds of different types (52.5%) than cows fed with pasture and hay. Generally, cows in good housing system have less chance to get their udder contaminated and to get mastitis. However, the result in this study might be due to management practice applied to different breeds of cattle. Cross breeds are kept mostly for dairy purpose and are more susceptible; so desire better management, feeding and housing. Therefore, the higher prevalence of mastitis might be due to confounding effect in the managerial practices given for different breeds.

Tick infestation

Higher prevalence was observed in cows infested with tick; but there was no statistically significant difference in prevalence of mastitis between the two groups of cattle. This might be due to seasonal occurrence of ticks in the study area. However, according to Lakew et al. (2009), prevalence of mastitis can be affected by tick infestation of the udder.

Parity

In the current study, as parity increases it had a tendency towards increasing prevalence of mastitis. This is in agreement with the work of Kerro and Tareke (2003), Mungube et al. (2004), Biffa et al. (2005), Getahun et al. (2008) and Lakew et al. (2009). Quinn et al. (1994) have also stated that older cows, especially after four lactations, are more susceptible to mastitis.

Chemical composition of milk

Of all parameters, especially in chemical composition of

milk, statistically significant difference ($P < 0.05$) was observed in the mean fat composition among the different mastitic milk. The result of the current study in fat concentration was according to Andrews et al. (2003) who described mastitis as a cause for decrease in fat composition. Coulon et al. (2003) also reported altered fatty acid composition of raw milk due to elevation of somatic cell count of milk caused by mastitis. However, Payne and Wilson (1999) indicated that fat content of milk can vary even between milking of the same cow whether diseased or not. Whether the difference in mean fat composition can be affected by breed was tested; breed was not found as confounding factor affecting fat composition. However, according to McDonald et al. (1995), Andrews et al. (2003) and Radostits et al. (2007) composition of milk can be affected by breed.

Alteration in chemical composition of milk and different degrees of increment or decrement with respect to types of mastitis from the milk collected from normal cows (non-mastitic cows) in the present study is in agreement with different works. It is generally accepted that during mastitis, there is an increase in milk proteins (Auldism and Hubble, 1998) that has been attributed to the influx of blood-borne proteins (such as serum albumin, immunoglobulins) (Auldism et al., 1995; Auldism and Hubble, 1998), the minor serum proteins, transferring α -macroglobulin (Auldism and Hubble, 1998) into the milk coupled with a decrease in caseins (Holdaway, 1990). Auldism and Hubble (1998) reported a decrease in fat concentration, but the majority of the authors recorded an increase in total fat content of mastitic milk (Pyorala, 2003). It is well accepted that mastitis causes a decrease in the concentration of milk lactose (Auldism et al., 1995; Auldism and Hubble, 1998). The ionic content of milk varies markedly from that of extracellular fluid which batches the acini of the mammary gland. Milk contains a high concentration of potassium relative to sodium, the later being actively removed from the secretary cells by an energy dependant ATPase, which is located at the baso-lateral surface of the cell (Holdaway, 1990).

Conclusion

The study indicated mastitis as important disease for the dairy industry in the study area. Breed, milk yield, housing and feeding was important risk factors precipitating occurrence of mastitis. Of the two types of mastitis, subclinical mastitis was observed at higher prevalence. Mastitis was not as such an important cause for deterioration of chemical composition of milk in the study area. Therefore, individuals, and governmental and nongovernmental institutes working on dairy production should give emphasis on control of mastitis. Furthermore, improvement of milk production by providing crossbred

heifers with systemic mastitis control and prevention is very important. Even though the current and previous studies indicated importance of mastitis, the economic impact is not well addressed; therefore, further study involving different risk factors, economic impact and ways to improve milk production of local breeds by overcoming risk factors other than breed should be conducted in the study area.

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Full Length Research Paper

Prevalence of ovine gastrointestinal nematodes in and around Asella, South Eastern Ethiopia

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A cross-sectional study was carried out to determine the prevalence and risk factors associated with ovine gastrointestinal nematode infestation by faecal examination of 408 sheep from five different sites in and around Asella, South Eastern Ethiopia. The mean eggs per gram (EPG) count determined using modified McMaster technique showed that 73 (30.04%) of the sheep were lightly infested, 98 (40.34%) moderately infested and 72 (29.62%) heavily infested. Out of the total sampled sheep, 278 (68.1%) had a gastrointestinal nematode infection. Strongyles were the most frequently (64.0%) recovered nematode eggs followed by *Strongyloides* (7.4%) and *Trichuris* species (3.7%). The prevalence of gastrointestinal nematode infection showed a significant difference ($p < 0.05$) between young and adult age groups, and animals with poor body condition had a significantly higher worm egg count ($p < 0.05$) than those sheep in moderate or good body condition. There was significant association between the gastrointestinal nematode infection and animals with different age group, and body condition. In addition, there was a significant difference ($p < 0.05$) in prevalence among months of the study period. There was no significant difference ($p > 0.05$) in prevalence between sexes and different study sites of the subject area. Due to its important health problem and impact on production in the study area, emphasis should be given for the control and prevention of gastrointestinal nematode infection with further studies on species identification and larval ecology.

Key words: Asella, eggs per gram (EPG), gastrointestinal nematode, ovine, prevalence, risk factor.

INTRODUCTION

Sheep and goats are the most numerous of man's domesticated livestock and are especially important in more extreme climates of the world. Over two-thirds of the total population of sheep and goats occur in the less developed countries where they often provide major contribution to farming enterprises (Tony, 2007). Ethiopia is the second in Africa, and the sixth in the world, in terms of sheep population. Its great variation in agro-climatic zones represents a good reservoir of small ruminant genotypes (Food and Agriculture Organization (FAO), 1983). With its great variation in climate and topography, the country possesses one of the largest livestock populations in the world, which is managed by smallholder farmers under extensive low input traditional management system and adjunct to crop production

(International Lactation Consultant Association (ILCA), 1993). The latest estimate gives 23 million sheep and 18 million goats in Ethiopia (Anonymous, 2005).

In spite of huge population and importance of small ruminants, the country has benefited little from this enormous resource owing to a multitude of problems, disease being the most important. Disease alone accounts for mortality of 30% in lambs and 20% in adults (Demelash et al., 2006). It has well recognized that in resource poor regions of the world, helminth infections of sheep and goats are major factors responsible for economic losses through reduction in productivity and increased mortality (Urquhart et al., 1996; Tibbo et al., 2006). Smallholders and pastoralists may not easily detect the effect of helminths because of the subclinical

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nature of the infections (Soulsby, 1986; Urquhart et al., 1996). Thus, the sub-clinical helminth infections are responsible for significant economic losses. Once the clinical diseases are noticed, such economic losses in terms of animal productivity have already occurred (Kaplan, 2006; Tibbo et al., 2006). They are responsible for immunosuppression, enhancing the susceptibility of the animals to other diseases. Productivity losses attributable to helminth parasites are often substantial. A loss of US \$81.8 million is reported annually due to helminth parasites in Ethiopia (Demelash et al., 2006).

In developed world, the greatest component of impact by these nematode parasites is probably found in the cost of control. But their impact is greater in the sub-Saharan Africa in general and Ethiopia is particular due to ecological factors suitable for diversified hosts and parasite species (Ragassa et al., 2006). The epidemiology of gastro-intestinal (GIT) parasites in livestock varied depending on the local climatic condition, such as humidity, temperature, rainfall, vegetation and management practices (Takelye, 1991). These factors largely determine the incidence and severity of various parasitic diseases in a region. Therefore, it is important to assess the type and level of parasitism in ruminant livestock, in order to determine the significance of parasite infestations and to recommend the most beneficial and economically acceptable control.

In highland of Arsi, gastrointestinal nematodes infection still remains an important disease problem of sheep in the area. Hence, this study was devised to be conducted with the objective to determine the prevalence and identify the potential risk factors associated with occurrence of the parasite infection of ovine gastrointestinal nematode in and around Asella.

MATERIALS AND METHODS

Study area

The present study was conducted from November, 2008 to April, 2009 in Asella town and its surrounding, Tiyo woreda. The Town is a capital of Arsi Zone, Oromia regional state. It is located about 175 km south east of Addis Ababa at 6° 59' to 8° 49' N latitudes and 38° 41' to 40° 44' E longitudes. The altitude of the area ranges from 2500 to 3000 m.a.s.l. Asella and its surrounding is characterized by mid subtropical weather, with minimum and maximum temperature ranging from 8.4 to 22.6°C, and the relative humidity ranging from 43 to 60%. The average rainfall is 2000 mm. The area has a bimodal rainfall occurring from March to April (short rainy season) and July to October (long rainy season). According to Arsi Planning and Development Office (2007), the area is densely populated, with livestock population of 85,893 cattle, 57,118 sheep, 10,725 goats, 7841 horses, 15,642 donkeys, 517 mules and 35,489 poultry. The farmers in the area practice mixed crop-livestock farming system.

Study animals

The study subjects include all grazing sheep of different age groups and both sexes in Asella town and its surroundings that are kept

under traditional extensive production management system. The sample size was determined by taking 50% expected prevalence with a total of 384 but increased to 408 (Thrusfield, 1995).

Study design

A cross-sectional type of study was used for prevalence determination of sheep GIT nematode by coproscopic examination.

Study protocol

Sampling method

Out of 18 peasant associations (PAs) of Tiyo Woreda, five were selected, including Asella town by simple random selection or lottery method. The selected sites were: Denkeka Koncha, Haro Bilalo, Dosh, Gora Silingo and Asella town. Equal proportions of samples were collected from each site by random selection of farmers and animals. The participating farmers were identified by name (codes) and their animals were identified by ear tags with code numbers. Faecal samples were collected every month throughout the study period. The animal breed type, body condition scores, estimated age group and sex were recorded. The body condition scores and age group were recorded. Body condition scoring of sampled animal was carried out according to the method described by Cooper and Thomas (1985) and categorized into three scores as poor, medium and good. The poor body condition was recorded when individual spinous process were sharp to touch and easily distinguished, in addition, the bony structure of the sheep were easily noticeable. The eye muscles are of moderate depth. Medium body condition was recorded when the spinous process examined with very firm pressure and they were round rather than sharp. The eye muscle areas are full with moderate fat cover. Good body condition was recorded when the top and side of the back bone in loin area immediately behind the last rib and above the kidney were covered with muscles. The eye muscles were full and had a thick fat cover. Age group was determined by dentition and categorized as lambs (less than 9 month old), and adult (greater than 9 month old) as indicated by Yohannes (1989).

Faecal sample collection

A fresh faecal sample of approximately 10 g was collected directly from the rectum of each animal. The faecal samples were placed in a separate screw capped bottles (universal bottles), labeled and kept in cool box before transportation to Asella regional veterinary laboratory for coprological investigation. Those samples which were not examined within 24 h of arrival at laboratory were stored at +40°C and examined the next day early in the morning.

Coprological examination

The collected faecal specimens were processed and examined by direct faecal floatation technique for qualitative investigation of the types of gastro-intestinal nematode eggs. Quantitative examinations of faecal samples were made using the modified McMaster technique following standard procedures (Soulsby, 1986).

Those samples found positive for gastro-intestinal nematode were subjected to EPG counting. In this study, the floatation solution used was NaCl (sodium chloride). Eggs were identified by ova identification keys.

Data management and analysis

Computer based primary analysis was done on data set entered in to Microsoft-Excel spread sheet. The prevalence was calculated for all data as the number of infected individual divided by the total number examined times hundred. Stat-view computer based statistical software package was used to carry out different statistical analysis of collected data, and the Pearson's chi-square (χ^2) was used to test the existence of differences in prevalence between age groups, sex, body condition scores, place of collection and months. For the purpose of this study, 95% probability ($P < 0.05$) was considered the significant level.

RESULTS

Prevalence of gastrointestinal nematodes of sheep encountered in the study area

Of the total 408 sheep examined, 278 (68.1%) were found infected with different types of gastro-intestinal nematodes. Of the total positive cases, 261 (64.0%) were infected with strongyles, 30 (7.4%) were infected with *Strongyloides* spp. and 15(3.7%), were infected with *Trichuris* species (Table 1).

Variation between sex and age categories

Of the total 408 of sheep examined coprologically for gastrointestinal nematode eggs, 68.1% were found positive. The prevalence was 79.6% in lambs and significantly higher ($P < 0.05$) than 62.4% in adults (Table 2). There was no significant difference ($P > 0.05$) in prevalence of gastrointestinal nematode between the two sexes (Table 2).

Variation with body condition scores

Of the total 408 sheep examined, 65, 98 and 115 were categorized as having poor, medium and good body condition scores. Infection prevalence was significantly higher in animal with poor body condition when compared to that of medium and good body condition scores ($P < 0.05$). The overall infection prevalence according to body condition grades, 81.3, 69.5 and 61.5% with poor, medium and good, respectively (Table 3).

Variation on monthly basis

Analysis of prevalence of gastrointestinal nematode infections of sheep by months showed that there was statistically significant variation between months ($P < 0.05$). The higher infection prevalence was recorded in months during wet seasons, March and April whereas the lower was in months during dry seasons, January and February (Table 4).

Variation between study sites

Of all the sheep examined in the five sites, samples from Asella (71.1%) and Denkeka Koncha (70.0%) showed the higher GIT nematode infection prevalence and samples from Haro Bilallo (54.8%) showed lower infection prevalence recorded. The chi-square (χ^2) test value indicated that there was no statistically significant difference ($P > 0.05$) in prevalence of gastro-intestinal nematode infection of sheep between these sites (Table 5).

Quantitative faecal examination

The results of quantitative faecal examination using the modified McMaster technique for GIT nematodes of 243 infected sheep were 30.04, 40.32 and 29.62% for light, moderate and heavy infection, respectively. Most of the infected sheep had a faecal egg count in a range of 801 to 1200 epg and more (Table 6).

DISCUSSION

The gastrointestinal nematodes of sheep are one of the important parasitic disease that obviously result in reduced productivity of sheep raised by smallholders using traditional husbandry management system in and around Asella, Arsi zone of Oromiya region. The coprological examination done for this study using direct faecal floatation method revealed an overall gastro-intestinal infection prevalence of 68.1% of sheep originating from this area which were being parasitized at least by one type of gastrointestinal nematodes. However, apparent difference were also noted, this finding agrees with previous studies by coprological examination in some areas of Ethiopia 76.3% (Moti, 2008) and 79.09% (Achenef, 1997).

Accordingly, similar prevalence of gastrointestinal nematodes results agrees with reports of previous studies conducted in Ethiopia as 56.6% strongyles, 8.2% strongyloides and 5% trichuris in Debre Zeit (Tigist, 2008); 66.6% strongyles type and 3.3% *Trichuris* species in Bedele (Temesgen, 2008); 70.2% strongyles type and 4.5% *Trichuris* species in Western Oromia (Ragassa et al., 2006) and 42.25% strongyles type in Kelela (Tesfaye, 1998). Other comparatively very large coproscopic examination report was 97.03% strongyles type, 45.22% strongyloides and 30.25% *Trichuris* species in eastern part of Ethiopia (Abebe and Eseyas, 2001).

Many surveys were carried out in different regions of the country using both coproscopic and post mortem examination. The gastrointestinal nematodes are the predominant parasites prevalent in the country reported by Hailuleul (2002) in Wolayta Soddo and Yosef (1993) in Asella, and showed very high prevalence of infested sheep over 85% in their study areas. The variation is

Table 1. Prevalence of gastrointestinal nematodes of sheep encountered in the study area.

Parasite egg types	Number of animals examined	Positive samples nematode eggs	Prevalence (%)
<i>Strongyles</i> spp	408	261	64.0
<i>Strongyloides</i> spp	408	30	7.4
<i>Trichuris</i> spp	408	15	3.7
Total	408	278	68.1

Table 2. Prevalence of gastrointestinal nematode infection based on sex and age of animals using coprological examination.

Risk factors	Total no. of animals examined	No. of positive samples (%)	χ^2	P- value
Age				
Lamb		109 (79.6)	12.4005	0.00
Adult	271	169 (62.4)		
Total	408	278 (68.1)		
Sex				
Male	179	119 (66.5)	0.4032	0.525
Female	229	159 (69.4)		
Total	408	278(68.1)		

Table 3. Results of chi- square (χ^2) analysis of association of body condition of the sheep as risk factor of GIT nematode infection.

Body condition	No. of animals examined	No. of positive samples (%)	χ^2	P-value
Good	187	115 (61.5)	10.2547	0.006
Medium	141	98 (69.5)		
Poor	80	65 (81.3)		
Total	408	278 (68.1)		

Table 4. Prevalence of gastrointestinal nematode of sheep during the period November, 2008 to April, 2009 using coprological examination.

Months	Faecal samples examined	No.of positive samples	Prevalence (%)
November	68	45	66.2
December	68	47	69.1
January	68	35	51.5
February	68	39	57.4
March	68	60	88.2
April	68	52	76.5
Total	408	278	68.1

$\chi^2 = 27.3204$, P = 0.00

reported in prevalence rate among different works. This difference could be due to the sample size considered, climatic condition of the study area, long dry season between November and January and short of rain season between February and April in the study area and types of techniques utilized.

This study showed that strongyles having direct life cycle were the most prominent among those that were positive for gastrointestinal nematode parasites of animals. Therefore, strongyles are gastrointestinal nematodes of greatest importance in sheep, and causes serious direct and indirect losses in most parts of the

Table 5. Prevalence of gastrointestinal nematodes of sheep at different sites of the study area using coprological examination.

Study sites	No. of faecal samples examined	No. of positive sample	Prevalence (%)	χ^2	P-value
Denkeka Koncha	120	84	70.0	4.7151	0.318
Haro Bilallo	42	23	54.8		
Gora Silingo	36	23	63.9		
Dosha	30	20	66.7		
Asella	180	128	71.1		
Total	408	278	68.1		

Table 6. Level of infection based on egg per gram (e.p.g) count of examined positive animals for nematode according to Hansen and Perry (1994).

Intensity of infection	Examined no. of samples (%)	e.p.g
Light	73 (30.04)	50-800
Moderate	98 (40.32)	801-1200
Heavy	72 (29.62)	More than 1200
Total	243 (100)	-

country by Hailuleul (2002) in Wolayta Soddo and Yosef (1993) in Asella. *Strongyloides* and *Trichuris* species were poorly represented. This agrees with the idea of Urquhart et al. (1996) which indicates only young are more susceptible to these parasites while adults usually develop certain immunity. Soulsby (1986) also indicated the presence of resistance to *Trichuris* in sheep over eight months and not usually severe enough to cause clinical disease. Clinical signs are seen mainly in the young and appear only in case of severe infection.

When infection rate on age was subjected to analysis, lambs were found more frequently infected than adult sheep. Even though their prevalence was not shown in a dramatic difference, the statically significant difference ($P < 0.05$) was recorded between the two age groups. The reason is that as new born and younger sheep, they lack strong immunity as in the adults. The possible explanation is that in adult sheep, after primary infection, rapid solid immunity is acquired. In fact, sheep continually exposed to infection are at low risk provided the rate of acquisition of infective larvae is sufficient to stimulate satisfactory response, and no cause of clinical illness was reported by Soulsby (1986). There are also special conditions encountered during peri-parturient rise in nematode eggs excretion, as early as two weeks before lambing, and persisted up to eight weeks post-partum when lambing, and took place during the wet seasons is the idea of Ng'ang'a et al. (2006). Thus, pregnant or lactating ewes became the major source of infections for the newborn lambs. In the same manner, other studies in Africa have shown that the age and immune status of the host animal have significant influences on nematode egg output (Magona and Musisi, 2005).

The present study shows no statistically significant

differences ($P > 0.05$) between different sex groups. This finding agrees with report by Assefa and Sissay (1998), with gastrointestinal helminthes affecting both sex groups equally. This is due to equal exposure of both sexes, and they are from similar agro-ecology. The variation may occur in the intensity of infection due to post-parturient parasite rise in lambed sheep. Similarly, there is no statistical significant difference observed between the study sites since they have the same agro ecology. This also agrees with report by Armour (1980) significant difference was reported in animals reared in different geographical areas.

Difference in body condition score is statistically significant ($P < 0.05$) with gastrointestinal nematode infection such that shedding of nematodes eggs increased with poor body condition (81.3%) than in good body condition (61.5%). This finding agrees with Bisset et al. (1986) who suggest that well-fed animals develop good immunity that suppresses the fecundity of the parasites. The highly statistical significant difference ($P < 0.05$) result obtained on monthly study revealed that the highest percentage of infection of the study subjects was 88.2% on March during the short rainy season and the lowest was 51.5%, recorded in January during the dry season. In the rest of the months, almost a close similarity records were obtained. This could be due to the development, survival and transmission of free living stage of nematode parasites which is influenced by micro-climatic factors within the faecal pellets and herbage which is in agreement with Urquhart et al. (1996). These include sunlight, temperature, rainfall, humidity and soil.

The seasonal fluctuations in numbers and availability of the infective larval stages are influenced by the level of

contamination of pasture. Larvae of important gastrointestinal nematodes are able to undergo a period of arrested development (hypobiosis) in host following infection; larvae may become metabolically inactive for several months. The greatest proportion of larvae usually becomes arrested at times when conditions in the external environment are least favorable for development and survival of eggs and larva (Michael et al., 1975). This suspension of development helps some nematode to survive the dry seasons. Resumption of rainy season is the most favorable period for larval development and transmission on pasture (Agyei et al., 1991).

CONCLUSION AND RECOMMENDATIONS

The present study was based solely on coproscopic examination for detection of gastrointestinal nematode eggs; it has provided an insight to the current prevalence and associated risk factors. It suggested that ovine gastrointestinal nematodes are of the major helminthosis in and around Asella. Age, body condition and seasonal dynamics are the most prominent risk factors associated with gastrointestinal nematode infection. In addition, weak status of animal health services and lack of proper management, especially in the study area, crop-livestock mixed farming is highly practiced, and most land is cultivated so that many species of animals are kept together on marginal and a piece of land. However, they give low priority to sheep in respect to the value they obtained from them. They give the first line to draught animals and forced sheep to graze behind on overstocked areas which lead them to graze close to the ground and on faecal materials, resulting in the uptake of higher numbers of infective larvae.

On the basis of the above conclusion and the present findings, the following recommendations are forwarded:

1. Detailed study should be conducted to clearly identify parasitic fauna using faecal culture and postmortem examination in the study area.
2. Strategic anthelmintic treatments: Treat sheep with broad spectrum anthelmintic at the beginning of rain season and at the end of dry season to reduce the worm burden and minimize pasture contamination with larvae, and treat flock with special consideration to those sheep in poor condition rather than individual animal separately. To prevent anthelmintic resistance, regular study should be carried out on the efficacy and resistance of the anthelmintic drugs directed to the subject area.
3. Using pasture management: Applying rotational grazing system for different seasons would reduce pasture contamination, separating the most susceptible young animals from adults, which is a possible source of contamination. Maintaining the stocking rate to reasonable level avoids consequent pasture contamination.
4. Education of farmers on the importance of the parasitic

diseases, its economic losses and the correct ways to improve animal husbandry system need to be applied.

5. Support role of veterinarians and animal health extensions in giving professional advices regarding preventive and control measures against gastrointestinal helminthes parasites and prevention of drug abuses.

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Full Length Research Paper

Evaluation of the effectiveness of two medicinal plants *Vernonia amygdalina* and *Leonotis nepetaefolia* on the gastrointestinal parasites of goats in Rwanda: Case study of Huye and Gisagara districts

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The two most commonly used medicinal plants as traditional healers were identified (*Vernonia amygdalina* and *Leonotis nepetaefolia*) and were tested for their effectiveness as antiparasitic drugs on the gastrointestinal parasites of goats in some sectors of Huye and Gisagara districts of Rwanda. A survey was conducted which revealed that 87.5% of the knowledge of veterinary traditional medicine is transmitted from generation to generation. The combination of *V. amygdalina* and *L. nepetaefolia* is used at an average of 87.5% while *V. amygdalina* alone is used on the average of 66.7%. For the goats treated with the combination of *V. amygdalina* and *L. nepetaefolia* (group 1), the mean prevalence of faecal shedding of strongyles' eggs was 78%, while for those treated with *L. nepetaefolia* alone (group 2) was 77.4% for pregnant goats and 86% for empty ones. For the fecal excretion of coccidial oocysts, the average prevalence was 73% for group 1 and 39% for group 2 whereas it was 13% for nematodirus. This investigation showed no influence of the sex or the age on the fecal egg excretion of Strongyle eggs and coccidia oocysts. The results showed that the single treatments were not effective in reducing the eggs in the faeces while the repeated treatments caused a considerable fall of level of faecal gastrointestinal egg excretion of strongyle as from day 14.

Key words: Coccidian oocysts, effectiveness, gastrointestinal helminthes, goats, *Leonotis nepetaefolia*, medicinal plants, Strongyle egg, *Vernonia amygdalina*.

INTRODUCTION

The problem of parasitism has been complicated by the appearance of phenomena characterized by the resistance to the many types of anthelmintics currently in use (Larrat, 1988). This resistance increases in animals that apparently seem to be sound but in reality, that are sick

and chronic parasites carriers. All along, the helminthiasis causes losses due to reduction in the animal production and reproduction due to strong morbidities and mortalities as well as an increase in their treatment cost (Beugnet, 2005; Tabuti (2003). Food and Agriculture Organization

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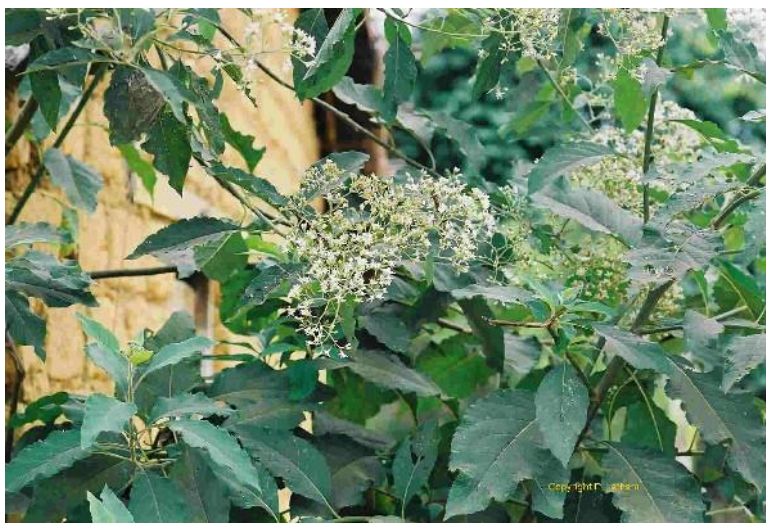


Figure 1. Leaved branch of blooming *V. amygdalina* tree at this stage, the aqueous extracts of this plant are considered more effective.

(FAO), 1992). Various measures have been taken and some remedies are being used to tackle the problem related to the resistant parasitism in domestic animals. The promotion of traditional veterinary medicine in Rwanda can have a significant impact directly on animal husbandry and indirectly on agriculture. This impact should mainly be seen within the framework of putting into place the efficient alternatives to the modern medicine which confronted with several constraints. One example among many is the high cost of drugs for animals which does not correlate with the low income of the stockbreeders and the scarcity of qualified veterinarians (Nyamanga et al., 2008). Among the threatened animals, the goat is menaced while it is the main domestic animal that improves the everyday life of the population in developing countries. Goats can be infected by numerous internal parasites (intestinal protozoa, nematode, etc) and the effect of infection by these gastrointestinal parasites varies according to the parasite involved, the degree of infection, common environmental factors (Terefe et al., 2012).

Some authors reported miscellaneous benefits of the recourse to the medicinal plants in healthcare of animals. The main benefits are the contribution to the fight against many types of diseases at the same time, the relief of the economic and commercial balance and the improvement of the social conditions of the breeders and healers. In addition, the country benefits from it since it leads to the reduction of problems related to synthetic drug residues and to biodiversity protection (Landais and Lhoste, 1990; Pieroni et al., 2004). Within this framework, we carried out an investigation on two used plants mostly used by the traditional healers of two districts of the Southern

Province of Rwanda in curing their domestic animals. A survey made to the traditional practitioners revealed that *Vernonia amygdalina* (locally called “Umubirizi”) and *Leonotis nepetaefolia* (locally called “Igcumucumu”) are the most commonly used plants, and these can be considered for antiparasitic activity. So, these were considered in this study.

Figure 1 shows *V. amygdalina*, commonly called “bitter leaf”. It is a member of the Asteraceae family. In the wild, chimpanzees have been observed to ingest the leaves when suffering from parasitic infections (Huffman and Seifu, 1989; Ademola and Eloff, 2011). In all cases, this medicinal plant, *V. amygdalina*, revealed to exhibit anticancer, anthelmintic and antiparasitic properties (Swee et al., 2010; Gresham et al., 2008; Sweeney et al., 2005; Izevbigie et al., 2004; Kupchan et al., 1969). *L. nepetaefolia* shown by Figure 2, also known as “Lion’s ear”, is a species of plant in the Lamiaceae family. *L. nepetaefolia* is known in some Asian countries as “shandilay” and the leaves are brewed as a tea for fever, coughs, womb prolapse and malaria (Mendes, 1986; Calixto et al., 1991).

MATERIALS AND METHODS

Field investigation

The experiment was conducted in Save sector of Gisagara district and Ngoma, Gishamvu, Maraba and Mbazi sectors of Huye district. A survey questionnaire was submitted to the traditional healers. The interview was conducted and aimed at collecting the information about their work organization; the medicinal plants they use to treat the verminosis in goats and the minimum doses for respective diseases. Experiments were carried out according to the



Figure 2. Leaved stem and inflorescence of *L. nepetaefolia*. The leaves are generally harvested when the bees arrive in droves for nectar-hunting.

information given about the plants.

Effectiveness evaluation

Sixty-three goats were subjected to the test of the effectiveness of combined extracts of *V. amygdalina* and *L. nepetaefolia* on the strangles while forty-nine goats was also subjected to the test of the effectiveness of the extract of *V. amygdalina* alone. As for the prevalence of faecal eggs shedding, all animals were considered while for the estimation of the rate of eggs reduction in faeces only 45 animals were used for each of the two tests.

Test of prevalence of fecal strongyle eggs and coccidia oocysts and reduction of the eggs/oocyst excretion

The completely experimental designs consisted of four treatments which corresponded to either *V. amygdalina* in single and repeated dose or the combination of the extracts of *L. nepetaefolia* in single and repeated dose. The faeces samples were directly taken from the rectum of each goat two days before the treatment (J_2) and then from rectal bolus seven days (J_7), fourteen days (J_{14}), twenty-one days (J_{21}) and twenty-eight days (J_{28}) after treatment. After collection, the samples were brought to veterinary laboratory of the School of Agriculture and Veterinary of Kabutare (EAVK) in Butare for coproscopic examinations. The counting of nematode eggs and the coccidia oocysts was made according to the Mc Master technique (Thienpont et al., 1995). However, for the heavy eggs such as those of the trematodes, it was necessary to use more specific solutions. The test of the effectiveness of different solutions against the strongyles in goats was done based on the reduction percentage of eggs excretion. The protocol for the eggs excretion

reduction was done as per World Association for the Advancement of Veterinary Parasitology "WAAVP" (Coles et al., 1992).

Composition of solutions and scheme of treatment and effectiveness evaluation time

Tables 1, 2 and 3 show the composition of the different solutions used in single or repeated treatment, the scheme of treatment and evaluation of the effectiveness of drug solution in goats respectively.

Data analysis

$$\text{Percentage of reduction} = 100 \left[1 - \left(\frac{\bar{X}_t}{\bar{X}_c} \right) \right]$$

X_c = arithmetic mean of the excretion per gram of the control(c), untreated goats, between 10 and 14 days after treatment

X_t = arithmetic mean of the excretion per gram of the treated (t) goats, between 10 and 14 days after treatment.

If the percentage reduction is greater at least to 95% and the less confidence limit greater than 90%, the solution is effective. The solution is ineffective if the percentage reduction is less than 95% and the confidence limit less than 90%.

All survey data and excretion per gram were encoded on an Excel spreadsheet. This spread sheet was used to produce tables and calculate the arithmetic means and standard deviations. Analysis of variance performed with statistical package for social

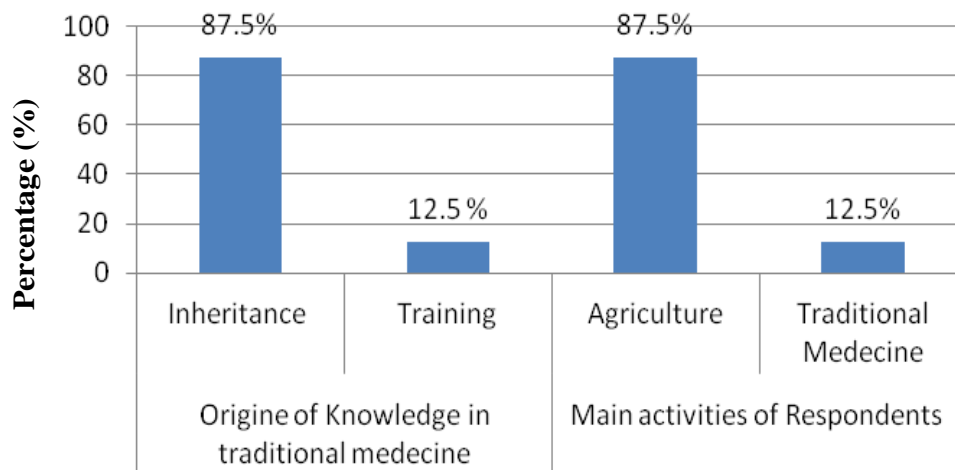


Figure 3. The origin of knowledge of interviewed persons in traditional veterinary medicine. In this survey, the traditional veterinary healers listed about 33 plants with animal helminthes remedial properties and targeted the two plants (*V. amygdalina* and *L. nepetaefolia*) to be frequently and efficiently used.

sciences (SPSS 14.0) software was used to compare the prevalence of fecal shedding of eggs and the value of excretion per gram of goats groups. The values of excretion per gram underwent logarithmic transformation before being analyzed statistically. The software FECR4 (Cameron, 2004) was used to calculate the rate of reduction of excretion per gram. The results of these tests to reduce excretion per gram based on the criteria were used to decide the effectiveness of the treatment used. Then, the number of eggs excreted per gram of faeces is given by the formula $Y*100$, with "y" represents the number of eggs counted in the two cavities of the cell.

RESULTS

Data from field investigation

The survey results (Figure 3) show that major part of interviewed people are farmers and their traditional medicine knowledge was inherited by their parents while only a small fraction of them got their knowledge from trainings accorded by the stakeholders. The diagram below shows interviewees' statistics with regards the origin of their knowledge in traditional medicine and their main activities.

Prevalence of fecal strongyloous eggs and coccidia oocysts in goats

Goats treated with the combined V. amygdalina and L. nepetaefolia (group 1)

This investigation in Ngoma, Maraba and Save sectors

showed that the comparison between the average prevalence of strongyle eggs excretion is quite high (78%), coccidia oocysts 73%, nematodirus 13%. There is a significant difference between the observations in Maraba and Ngoma sectors but for the event of nematodirus ($p = 0.025$) as well as the case of oocysts ($p = 0.039$), there was a significant difference between the results in Maraba and save sectors ($p = 0.008$). Age wise, there was no significant difference between the prevalence of eggs excretion of strongyle and coccidia oocysts obtained. As for the races of goats subjected to this investigation (14 goats of crossed race and 49 goats of local race), the prevalence of the egg excretion of strongyles for the cross bred was 100% while for local breed goats, the prevalence was 71% ($p = 0.04$). It was the same case for the prevalence of the infestation by nematodirus ($p = 0.003$). However, for the coccidia oocysts, there was no significant difference ($p > 0.05$).

Goats treated with V. amygdalina alone (group 2)

The average prevalence of strongyles eggs and coccidia oocysts was 77.4 and 39%, respectively depending on the physiological state. The average prevalence of fecal shedding of strongyle eggs was 71% for pregnant goats and 86% for void goats. For oocysts of coccidia prevalence was slightly higher in pregnant goats compared to non-pregnant ones (41 against 36%). There was no significant difference between the two groups ($p > 0.05$).

Table 1. Composition of the different solutions used in single or repeated treatment.

Types of measurements	Mixture of <i>V. amygdalina</i> and <i>L. nepetaefolia</i>	<i>V. amygdalina</i>
	Solution 1	Solution 2
Single dose per 15 animals		
Average quantity <i>V. amygdalina</i> (kg)	2.5	22.5
Average quantity <i>L. nepetaefolia</i> (kg)	1.7	-
Average quantity of water (L)	6	7.5
Single dose (L)	0.33	0.33
Repeated dose per 15 animals during 3 days		
Traditional healers	67	91
Average quantity <i>V. amygdalina</i> (kg)	1.81	56.5
Average quantity <i>L. nepetaefolia</i> (kg)	1.63	-
Average quantity water (L)	6	22.5
Daily dose (L)	0.33	0.33
Average time (days)	3	3
Average time of treatment (days)	1	1

The "solution 1" consists of a mixture of *V. amygdalina* and *L. nepetaefolia*. The "Solution 2" consists of a solution of *V. amygdalina* alone.

Table 2. Scheme of treatment and evaluation of the effectiveness of drug solutions in goats.

Groups of animals	Batch according to the type of treatment	Numbers of animals by batch	Administered solutions	Time of treatment
Group 1 (treated with the mixture of <i>V. amygdalina</i> and <i>L. nepetaefolia</i>)	Batch of control	15	Nil	No treatment
	Batch treated with a single dose	15	Solution 1 containing <i>V. amygdalina</i> and <i>L. nepetaefolia</i>	1 day
	Batch treated with a repeated dose	15	Solution 2 containing <i>V. amygdalina</i> and <i>L. nepetaefolia</i>	3 days
Group 2 (treated with <i>V. amygdalina</i>)	Batch of control	15	Did not receive anything	No treatment
	Batch treated with a single dose	15	Solution 1 containing <i>Vernonia amygdalina</i>	1 day
	Batch treated with a repeated dose	15	Solution 2, which contain <i>Vernonia amygdalina</i>	3 days

Table 3. Results of the test of reduction of eggs per gram for the group treated with both *V. amygdalina* and *L. nepetaefolia*. Case of single treatment.

Batches	Single treatment				Control			
	J ₇	J ₁₄	J ₂₁	J ₂₈	J ₇	J ₁₄	J ₂₁	J ₂₈
Day of analysis	J ₇	J ₁₄	J ₂₁	J ₂₈	J ₇	J ₁₄	J ₂₁	J ₂₈
Number of animals	14	14	14	13	14	15	15	15
Arithmetic mean	264	943	700	662	1.479	840	1.260	1.480
Variance (eggs per gram)	25.549	-	1,555.385	939.231	2,772.582	548.286	749.714	687.429
Reduction (%)	82	-12	44	55				
Variance of reduction	0.12	0.21	0.26	0.19				
Lower limit within confidence 95%	91	0	81	82				
Upper limit within confidence 95%	63	57	0	0				

Table 4. Results of the test of reduction of eggs per gram for the group treated with *V. amygdalina* and *L. nepetaefolia*. Case of repeated treatment.

Batches	Single treatment				Control			
	J ₇	J ₁₄	J ₂₁	J ₂₈	J ₇	J ₁₄	J ₂₁	J ₂₈
Day of analysis	J ₇	J ₁₄	J ₂₁	J ₂₈	J ₇	J ₁₄	J ₂₁	J ₂₈
Number of animals	12	13	15	13	13	15	15	15
Arithmetic mean	42	46	13	8	954	840	1.260	1.480
Variance (eggs per gram)	4.470	4.359	1.238	769	1,532.692	548.286	749.714	687.429
Reduction (%)	96	95	99	99				
Variance (reduction)	0.34	0.21	0.50	1.02				
Lower limit within confidence 95%	85	98	100	100				
Upper limit within confidence 95%	99	86	95	96				

Reduction level of the eggs excretion per gram of faeces

For all these treated animals, the analysis of the faeces was carried out in 7, 14, 21 and 28 days of the treatment while the reduction of excretion per gram was used to evaluate the effectiveness degree of the solutions.

Reduction level of the excretion per gram in goats of group 1

The Tables 3 and 4 used in the subsection show the results of the test of eggs reduction per gram for the group with both *V. amygdalina* and *L. nepetaefolia* in the case of single treatment and the case of repeated treatment respectively. The single treatment on day 7, the percentage of reduction was 82% from the following days until day 28 while the percentage of reduction was 55%. Consequently, the single treatment has not been effective in this investigation. For the repeated treatment, the action started on 14th day with 95% and on 28th day was 99% of reduction.

Reduction level of egg per gram in goats of group 2

In this subsection, the Tables 5 and 6 show the test of reduction eggs per gram for the goats treated with *V. amygdalina* alone in the case of single treatment and the case of repeated treatment respectively. Also in this case, the single treatment has not been effective to the goats of group 1. There was a reduction in the excretion of eggs from day 7 until day 28. For the case of repeated treatment, the reduction of the excretion of eggs per gram was fast and progressive from day 7 (88%) to day 28 (98%). During this test, the treatment was effective as from the 14th day.

DISCUSSION

In this study, we noticed that 87.5% of knowledge of the questioned traditional healers of animals were transmitted from generation to generations, frequently from parents to children. This situation was also reported by McCorkle and Martin (1998) and Nyamanga et al. (2008). According to them, around 80% of traditional

Table 5. Test of reduction eggs per gram for the goats treated with *Vernonia amygdalina* alone. Case of single treatment

Batches	Single treatment				Control			
	J ₇	J ₁₄	J ₂₁	J ₂₈	J ₇	J ₁₄	J ₂₁	J ₂₈
Day of analysis	J ₇	J ₁₄	J ₂₁	J ₂₈	J ₇	J ₁₄	J ₂₁	J ₂₈
Number of animals	15	15	15	15	15	15	15	15
Arithmetic mean	80	173	147	160	500	607	740	687
Value (egg per gram)	14.571	37.810	19.810	19.714	118.571	112.095	109.714	114.095
Reduction (%)	84	71	80	77	-	-	-	-
Variance (reduction)	0.18	0.10	0.07	0.07	-	-	-	-
Lower limit within confidence 95%	93	85	65	60	-	-	-	-
Upper limit within confidence 95%	61	44	89	86	-	-	-	-

Table 6. Results of the test of reduction of eggs per gram in goats treated with *Vernonia amygdalina* alone. Case of repeated treatment.

Batches	Single treatment				Control			
	J ₇	J ₁₄	J ₂₁	J ₂₈	J ₇	J ₁₄	J ₂₁	J ₂₈
Day of analysis	J ₇	J ₁₄	J ₂₁	J ₂₈	J ₇	J ₁₄	J ₂₁	J ₂₈
Number of animals	15	15	15	15	15	15	15	15
Arithmetic mean	60	27	27	13	520	15.607	740	687
Value (egg per gram)	12.571	2.095	2.095	1.238	81.714	112.095	109.714	114.095
Reduction (%)	88	96	96	98	-	-	-	-
Variance (reduction)	0.25	0.22	0.21	0.48	-	-	-	-
Lower limit within confidence 95%	96	98	99	92	-	-	-	-
Upper limit within confidence 95%	67	88	91	100	-	-	-	-

medicine knowledge come from father to their sons while around 18% of knowledge of traditional medicine come from the trainings.

With regards to plants used by traditional healers for animal verminosis treatment, 87.5% of questioned traditional healers from the aforementioned locations use the combination of *V. amygdalina* and *L. nepetaefolia* while 66.7% of them use *V. amygdalina* alone. Our observations were similar to the observations earlier recorded by Wan Yong Ho et al. (2010) and Nfi et al. (1999). They observed that *V. amygdalina* alone was able to control the animal verminosis on the

average rate of 52.4%. Alawa et al. (2000, 2003) hypothesized that the traditional antihelminthic claim of this plant extract may be contributed by the cleansing of gastric and intestines through increase of smooth muscle motility. The survey results showed that the posology is imprecise because there was no defined quantity.

As far as the rhythm of frequency is concerned it was also reported that it depends on the nature of remedy and the seriousness of diseases (Larrat, 1988). The animals of group 1 have shown a mean prevalence of fecal shedding of strongyle eggs of 78% while those of group 2

have shown the average prevalence of 77.4% for pregnant goats and 86% for empty females. These results differ from the prevalence (49.5%) reported by Terefe et al. (2012) but similar to those found by Gashururu (2006) and Hitimana (2009). As for the results of the test of the reduction of the eggs per gram in faeces, the evaluation of the effectiveness of the medicine containing *L. nepetaefolia* and or *V. amygdalina* was made in the image of other previous authors (Beugnet, 2005; Githiori, 2004). The solutions in single treatment (UT1 and UT2) were administered only once as indicated by certain traditional

healers. By single or repeated treatment of *V. amygdalina* and associated with other plants, the solutions were given in three successive days according to the previous reports of Niang (1996) and Kabore et al. (2007).

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Full Length Research Paper

Temporal distribution of diseases of farm animals presented to Gondar University Veterinary Clinic, Ethiopia, during the years 2007 to 2009

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A retrospective study was conducted to determine temporal distribution of clinical diseases of farm animals presented to Gondar University Veterinary Clinic during the years 2007 to 2009. Of the total 1966 clinical cases, septicemia, parasitic cases, pneumonia, reproductive tract problems, metabolic disorders, wound, clinical mastitis and dermatitis were frequent cases and contributed 33.2, 22.4, 15.7, 5, 4.2, 4.1, 3 and 2.6% of the total cases, respectively. Highest and lowest number of cases were registered in the years 2009 (38.9%) and 2007 (27.8%), and during winter (27%) and spring (23.3%) seasons, respectively. Septicemia, parasitic cases/diseases, and pneumonia were the most frequent cases observed. The highest number of cases of septicemia, 208 of 653 (31.9%), was observed in summer, being peak in June. The highest number of parasitic (126 of 440) and pneumonia (117 of 312) cases was observed in winter, being peak in February. Occurrence of the common diseases follow relatively similar pattern of temporal distribution in sheep and cattle. Generally, lowest peaks of clinical diseases were observed during the months of November and December. The study indicated that occurrence of clinical cases had been affected by temporal factor. Therefore, animal owners and animal health service providers should give more emphasis for winter and summer months to prevent occurrence of clinical diseases in their animals in the study area.

Key words: Cattle, Gondar, parasite, pneumonia, septicemia, sheep.

INTRODUCTION

Emphasis of veterinary medicine had been on the treatment of individual animals with clearly identifiable diseases or defects. Currently, restricted attention is given to herd health and comprehensive preventive medicine which give proper consideration to both infectious and non-infectious diseases, and designed to increase production by preventing disease, rather than just dispensing traditional treatment to clinically sick

animals (Thrusfield, 2005). However, in the developing countries like Ethiopia, the infectious diseases still cause considerable loss of animal life and production (Rashid and Shank, 1994; Thrusfield, 2005). In such countries, animal disease management is still practiced by treatment of individual animals.

Diagnosing a disease and provision of treatment and control measures for disease management involves

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physical examination and generation of a list of differential diagnoses; the critical part of which is clinical examination of individual animal or group of animals (Faccini, 2008). However, in addition to the clinical examination of individual or group of animals, epidemiological investigation may make a valuable contribution to the making of a diagnosis for a herd of animals affected with clinical disease (Thrusfield, 2005).

Prevalence and intensity of pathogenic infections are often seasonal and occur in many species and may be linked to changes in the host or to seasonal changes in the prevalence of the pathogen or vector (Nelson et al., 2002). In this regard, knowledge of temporal pattern of distribution of a disease in a population is important in suggesting the type of disease that is occurring and its possible causes. It also helps to relate the information to management or environmental changes (Radostits et al., 2007) and is an important step in planning and implementing effective control measures. It helps to understand the natural history of infectious diseases in different populations and to determine their importance and efficacy of control campaigns (Thrusfield, 2005). This can be determined by collecting and graphing of time of occurrence of clinical diseases (Radostits et al., 2007). However, spatial and temporal distribution of clinical diseases of farm animals was not known in and around Gondar. A study of temporal distribution of clinical diseases of farm animals was therefore carried out on farm animals presented to Gondar University Veterinary Clinic in the years 2007 to 2009, Ethiopia.

MATERIALS AND METHODS

Origin of study animals

The area where study animals were originated was Gondar town and its surroundings. This area has four seasons with sub-humid agro-climatic zone. Months of June to August are summer (rainy seasons), months of September to November are spring, months of December to January are winter (dry seasons) while months of March to May are autumn. The area has daily temperature of 22 to 30.7°C, and it receives an annual rainfall of 1172 mm. In the study area, there were 78,123 cattle, 25,067 sheep, 21,515 goats and 9,588 equines (horse, donkey and mules) (Community-supported agriculture (CSA), 2008).

Study subjects

Clinically sick farm animals' species including cattle, sheep, goats, horses and donkeys were the study subjects. In Gondar town, animals were kept in intensive and semi-intensive management system; fed with concentrates and hay; water available free throughout the day time. Sheep and goats were left to graze road sides. Most cattle are indigenous zebu and Holstein-Zebu crossbred kept for dairy purpose; most of them were females. In the surroundings of Gondar, animals were kept in extensive management system, and allowed to graze native pastures. Animals trekk-

ed for watering once in a day. Crop residues were given for oxen and cows when there is scarcity of pasture to graze at the late dry season. However, supplementary feeding after work for oxen, for milking cows, before and after packing for equines and for fattening of sheep and goats was not uncommon. Most cattle were the indigenous zebu breeds of both sexes kept mainly for breeding for the purpose of replacing draught oxen.

Study design

It was a retrospective study conducted on 1966 clinical cases of farm animals presented to University of Gondar Veterinary Clinic during the years 2007 to 2009. Clinical cases of bloat, clinical mastitis, colic, diarrhea, hernia, conjunctivitis, septicemia and tumor were taken as separate problems. Other cases were grouped into the following ten major categories. Cases of hematoma and omphalitis were categorized under cellulites. Orf, dermatophilosis, dermatophytosis and otitis categorized as cases of dermatitis. Cases associated with consumption of foreign materials like eating of polyethylene plastic materials, cases associated with traumatic reticuloperitonitis and esophageal obstruction was categorized into foreign body problems. Cases which discharge pus without intervention or following paracentesis or minor surgery like localized purulent lesions, actinobacillosis and actinomycosis were considered localized abscess. Cases of hypocalcemia, acidosis, simple indigestion and pregnancy toxemia were grouped as metabolic disturbances. Cases of tetanus, coenurosis and cowdriosis were categorized into cases of nervous disturbances. Internal parasites including strongyles, lungworms, trypanosomiasis, nasal bot, babesiosis, fasciolosis, ascariasis and coccidiosis and external parasites including ticks and mange mites were grouped into problems associated with parasites. Aspiration pneumonia, *Pasteurella* pneumonia, verminous pneumonia, contagious caprine pleuro-pneumonia (CCPP), contagious bovine pleuropneumonia (CBPP) and other pneumonia associated with unpredictable causes were categorized into problems of pneumonia. Cases due to metritis, abortion, retained fetal membrane, vaginal prolaps, cystitis, uterine torsion, pyometra, dystocia and orchitis were categorized into problems of reproductive tract. Cases of saddle sour, yoke sore, mechanical injury and any wound produced due to any trauma were categorized into cases of wound.

Data management and analysis

The data were entered and managed in MS Excel work sheet. Proportion of different farm animals' health problems was expressed as percentage by dividing total number of animals positive to a specific health problem to the total number of animals which showed clinical disease

RESULTS

Of the total 1,966 animal health cases presented to University of Gondar Veterinary clinic in the three years period, the highest 53% (1,041 of 1,966) were cattle followed by sheep (38%) and equine (7.4%) while the lowest 1.7% (33 of 1,041) were goats. When the distribution of clinical cases was observed during the years 2007 to 2009, the highest number of cases was registered in the year 2009 (38.9%) while lowest was

Table 1. Number of clinical cases diagnosed during the years 2007 to 2009 in University of Gondar Veterinary clinic.

Type of cases	Total no. of cases (%)	Number of cases in the three years period		
		2007 (%)	2008 (%)	2009 (%)
Septicemia	653 (33.2)	197 (30.2)	253 (38.7)	203 (31.1)
Parasitic cases	440 (22.4)	159 (36.1)	122 (27.7)	159 (36.1)
Pneumonia	312 (15.9)	88 (28.2)	93 (29.8)	131 (42)
Reproductive tract problems	98 (5)	16 (16.3)	13 (13.3)	69 (70.4)
Metabolic disorders	83 (4.2)	16 (19.3)	22 (26.5)	45 (54.2)
Wound	81 (4.1)	14 (17.3)	28 (34.6)	39 (48.1)
Clinical mastitis	60 (3)	12 (20)	19 (31.7)	29 (48.3)
Dermatitis	52 (2.6)	13 (25)	22 (42.3)	17 (32.7)
Localized abscess	48 (2.4)	13 (27)	20 (41.7)	15 (31.2)
Diarrhea	43 (2.2)	8 (18.6)	24 (55.8)	11 (25.6)
Foreign body	27 (1.4)	5 (18.5)	6 (22.2)	16 (59.3)
Tumor	20 (1)	-	10 (50)	10 (50)
Bloat	13 (0.7)	1 (1.9)	9 (69.2)	3 (23.1)
Conjunctivitis	12 (0.6)	-	5 (41.7)	7 (58.3)
Colic	7 (0.4)	1 (14.3)	4 (57.1)	2 (28.6)
Hernia	7 (0.4)	-	3 (42.9)	4 (57.1)
Nerveous disturbances	7 (0.4)	3 (42.9)	2 (28.6)	2 (28.6)
Cellulitis	3 (0.2)	-	-	3 (100)
Total	1966	546 (27.8)	655 (33.3)	765 (38.9)

registered in 2007 (27.8%) (Table 1).

When pattern of the most frequent 10 cases was considered, highest number of cases of septicemia, 208 of 653 (31.9%) was observed in winter seasons while the lowest (142 of 653) was observed in summer. Highest number of parasitic cases (126 of 440) and pneumonia cases (117 of 312) was observed in summer while the lowest parasitic cases (92 of 440) and pneumonia cases (47 of 312) was observed in winter seasons of the study period (Figure 1).

Peak septicemia was observed during the months of June and March while the lowest number of cases of septicemia was observed in December. The highest parasitic case was observed in September while the lowest was observed during August. The highest case of pneumonia was observed during the months of February while the lowest was observed during the months of July, August and September. Generally, lowest peaks of clinical diseases were observed during the months of November and December while relatively highest number of clinical cases was observed during the months of June, February and March (Figure 2).

The number of sheep with clinical cases of septicemia was peak during August while that of parasitic cases and pneumonia was highest during the months of October and February, respectively. The lowest number of cases of septicemia was observed during July while that of

parasitic cases and pneumonic cases was observed during the months of June and July, respectively (Figure 3). The number of cattle with clinical cases of septicemia was peak during the months of June and March while the lowest number of cases was recorded during September. The number of cattle with parasitic cases was highest during September while the lowest number of cases due to parasites was observed during August. Highest number of cattle with cases of pneumonia was observed during June while the lowest was recorded during September (Figure 4).

DISCUSSION

Highest number of cases was registered in the year 2009 compared to the other two years which may be associated with changes in environmental factors like rain, temperature, and humidity which might affect animal disease occurrence among the study years or increase in the number of clients in the years 2008 and 2009, as the veterinary clinic was recently established. However, when the number of animals for each of clinical problems was compared among the study years, almost similar pattern of occurrence was observed. Number of cases with septicemia was highest in each of the study years followed by parasitic cases, pneumonia, reproductive

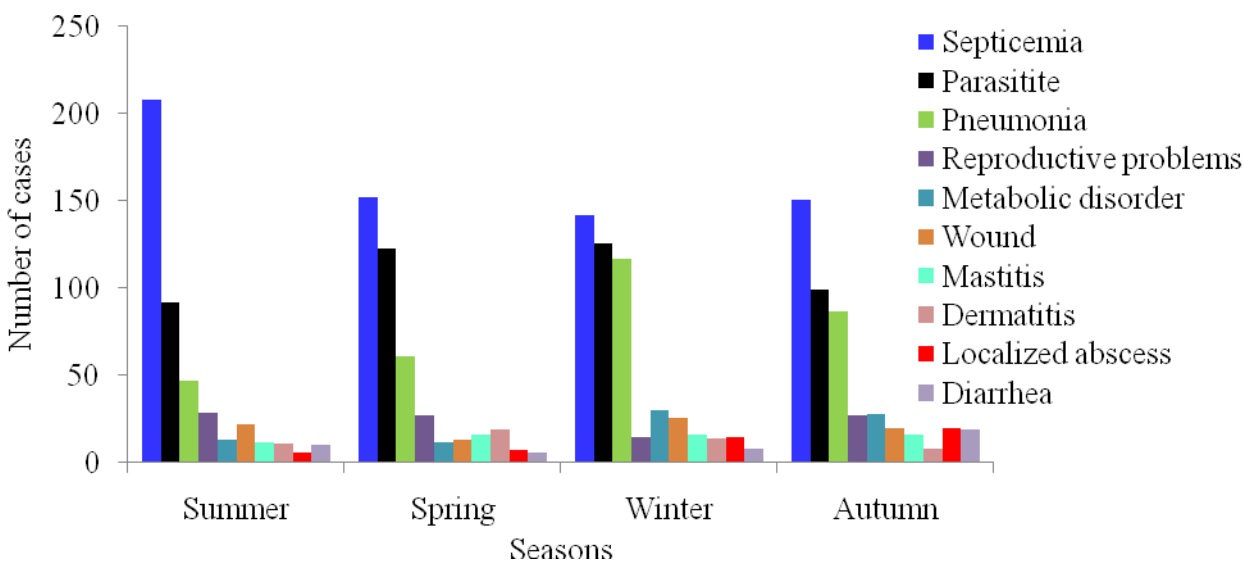


Figure 1. Seasonal occurrence of most common clinical cases of farm animals presented to Gondar University Veterinary clinic during the years 2007 to 2009.

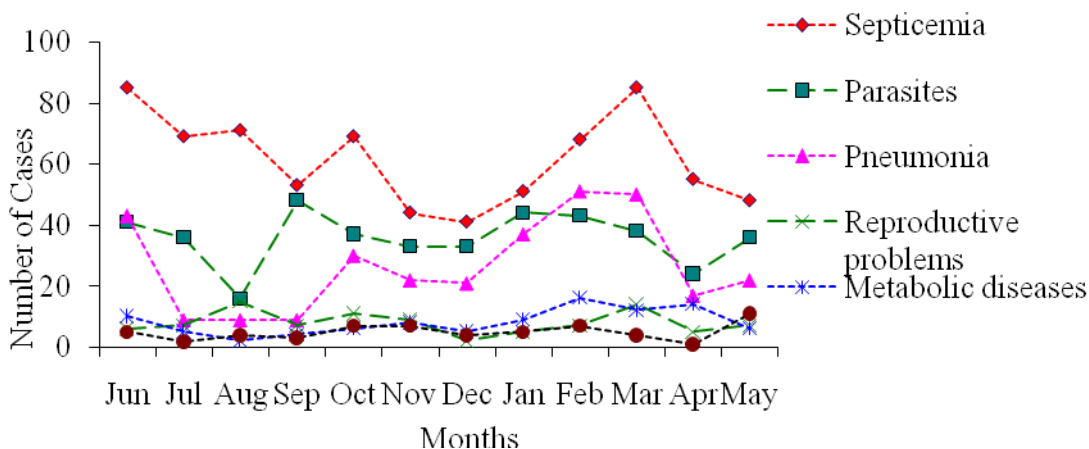


Figure 2. Monthly dynamics of major clinical cases of farm animals presented to Gondar University Veterinary clinic during the years 2007 to 2009.

tract problems and metabolic disorders. Occurrence of highest number of cases of septicemia observed in summer and especially during the month of June can be justified from the point of high level of environmental contamination as the result of flooding following the start of rainy season which disseminates infectious agents from cadavers and other reservoirs. Human activity like excavation of soil for cultivation during these times can also expose and activate latent organisms and facilitate disease transmission (Radostits et al., 2007). Similarly, highest number of septicemia during March could be associated with high level of exposure to infectious

agents. Animals graze close to the ground as a result of scarce grazing and have higher chance to acquire infectious agents, and short rain might favor multiplication and transmission of infectious agents.

Highest number of parasitic cases was observed during spring and winter. The result in this study coincides with the previous works of Alemu et al. (2006) and Regassa et al. (2010) who reported highest prevalence of small ruminant lungworms in November (spring) and February (winter). The difference might be associated with variation in seasonal factors as the epidemiology of gastrointestinal nematode infections is influenced by

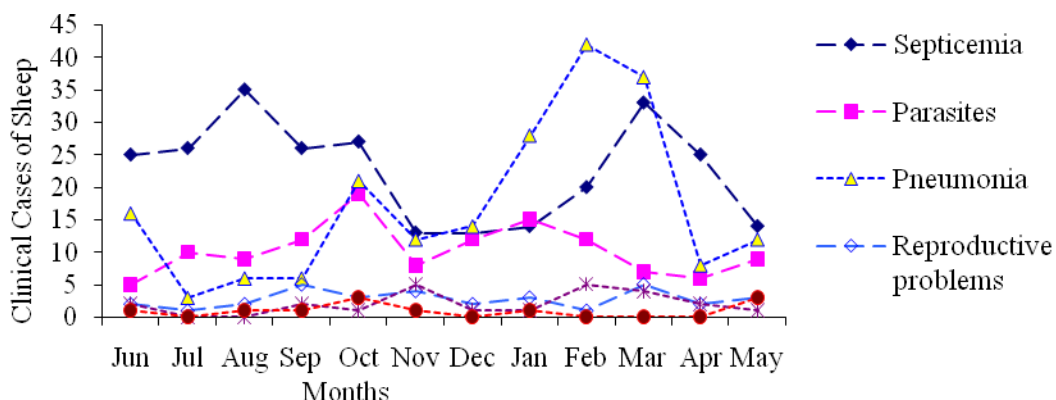


Figure 3. Monthly dynamics of major clinical cases in sheep presented to University of Gondar Veterinary clinic during the years 2007 to 2009.

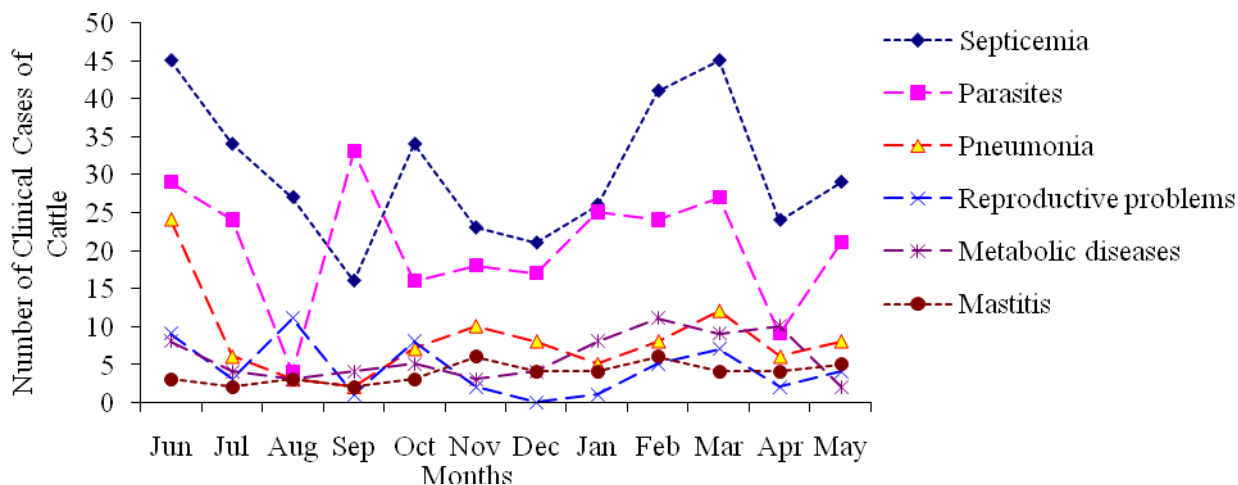


Figure 4. Monthly dynamics of major clinical cases in cattle presented to University of Gondar Veterinary clinic during the years 2007 to 2009.

climatic factors (particularly rainfall and temperature), management systems used for the animals, and parasite factors including intermediate hosts all determine the epidemiology of the parasite as well (Kusiluka and Kambarage, 2006). According to Taylor and Andrews (2003), parasitic gastroenteritis normally occurs when calves or non-immune older cattle are grazed on pastures on which a large number of infective larvae are present.

The highest number of cases of pneumonia was observed in winter, especially during February. According to Radostits and his colleagues, deprived of feed and water for prolonged periods, marked changes in weather, and other factors that impair innate or adaptive resistance increase the animal's susceptibility to pneumonia (Radostits et al., 2007). In such cases, most of the bac-

teria which are normally resident in the upper respiratory tract have the ability to establish themselves in the lower respiratory tract (lung) and cause disease when the defense mechanism of the host is affected (Lopez, 1995; Health and Age, 2005). Therefore, the highest number of pneumonia is associated with change in the factors that determine animals' resistance to infection.

Occurrence of the common cases of clinical diseases follow relatively similar pattern of temporal distribution in sheep and cattle. Generally, the relative difference in the temporal distribution of the number of clinical cases might be associated with changes in environmental factors directly or indirectly affecting animals' immunity and/or factors which favor multiplication, survival and transmission of disease causing agents. Some non-infectious diseases may also show seasonal trends

(Thrusfield, 2005).

Conclusion

When the most common clinical cases were considered, highest number of cases of septicemia, parasitic cases, and cases of pneumonia was observed in summer, spring and winter seasons especially in the months of June, September, and February, respectively. Therefore, animal owners and animal health workers should give more attention during this time of the year for optimal prevention and control of clinical diseases of farm animals in the study area.

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