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Ansell JE, Buttaro ML, Thomas VO (1997). Consensus guidelines for coordinated outpatient oral anti coagulation therapy management. Ann. Pharmacother. 31:604-615

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.

Furmaga EM (1993). Pharmacist management of a hyperlipidemia clinic. Am. J. Hosp. Pharm. 50: 91-95

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Full Length Research Paper

Pre-weaning kid mortality in Adamitulu Jedokombolcha District, Mid Rift Valley, Ethiopia

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A longitudinal study was conducted, from October 2008 to April 2009, on 188 kids born from flocks of 50 randomly selected households in Aneno and Edokontola villages in Adamitulu Jedokombolcha district, mid rift valley, Ethiopia. The aim of the study was to estimate pre-weaning mortality, identify associated factors and establish possible causes of death in goat kids. Data collected were used to evaluate the effect of sex, birth weight, parity, type of birth and some management practices on pre-weaning mortality. All the factors, except sex of the kid, significantly (at least *P*<0.05) influenced the mortality of kids. Generally mortality increased (*P*<0.05) with parity. There were more deaths in kids born in triplets than in twins and single litters. Management practices such as keeping new born kids with their doe near homestead, and separation of sick animals had significantly reduced (*P*<0.001) pre-weaning kid mortality. Mismothering was the most frequently suspected cause of mortality followed by pneumonia, enzootic ataxia, diarrhea, goat pox and predators. The study revealed the existence of very high kid mortality in the study area. Supplementation of multiple-bearing pregnant does and nursing does with multiple litters may be considered to reduce pre-weaning kid lose.

Key words: Adamitulu, Ethiopia, goat, kid, mortality, pre-weaning

INTRODUCTION

Goat production is affected both by genetic and environmental factors. One of the most important production factors that adversely affect goat production is high pre-weaning mortality of young kids (Devendra and Burns, 1970). Kid mortality, in addition to the immediate economic loss, has a direct effect on genetic progress by its effect on selection pressure. A high mortality may also represent a compromised animal welfare which poses ethical concern in animal production (Martin et al., 2004). Several factors had been reported in the literature to affect mortality rate in goat kids such as type of birth, sex of kid, birth weight of kid, parity order, season of kidding and age of the kid (Awemu et al., 1999; Mtenga et al., 1993; Turkson, 2003; Turkson et al., 2004; Hailu et al., 2006). Generally, higher kid mortality occurs at birth and from birth to weaning while mortality is relatively low from weaning to breeding age in many production systems (Mtenga et al., 1993; Donkin and Boyazoglu, 2004).

The death of kids before weaning is perhaps the single biggest cause of economic loss to goat farmers and may be reduced by improvements in the management and feeding of the kidding flock (Payne and Wilson, 1999; Snyman, 2010). Such efforts to improve survival of kids would increase productivity and economic return to the farm (Devendra and Burns, 1970). Very little work on mortality, morbidity and their causes in goat kids has been published from Ethiopia (Hailu et al., 2006; Debele et al., 2011). In general, there is shortage of information on diseases, mortality and morbidity rates and constraints in goat production in Ethiopia. Therefore the objective of this study was to estimate pre-weaning kid mortality, identify factors which influence mortality and to find out

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probable causes of mortality in traditionally managed goat flocks in the study area.

MATERIALS AND METHODS

Study area

The study was conducted between October 2008 and April 2009 in Anenno and Edokontola villages in Adiamitulu Jedokombolcha district, which is located in the mid rift valley of Ethiopia, approximately 170km south of Addis Ababa. The area is situated at an altitude of 1650 m above sea level at 7°9'N latitude and 38°7'E longitude and receives an average rainfall of 766 mm. Mean maximum and minimum temperatures of the area are 29.2 and 12.7°C respectively. The area is mainly dominated by Pennisetum, Cenchrius grass species and acacia trees (Hailu et al., 2006). The study period mainly falls in the dry season.

Study Animals

The study was conducted on 188 Arsi-Bale kids born during the study period in randomly selected 50 households. The kids were individually identified with ear tags and followed until the age of 90 days (3 months) or until the end of the study period. Goat flocks in the area were traditionally managed. The flocks browse oncommunal grazing area dominated by open grassland and there is virtually no habit of supplementation of any group of goats including nursing and pregnant does. The goats reproduce year round without control breeding (Kebede et al., 2012).

Study design

The study involved a longitudinal monitoring of kids born from flocks of 50 randomly selected households in Anneno and Edokontola villages in Adamitulu Jedokombolcha district. A structured questioner was used to collect information regarding animal management practices of the households (care for neonatal kids, disease prevention measures and feed supplementation) and doe history. Kids born during the study period were weighed within 12hr, using suspended scale with sensitivity of 100 g, and ear tagged. They were monitored by regular weekly visit for the rest of the study period. Date of birth, birth weight, sex, type of birth, death of kids, disease signs and possible causes of mortality were recorded by resident enumerators and by research team members though weekly visits. Probable cause of death was established based on signs of disease observed by the owners and research team members.

Data Analysis

Recorded data were entered in excel spread sheet as database and used to analyze different attributable factors. The response variables considered were kid birth weight and mortality of kids to a specific age (birth to 30, birth to 60 and birth to 90 days). The factors considered for birth weight were birth type, parity and sex, while the risk factors considered for mortality were sex of the kid, birth weight, parity of the doe, type of birth and management practices. Descriptive statistics was employed to summarize the data. Student t-test (two samples) and ANOVA were used to determine the effect of the independent variables on birth weight, while chi-square and fishers exact test were used to see the effect of the risk factors on mortality of kids. STATA version 7 (Stata corporation, 2001) and SPSS version 13(SPSS, 2004) were used to analyze the data.

Table 1. Birth weight of kids by sex, parity and type of birth.

Factors	Number of Obs.	Mean	SD
Overall mean	188	2.04	1.03
Sex		NS	
Male	101	2.13	1.07
Female	87	1.95	0.97
Dam Parity		***	
1	23	3.24^{a}	0.77
2	24	2.75^{b}	0.98
3	30	2.15^{c}	0.99
4	35	2.00^{c}	0.85
5	34	1.46^{d}	0.77
6	42	1.42^{d}	0.64
Type of birth		***	
Single	33	3.03^{a}	0.92
Twins	78	2.30^{b}	0.96
Triplets	77	1.37^{c}	0.60

NS, P>0.05, *** $P < 0.001$. ^{a,b,c,d} means within a column and within the same factor followed by different alphabets differ significantly $P< 0.05$.

RESULTS

Birth weight

The overall mean birth weight of kids was 2.04(±1.03 sd) Kg. There was no significant difference in birth weight between male and female kids (P>0.05). Birth weight was significantly (P<0.001) affected by parity of the dam and the type of birth. Generally birth weight decreased with increased parity and kids born single were heavier than kids from twins and triplets. The birth weight of triplets and those from 5th and 6th parities was less than 2 kg (Table 1).

Type of birth

Table 2 summarizes the number of kids obtained from single, twin and triplet births. As parity increased the number of kids obtained from multiple births generally increased. The highest proportion of single born kids were recorded from primiparous does, while the highest proportion of kids obtained from twins and triplet births were observed from does at parity 4 and 6 respectively.

Mortality of kids

One hundred and seventy eight kids were followed for up to 30 days of their age and 54 (30.3%) died before they were 30 days old, 162 kids were followed up to 60 days and 62 (38.3%) died before they were 60 days old and 65 out of 139 (46.8%) died before they were 90 days old.

Age of the kid in months had significant effect (P <0.05) on mortality of kids (Table 3). Out of 65 kid deaths

Table 2. Type of birth by parity.

Type of birth	Parity of does												
	1		2		3		4		5		6		
	N	%	N	%	N	%	N	%	N	%	N	%	
Single	14	60.9	8	33.3	6	20	2	5.7	2	5.9	1	2.4	33
Twin	9	39.1	11	45.8	14	46.7	19	54.3	12	35.3	13	31	78
Triplets	0	0	5	20.8	10	33.4	14	40	20	58.8	28	66.7	77
Total	23		24		30		35		34		42		188

Table 3. Number and proportion of kids died in their first, second and third months of life.

Age of kid in months	Number of Obs.	Number of deaths	% of total death
First month	178	54	83.1
Second month	162	8	12.3
Third month	139	3	4.6
Total		65	100

Table 4. Number and proportion of kids died in the first 4 weeks of their life.

Age in week	Number of deaths	% of total death
First week	19	35.2
Second week	13	24.1
Third week	10	18.5
Fourth week	12	22.2
Total	54	100

recorded during the study 54 (83.1%) occurred within the first month of their age. However, there was no significant difference (P>0.05) regarding number of deaths among the first 4 weeks of kid's life (Table 4).

Birth weight of kids affected (at least *P*<0.01) pre-weaning mortality to all specific ages considered in the analysis. A highest mortality (59.1%) was recorded for kids less than or equal to 2 kg while the lowest mortality (14.3%) was recorded for kids more than 3 kg at birth. There was no significant difference between kids born with less than or equal to 1kg and those born between 1.1 and 2 kg.

In this study parity of the dam significantly (P<0.05) affected pre-90 days and pre-60 days kid mortality. Generally mortality increased with parity. The influence of litter size on mortality of kids was significant source of variation (P<0.05). There were more deaths for kids which were born in triplets than in twins and single litters. Interestingly there was no statistically significant difference in the mortality of kids born as singles and twins (Table 5).

Management practices by the farmers, keeping the newborn kid and the doe near homestead for the first week postpartum and the habit of separation of sick animals from healthy ones had significantly affected pre-weaning kid mortality (*P*<0.05).

Keeping kids and does separated from the rest of the flock for at least 1 week significantly (*P*<0.05) decreased birth to 60 and 90 days mortality. However, birth to 30 days mortality was not influenced by this management practice (*P*<0.05). Kids born in households who have the habit of separating sick animal from the healthy ones had lower mortality (at least *P*<0.05) compared to kids from households without this practice.

Causes of kid mortality

Table 6 summarizes major causes of kid mortality identified during the study and their contribution to the total number of death. Mismothering was the most frequently suspected cause of mortality (26%); followed by pneumonia (20%), enzootic ataxia (18.5%), diarrhea (17%), unknown causes (7.7%), goat pox (6.2%) and predators (4.6%).

DISCUSSION

Factors affecting kid birth weight

The average kid birth weight (2.04 kg) recorded in this study is lower compared to reports from other parts of Africa (Aganga et al., 2005; Maphosa et al., 2009). This higher birth weight in other studies may be due to breed difference including difference in twining and tripleting. Multiple births were high in our study. Of the 188 live kids born during the period of the study 41.5 and 41.0% were twins and triplets respectively. Multiple litters had low

Table 5. Birth to 30, 60 and 90 days mortality of kids by risk factors.

Factor	Birth to 30 days			Birth to 60 days			Birth to 90 days		
	N	Death	%	N	Death	%	N	Death	%
Overall	178	54	30.3	162	62	38.3	139	65	46.8
Sex			NS			NS			NS
Male	96	32	33.3	88	37	42.0	76	37	48.7
Female	82	22	26.8	74	25	33.8	63	28	44.4
Birth weight (Kg)			**			***			***
≤1	63	28	44.4[a]	58	33	57.0[a]	54	35	64.8[a]
1.1-2	69	19	38.8[a]	47	19	40.0[a]	39	20	51.3[a]
2.1-3	34	5	14.7[b]	29	7	24.0[b]	25	7	28.0[b]
3	32	2	6.3[c]	28	3	11.0[c]	21	3	14.3[c]
Parity			NS			**			*
1	22	3	13.6	16	3	18.8[a]	14	3	21.4[a]
2	22	3	13.6	20	3	15.0[a]	15	3	20.0[a]
3	28	7	25.0	24	6	25.0[a]	19	7	36.8[a]
4	32	10	31.3	30	11	36.7[ac]	29	13	44.8[ad]
5	32	14	43.8	31	17	54.8[bc]	28	17	60.7[bd]
6	42	17	40.5	41	22	53.7[bc]	34	22	64.7[c]
Type of birth			*			*			*
Single	31	6	19.4[a]	28	7	25.0[a]	25	7	28.0[a]
Twins	74	18	24.3[a]	65	21	32.3[a]	53	21	39.6[a]
Triplets	73	30	41.1[b]	69	34	49.3[b]	61	37	60.7[b]
Separation of newborn kids and does			NS			**			**
Yes	82	19	23.2	72	18	25.0	58	19	32.8
No	96	35	36.5	90	44	48.9	81	46	56.8
Separation of sick animals			*			**			**
Yes	88	19	21.6	80	22	27.5	66	22	33.3
No	90	35	38.9	82	40	48.8	73	43	58.9

NS, not significant (P>0.05); * P<0.05; ** P < 0.01; *** P < 0.001. [a,b,c,d] proportions with in a column and within the same factor followed by different alphabets differ significantly at *P*<0.05

Table 6. Relative importance of causes of pre-weaning kid mortality

Causes of mortality	Number of deaths	% contribution to the total death
Enzootic ataxia	12	18.5
Miss mothering	17	26
Pneumonia	13	20
Diarrhea	11	17
Goat pox	4	6.2
Predator	3	4.6
Unknown	5	7.7
Total	65	100

birth weight compared to single litter kids.

Contrary to several reports of higher birth weight of male kids compared with females (Aganga et al., 2005; Ukanwoko et al., 2012), there was no statistically significant difference in birth weight of male and female kids in this study.

We observed a steady decline in birth weight of kids as parity of dam increased. This may be explained by the observed increase in litter size as parity increased.

Factors affecting kid mortality

The overall pre-weaning kid mortality observed in this

study (46.8%) was very high compared to 25% mortality reported for an experimental flock of the same breed reared on station not far from our study area (Hailu et al., 2006) and 34.2% on farm (Debele et al., 2011). It was also high compared to reports from other African countries ranging from 10 to 40.6% (Mtenga et al., 1993; Awemu et al., 1999; Turkson, 2003; Turkson et al., 2004; Aganga et al., 2005; Snyman, 2010).

Sex

The effect of sex on pre-weaning mortality was not found important ($P>0.05$), consistent with the works of Mtenga et al. (1993) and Awemu et al. (1999). However it contradicts with the finding of Perez-Razo et al. (1998), Aganga et al. (2005) and Hailu et al. (2006) who recorded a higher mortality for male kids compared to females. Debele et al. (2011) on the other hand, reported higher death rates in females than males in Arsi-Bale kids kept in a similar environment.

Birth weight

Birth weight of kids significantly affected mortality to all age groups considered (birth to 30, 60 and 90 days). A high pre-weaning mortality was recorded for kids less than or equal to 2 kg at birth. Losses were relatively low in kids that weighed 3 kg or more at birth. The result found in this investigation is in agreement with many earlier works (Mtenga et al., 1993; Awemu et al., 1999; Aganga et al., 2005; Hailu et al., 2006; Snyman, 2010) who reported higher mortality in light kids at birth. This may be attributed to low energy reserve which renders the kid susceptible to harsh environmental conditions.

Type of birth

The influence of litter size on mortality rate of kids was a significant source of variation. There was more death for triplets than twins and single litters. The low birth weight of kids observed for multiple births in this study may be partly responsible for higher mortality in triplets. Insufficient milk to satisfy triplets can also largely contribute for this. Feed resources are in general in short supply in the dry season in Ethiopia. This result is in agreement with Hailu et al. (2006), who reported high mortality in triplets compared to singles and twins.

Mtenga et al. (1993) recorded higher mortality in twins than singles and Snyman (2010) reported highest survival rate in single born kids followed by twins and triplet-born kids.

Parity

Parity had a significant influence on pre-weaning kid mortality. Mortality rates were generally found increasing with increasing parities. This result is in agreement with reports of Butswat et al. (1995) who reported an increase in mortality rate with parity in lambs due to an increase rate of twinning as parity increased. The increase in mortality as parity increased may be due to increase in multiple births as parity increased as shown in Table 2. Increase in litter size was associated with low birth weight. Low birth weight is frequently associated with high kid mortality (Mtenga et al., 1993; Awemu et al., 1999; Hailu et al., 2006; Snyman, 2010). However, this result contradicts with Awemu et al. (1999) who reported reduction in mortality rate with increased parities and attributed this to physiological maturity of older does and their ability to provide enough milk for the kids. The difference between the two results may be due to high percentage of tripleting in our study and difference in feed availability. This study was conducted in the dry season when forage availability and quality is generally low.

Management

In the present study, keeping the new born and the doe near homestead separated from the rest of the flock for 1 week significantly affected pre-weaning kid mortality, more deaths were found in flocks in which new born kids and their does run with the rest of the flock. This may be associated with a high risk of miss-mothering, injury, exposure to predators and insufficient ingestion of colostrum. There might also be a high chance of getting contagious diseases by running with the flock when the new borne kids are not immunologically competent. This result is in agreement with Sharif et al. (2005) who reported that kids were at higher risk of dying if they were not separated from adult animals. Separation of sick animals from the flock contributes to kid survival as it minimizes the risk of transmission of contagious diseases.

Causes of kid mortality

In this study the most frequently suspected cause of mortality was miss-mothering. This may be due to extensive system of goat husbandry practiced in the study area and large flock sizes which contribute to poor mother-kid relationship. Another important possible cause for loss of kids due to miss-mothering may be allowing the new born kid to run with the rest of the flock. Death due to starvation-mismothering exposure was reported in lambs and kids in Jordan (Sharif et al., 2005) and in lambs in Ethiopia (Bekele et al., 1992; Mukasa-Mugerwa et al., 2000).

Other important causes of mortality included pneumonia and diarrhea. Death in kids due to pneumonia and diarrhea were reported by earlier works (Khan et al., 1991; Donkin and Boyazoglu, 2004; Sharif et al., 2005;

Ershaduzzaman et al., 2007).

Diseases were responsible for the highest proportion of kid mortality in this study. High proportion of kid mortality (44.6%) due to diseases and parasites was reported from Botswana (Aganga et al., 2005). Even higher (63%) contribution of diseases to kid mortality was reported in Black Bengal Kids in Bangladesh (Ershaduzzaman et al., 2007). Enzootic ataxia was found to be the cause of mortality since the soil in the rift valley is deficient in copper. Enzootic ataxia in lambs and kids with high morbidity and mortality, in the Ethiopian Rift Valley, was described by Roeder (1980). Unknown causes, goat's pox and predators like hyena also contributed to the mortality of kids.

This study revealed that there is very high pre-weaning kid mortality in the study area; associated mainly with low kid birth weight and multiple litters especially triplets.

Therefore it is recommended that does bearing multiple litters and those nursing twins and triplets should be supplemented appropriately to reduce kid loses.

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Full Length Research Paper

Evaluation of the newcastle disease antibody level after vaccination regimes in chickens in Debrezeit Agricultural Research Center, Ethiopia

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Evaluation of the Newcastle disease (NCD) antibody level after different vaccination regime was conducted on 110 chickens: (32%) vaccinated and kept separated, (25.2%) unvaccinated and kept with vaccinated, (25.2%) were control groups. Four vaccination regime of chicken against NCD using live lentogenic stain, Hithcner B1 (at the age of 3 day old) and lasota (at the age of 27, 63, and 112th days of age) were used. The overall antibody level of ND in examined chickens using HI test was $Log_2^{4.42}$ in unvaccinated and mixed with vaccinated birds, $Log_2^{5.2}$ in vaccinated and mixed with unvaccinated chickens, $Log_2^{2.6}$ in control groups and $Log_2^{5.3}$ in vaccinated and kept separately. On the other hand chickens vaccinated four times at 3, 27, 63 and 112 days were found to be protective as that of common vaccination schedule (0, 18, 72, 132 and 216 day old age) in antibody level of Newcastle disease among different vaccination regime and frequencies. The result of the present study indicated that the protective antibody titter response was produced from the vaccination; hence, it is very crucial to vaccinate chickens with the full dose of vaccines against NCD in order to keep protected poultry population.

Key words: Newcastle disease, Newcastle disease virus, antibody titer, chickens, vaccination, response.

INTRODUCTION

Ethiopia is estimated to have about 57 million chickens, where the majority of them are being reared under the traditional (extensive) system. This system is characterized by a very little input from veterinarians and poultry farmers that also accounts for its small out put in terms of poultry egg and meat yield. The lack of attention given to the local chickens has forced them to roam and forage around their living premises to feed for themselves as well as to perch on higher places near human dwellings in search of shelter. It was reported that the hatchability of the eggs from local chickens is relatively high though the mortality after hatching is also immensely high which could have been avoided by proper disease prevention and husbandry measures (Serkalem, 2001).

Poverty and protein deficiency is manifested by wide spread malnutrition in children and women in village communities (Nassir, 1998; Tadesse et al., 2005). Though neglected in the development themes for a long

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time, recently many researchers and development agents believe that village chicken production play a major role in poverty alleviation and food security at household level. It provides off-farm employment and income generating opportunity and serves as a source of gifts and religious sacrifices (Rehmani and Spradbrow, 1995). The chicken also serve in waste disposal system by converting leftover of grains (Rehmani and Spradbrow, 1995) and human foods and insects into valuable protein foods (egg and meat) (Kirkland, 2000).

The first documented evidence of ND in Ethiopia dates back to 1971 in an area that is now known as the country of Eritrea**.** The NDV (Newcastle disease virus) involved was a velogenic strain and caused some 80% mortality. How the virus was introduced into the country is still unknown. Then the disease spread to other parts of the country at tremendous speed. Vaccination against the disease was not practiced until 1974. Since 1991 the national veterinary institute (NVI) has produced more than 12 million dose of vaccine, half of which was sold to commercial poultry farms (Yohannes, 2008).

Poultry diseases are considered as the most important constraints responsible for reducing both the number and productivity. The current disease related mortality from egg to adult chicken is estimated to be 20 and 50%. During some spectacular epidemics mortality high as 80% were recorded and further, loss of production of surviving birds must be noted (Almargot, 1987).

Newcastle disease in commercial or village chickens is a problem through out the year although it is more serious at the beginning of the rainy season (Nassir, 1998). In many developing countries Newcastle disease (ND) appears to be the most important avian disease. Outbreaks of ND unpredictable and discourage villager from paying proper attention to the husbandry and welfare of their chickens (Spradbrow, 2000). Newcastle disease (ND) is worldwide in distribution (OIE, 2008) and regarded as one of the most economically important diseases of poultry and other birds; because of devastating consequences of Newcastle disease virus (NDV) (Wambura ,2002) called avian paramixo virus serotype 1-(APMV-1). The virus has single stranded RNA that can be categorized in to three groups: the velogenic strain, mesogenic strain and lentogenic strain. ND is enzootic in some areas of the world, especially where rural chicken breeding is dominant (Jordan et al., 2001). Human infections have also been reported among laboratory workers (Echeonwu et al., 2007).

Sources of infection for NDV are exhaled air from infected birds and contaminated feed and water and transmission is mostly via aerosol. Feces, eggs lay during clinical diseases, and all parts of the carcass during acute infection and at death can also act as sources of infection. Chickens infected with virulent NDV may die without showing any clinical sign of illness though young chickens are more susceptible and show sign sooner than older ones. Much of the spread of ND in village is probably via human agents (Spradbrow, 1993).

ND control include strict quarantine, slaughter and disposal of all infected and exposed birds, and disinfection of the premises, but ND control through vaccination is generally a very cost effective intervention and given a high priority by farmers (Alexander et al., 2004). Vaccination has been considered the most effective means of controlling ND and has been used successfully through out the world since the 1940s (Dias et al., 2001). Vaccinations should be thought of as insurance. Like insurance, there is a price to be paid for the protection against a potential threat. Costs include price of the vaccine, time spent designing the vaccination schedule and paying for the crew that administers the vaccines. Another major cost for vaccination, which is rarely considered, is due to the losses from vaccine reactions from the live type vaccines and local tissue reactions associated with the inactivated vaccine injections (Dias et al., 2001).

Vaccine quality is commonly blamed when a disease occurs; however, there are usually other factors responsible such as lack of a cold chain. A comprehensive investigation is often called for to identify the cause(s) and to resolve the problem (Wambura, 2000). In Ethiopia, two types of vaccines which have been in use are: (1) Conventionally used vaccines which comprise: Hitchener B1(HB1) and LaSota live freeze dried vaccines produced in 500 and 100 dose vials, produced by NVI, Debre zeit, Ethiopia and (2) thermo stable vaccine. The thermo stable vaccine NDV I 2 is also live freeze dried, produced in 500 dose vials (Tadele, 1996). This is a non-pathogenic heat resistant vaccine, transportable without freeze and given orally with feed grain without catching birds (Wambura, 2000).

Vaccines are used to prevent or reduce problems that can occur when a poultry flock is exposed to field disease organisms. Vaccinations should be thought of as insurance. Like insurance, there is a price to be paid for the protection against a potential threat. Costs include price of the vaccine, time spent designing the vaccination schedule and paying for the crew that administers the vaccines. Another major cost for vaccination, which is rarely considered, is due to the losses from vaccine reactions from the live type vaccines and local tissue reactions associated with the inactivated vaccine injections. Vaccine quality is commonly blamed when a disease occurs; however, there are usually other factors responsible. A comprehensive investigation is often called for to identify the cause(s) and to resolve the problem (Alexander and Westbury, 2001).

There are two methods used to measure antibody

titers: the heamagltination inhibition (HI) test and the enzyme linked immunosorbent assay (ELISA). The most commonly used method is HI test. The HI titer is the reciprocal of the highest dilution of serum which completely inhibits haemaglutination and is usually and most conventionally expressed as the logarithm to the base 2. Although the test is difficult to standardize between laboratories, the HI titer gives an indication of the immune status of the bird. Sequential samples taken at different times can indicate whether the titer is rising or declining (Echeonwu et al., 2007; Alexander et al., 2004). Many trials have been conducted to develop a single annual vaccination program that can significantly control ND and reduce the vaccination cost. In Ethiopia various vaccines are available commercially for the control of ND. Therefore the objective of the study was to determine the protection level of the vaccine among vaccinated chicken; design and introduce new vaccination schedule and measure the protective level in unvaccinated mixed and separated group.

MATERIALS AND METHODS

Study area and animal

Study was conducted at Debrezite agricultural research institute which is located about 45 km south east of Addis Ababa at the altitude of about 1850 meters above sea level. One hundred and ten chicks were randomly split into four treatment groups; tagged (26 in number and receive vaccine based on the schedule), untagged (26 in number and doesn't take vaccine but kept with vaccinated chicken), vaccinated (took vaccine based on schedule and kept alone) and unvaccinated (control chicken doesn't take vaccine and kept away from those vaccinated). The chickens were vaccinated four times at 1, 3, 8 and 16 weeks of age through ocular.

Management of experimental house

The brooder house which is found in debrazite agricultural research institute was used as experimental house with 12 m^2 used for vaccinated, unvaccinated, vaccinated and mixed and unvaccinated and mixed chickens. The experimental house was thoroughly washed with water and also sprayed with 10% of formalin. After drying, clean new litter was spread over the floor, equipments including waterier, feeders was cleaned, disinfected and introduced to the house.

Management of chicken

All experimental chicken were brooded in one house until 30 days old and chickens randomly split into treatment during brooding the room and brooder temperature was maintained with a source of 500 watt bulb per bird. Water and feed was provided adequately, ration feed was obtain from their own farm. The chickens were visited by the veterinarian every day in addition to the brooder house guard.

Vaccine

Two types of vaccine were recommended for this experiment, these were HB1 and laSota strain vaccine; strain live freeze dried vaccine in 500 and 100 dose vial produced by NVI, Debrezite, Ethiopia. Within their life time the chicken was not only taking NDV vaccine, it was also taking different type of vaccine like, Infectious bursa disease virus, fowl typhoid, fowl pox at a given period of time.

Source of eggs and incubation procedures

Fertile chicken's eggs were harvested from the farm. Before incubation the egg was cleaned with 10% of formalin and checked for the size of air sac and dead embryos. Initially, eggs were incubated in an incubator at 37°C and relative humidity of 60 to 70%. The egg were incubated for 18 days, after 14 days incubated egg was candled to separate the fertile from non-fertile eggs and discard abnormal air sac size or position candling performed in dark room using Candler.

Vaccination of chickens using NDV HB1 and NDV laSota strain vaccine

The chickens used for experimental purpose were obtained from the institute farm. HB1 was used to vaccinate 3 day-old chicks and the same technique was followed for revaccination by the La Sota strain on 27, 63,112 day-old chicks. Both HB1 and LaSota vaccines were reconstituted at a rate of 100 dose/L of water and one drop of suspension (40 µl) was inoculated into one eye.

Research methodology

On the station, 110 chickens were screened by checking the protective antibody level. This was conducted by grouping them in to different experimental group.

Serology

Serum sample collection: Bleeding was done prior to vaccination, in order to obtain base line information on maternal immunity and the declining level of passive acquired immunity, from there on bleeding was carried out within interval, bleeding was carried out from all experimental chicken until the end of the experiment. This was to get information on the development of immunity after the series vaccination.

Method of serum collection: The bleeding was done by exposing and plucking feathers from the ventral surface of humeral region of the wing. Then the skin wetted with 70% alcohol and the needle which contain Alseaver solution was inserted into the wing vein, with 1 to 2 ml of blood collected and placed in vacuum tube, the sample was held at 37°C for several hours, the sample was left overnight before the serum was removed, that is if the serum was not tested immediately. This was store at -20°C until the one antibody detection mechanism called heamagglutination inhibition test was performed (OIE, 2009).

Heamagglutination inhibition test: Re and post vaccination sera was tested to see whether there was a response in antibodies after vaccination using the heamagglutination inhibition test. The test

was performed following the method described in OIE (2009) manual. Four haemagglutination (HA) unit, 1% chicken erythrocyte suspension and two fold serial diluted sera starting 1:2 were used. The antibody level for each serum sample was recorded.

Data analysis

The effects of vaccination delivered with different chicken were summarized. Then the data from the Microsoft excel sheet were processed and analyzed by using a statistical software program (SPSS version 16 ©2007 SPSS inc).

RESULT

One hundred and ten chickens were randomly split in to four groups, these were vaccinated based on schedule which are 26 (25%), unvaccinated chickens which were mixed with vaccinated chickens (26) (25.2%). The control groups which are unvaccinated and kept separately were 26 (25.2%), vaccinated and kept separately were 32 (31.1%). The overall antibody titters of Newcastle disease in vaccinated chickens (51%) (≥1:8) was 100%, which indicates that all vaccinated chickens that receive the vaccine based on new schedule were totally protected (Table 1).

The new vaccination schedule was conducted in the 3rd, 27th, 60th, and 112th day. The birds which were vaccinated and unvaccinated were shown antibody titter up to 15 days, antibody titer above (≥1:8). This means the birds have maternal derived antibody. The 16 to 30 days was unvaccinated and mixed with vaccinated birds 3.6 (±1.4), vaccinated mixed 4.9 ±1.8SD, vaccinated separated 4.4 ±1.3SD and control groups 1.6 (±0.5SD). The average antibody titer of birds examine between 31 to 15 was unvaccinated and mixed with vaccinated 5.3 ± 1.4 SD, vaccinated mixed 5.5 ± 2.3 SD, vaccinated and mixed 5 ± 0.9 SD and control groups 1.5 ± 0.7 SD. The average antibody titer of birds examine between 76 to 126 days was unvaccinated and mixed with vaccinated birds 3.3 ± 1.7SD, vaccinated and mixed 5.3 ± 0.9 SD, vaccinated and separated 5 ± 2.3 and control groups 1.5 ± 0.6 SD (Table 2).

The average antibody titter that were birds that mixed with vaccinated birds 23(88.5%) was ≥ 1:8 and 3 (11.5%) was < 1:8 and the birds that were unvaccinated and kept separately 9(34%) was ≥ 1:8 and 17 (65.4%) was < 1:8 (Table 3).

DISCUSSION

Newcastle disease is highly contagious and commonly fatal viral poultry disease affecting mainly domestic and wild avian species. The overall vaccinated chicken population which receive vaccination according to the new schedule in the study all had (100%) protective antibody titter (≥1:8) against NDV. The highest number of protected population in chicken vaccinated four times (3, 27, 63 and 112) due to the fact that booster dose vaccination of NCD was applied on chickens (Al-Garib, 2003). Based on the result of this study NCD average logarism antibody level response, vaccination of 3 days old chicken against NCD using the vaccine of Hitchner B1 (at the age of 3 days) and laSota strain vaccine at the age of (27, 63,112 days of age) produced from national veterinary institute, Debrezite, Ethiopia formed protective antibody level. Protective antibody level greater than 1:8 was detected in chickens vaccinated based on the newly designed program.

Table 1. Antibody titer of vaccinated chickens.

Variable	Mixed group Vaccinated N=26(%)	Separated group Vaccinated N=32(%)
Antibody titer (≥1:8)	26 (100)	32 (100)
Antibody titer (<1:8)	0 (0)	0 (0)

The most commonly used NCD vaccination program is giving vaccine to chicken at 0, 18, 72, 132,192 and 216th day old and between four month intervals, but the finding of this study showed that vaccination of chickens at 3, 27, 63 and 112th days of age was as protective as commonly used vaccination schedule (0, 18, 72, 132 and 216 days so that from economic point of view, the new vaccination schedule reduces cost of vaccine (transport and handling cost), labour cost and time. The less frequently that chicken have to be vaccinated the more efficient the strategy (Alders et al., 2001).

Antibody titter of chickens, which were unvaccinated and vaccinated, was protective until 18 days. So that vaccinating birds at 3 days of age was protective as that of vaccinating at day old. This is because the antibody that come from mother is protective until 18th day. After administration of the vaccine, immunity does not develop immediately, one to 2 weeks is required for a full immune response to occur (Dias et al., 2001). Vaccination at 27, 63 and 112 days is protective enough. This is due to the fact that booster dose vaccination of NCD was applied on chickens (Al Gabi, 2003). The average logarism antibody titer birds that were mixed with vaccinated birds 23 (88.5%) was ≥ 1:8 and 3 (11.5%) was < 1:8 and the birds that were unvaccinated and kept separately 9 (34%) was ≥ 1:8 and 17 (65.4%) was < 1:8. Therefore based on study findings, 23 (88%) of birds that were mixed with vaccinated birds had got protective average antibody titter ≥ 1:8 that was highly significant (< 0.05) and only 9

Table 2. Average antibody titer of examined chickens.

Group of study animal	Average antibody titer + SD /log_2/				Total
	1 to 15 days of vaccination	16 to 30 days of vaccination	31 to 75 days of vaccination	76 to 126 days of vaccination	
Unvaccinated (mixed)	5^a±1.5(7)	3.6^a±1.4(7)	5.3^a±1.4(8)	3.3^a±1.7(4)	4.4±1.3SD
Vaccinated (tagged)	5.1^a±1.9(7)	4.9^a±1.8(7)	5.5^a±2.3(8)	5.3^a±0.9(4)	5.2±1.9SD
Unvaccinated (control)	4.67^a±1.3(9)	1.6^b±0.52(11)	1.5^b±0.7(2)	1.5^b±0.6(4)	2.62±1.7SD
Vaccinated (separate)	6.3^a±0.5(12)	4.4^a±1.3(7)	5^a±0.9(9)	5^a±2.3(4)	5.3±1.3SD

a = logarithm average antibody ≥ 1:8 ($Log2^3$) which are protected. b = logarithm average antibody < 1:8 (< $Log2^3$) which are not protected.

Table 3. Antibody level of unvaccinated chickens

Variable	Mixed group	Separated group
	Unvaccinated	Unvaccinated (control)
	N= 26(%)	N= 26(%)
Antibody titer (≥1:8)	23 (88.5)	9 (34.6)* $p < 0.05$
Antibody titer (<1:8)	3 (11.5)	17 (65.4)

(34%) birds that were kept separately had got protective antibody titter. The live NCD vaccine spreads from vaccinated to unvaccinated birds when housed together. This is because of excretion of vaccine virus by these chickens evidently sufficient to re-infect the birds and boost their titter of antibody (Spradbrow, 1994).

The current study showed that ocular vaccination of chickens based on the newly designed schedule induced protective antibody level that can protect birds from NCD outbreak. When birds were mixed with vaccinated birds, they acquire the vaccine virus and their protective antibody increases, so that they can survive in case of outbreak.

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ABBREVIATIONS

APMV, Avian paramixo virus; **CSA,** Central Statistic Agency; **EDTA,** ethylene diaminetetra acetic acid; **HB1,** hithner B1; **HI,** heamagglutination inhibition; **HN,** heamagglutinin neuraminidase; **IgA,** immuno globulin A; **IgG,** immuno globulin G; **NDV4-HR,** Newcastle disease heat resistance V4; **NVI,** National Veterinary Institute; **OIE,** Office International Des Epizootics; **PBS,** phosphate buffer saline; **RBCs,** red blood cells; **SPF,** specific pathogen free; **SPSS,** statistical package for social science; **VN,** virus neutralization.

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Full Length Research Paper

Prevalence of clinical and sub-clinical mastitis on cross bred dairy cows at Holleta Agricultural Research Center, Central Ethiopia

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A study on bovine mastitis, designed to determine the prevalence and causal agent in cross breed dairy cow, was conducted from November, 2009 to March, 2010 at Holleta agricultural research center. A total of 90 cross bred cows were examined by physical examination and California mastitis test (CMT). Out of the total animals examined, 81.1% (73) had mastitis, in which 7.8% (7) and 73.3% (66) had clinical and sub clinical mastitis, respectively. Out of 340 quarters examined, 80.88% (275) were found to be infected in which 5.59% (19) were clinically and 75.3% (256) were sub clinically. Of 275 CMT and physically positive animals, quarter samples were taken for microbiological test in which, 66.4% (180) were culturally positive and 33.09% (91) were negative. Of 180 positive samples, the majority of isolates were *Staphylococcus aureus* (43.3%), followed by *Micrococcus* spp. (17.2%), *Streptococcus agalactiae* (12.2%), and *Streptococcus dysgalactiae* (7.2%). In addition, lowest isolation rate was for *Streptococcus uberis* and *Streptococcus feacalis* and each accounts for 2.8%. From this, proper mastitis control should be practiced by maintenance of an appropriate cow's environment and udder health management program in the farm including further investigation on risk factors associated to prevalence of mastitis and antibiotic resistance test to undertake measurable control options of mastitis in the farm.

Key words: Cross bred, dairy cow, causal agent, holleta, mastitis, prevalence.

INTRODUCTION

In Ethiopia, livestock represents a major national resource and form an integral part of the agricultural production system. The country has the largest livestock population of any African country with estimated 43.1 million heads of cattle and cows representing the largest proportion of indigenous cattle of the country (Central Statistical Authority (CSA), 2008).

Milk produced from these animals provides an important dietary source for the majority of rural as well as a considerable number of the urban and peri-urban population. However, milk production often does not satisfy the country's requirements due to a multitude of factors, out of which disease of the mammary glands known as mastitis is among the various factors contributing to reduced milk production (Fekadu, 1995). Mastitis can be defined as clinical (grossly evident changes

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to milk, the gland or the whole animal) or as subclinical (diagnosed using ancillary tests such as the somatic cell count).

Bovine mastitis can be caused by physical or chemical agents but the majority of cases are infectious and usually caused by bacteria. The disease has been reported by several authors on the prevalence and major causes of bovine mastitis mostly in cross bred dairy cattle in different parts of the country (Workineh et al., 2002; Biffa et al., 2005; Sori et al., 2005; Mungube, 2001). Several of these studies have shown the occurrence as a range of mastitis causing bacteria, indicating *Staphylococcus* and *Streptococcus* as dominant and pathogenic species.

Despite many years of research, mastitis remains the most economically damaging disease for dairy industry worldwide (Owens et al., 1997). Most estimates show that on the average an affected quarter suffers a 30% reduction in productivity and an affected cow loss of 15% of its production for the lactation.

In Ethiopia, the disease has been studied sufficiently, and information relating to its prevalence and risk factors are limited to some areas with a variable results. For this reason, more and exact knowledge from expanded epidemiological analysis of mastitis is needed for creating better control program. Efforts have only been concentrated on the treatment of clinical case.

The disease is worth studying as it causes financial losses attributed to reduced milk yield, discarded milk following antibiotic therapy, early culling of cows, veterinary costs, drug costs, increased labor, death in per acute septicemia, and replacement costs (Nesru et al., 1997).

Regular and systematic studies of Mastitis should be carried out in order to make information on the prevalence of the disease available and put forward an appropriate disease control strategies for this economically important disease. Therefore, the present study was undertaken to determine the prevalence of mastitis and isolation of predominant bacteria causing clinical and subclinical mastitis in cross bred lactating dairy cows of Holleta agricultural research center.

MATERIALS AND METHODS

Study area

The study was conducted at Holleta agricultural Research in the central high lands of Ethiopia. Holleta is located in central highland of Oromia special zone surrounding Finfine at a latitude of 38° 30'E, 9° 3'N and 29 km west of Addis Ababa on high way to Ambo. It has an altitude of 2400 m above sea level and receives mean annual rain fall of 1100 mm with bimodal distribution 70% of which occurs during the main rainy season (June to September) and 30% during the small rainy season (February to April) and the annual temperature of 11 to 22°C with relative humidity of 50.4%.

Study animals and husbandry practice

The study animals include crossbred dairy cows (Borana × Holstein breed) owned by Holleta Agricultural research center. The animals were often managed under a semi-intensive management system. They are often provided with some supplementary diet in addition to the natural pasture and agricultural byproducts and some are maintained usually in separate stalls, a short distance from each other in a house. Although milking was done by machine and hands; pre-milking and post-milking hygienic procedures, such as udder washing and drying, were frequently practiced. Cows were allowed to dry off at late-lactation period by abrupt cessation of milking.

Study design and sampling technique

Cross-sectional study was conducted from November, 2009 to March, 2010 in lactating dairy cows to determine the prevalence and identification of the pre dominant bacteria causing clinical and sub clinical mastitis in the study area. All lactating crossbred dairy cows were examined using clinical inspection and CMT results. From positive animals, milk samples were collected for bacterial culture and isolation.

Sample size

All lactating dairy cows of the farm (90 in numbers) represented by 360 samples at quarter level were examined and from positive animals milk samples were collected for bacterial isolation at quarter level.

Data collection

Data such as abnormal changes in the milk, mammary gland and CMT score were collected during animal examination. Depending on this clinical inspection and CMT results, cases were categorized as either positive or negative and positive case was further categorized as clinical and sub-clinical mastitis.

Detection of mastitis

Mastitis was detected using the California mastitis test (CMT) and results of clinical inspection of udder based on Quinn et al. (1994). A squirt of milk, about 2 ml from each quarter was placed in each of four shallow cups in the CMT paddle. An equal amount of the commercial reagent of (E.E.C. scientific limited Northampton, U.K. product) was added to each cup. A gentle circular motion was applied to the mixtures in a horizontal plane for 15 s. Accordingly, milk with pus flakes, clots or blood-tinged watery secretion, and acute mastitis with signs of systemic involvement was diagnosed as clinical mastitis. Sub clinical mastitis was diagnosed based on CMT results and the nature of coagulation and viscosity of the mixture, which show the presence and severity of the infection, respectively.

Preparing udders and teats

The udders, especially teats were cleaned and dried before sample collection. Each teat end was scrubbed vigorously with a pledged of cotton moistened (but not completely wet) with 70% of ethyl alcohol. Recontamination of teats during scrubbing was avoided by

Table 1. Prevalence of clinical and sub clinical mastitis at cow and quarter levels**.**

Form of mastitis	At cow level		At quarter level	
	No. examined	Affected no. (%)	No. examined	Affected no. (%)
Clinical	90	7(7.8)	340	19(5.59)
Sub clinical	90	66(73.3)	340	256(75.29)
Total	90	73(81.1)	340	275(80.88)

Table 2. Quarter prevalence of clinical and sub clinical mastitis.

Quarter	Clinical mastitis		Sub clinical mastitis	
	No. examined	Positive and prevalence (%)	No. examined	Positive and prevalence (%)
RF	83	6(7.2)	83	64(71.1)
RH	87	5(5.7)	87	65(74.7)
LF	84	3(3.6)	84	63(75.0)
LH	86	5(5.8)	86	64(74.4)
Total	340	19(5.6)	340	256(75.3)

*****RF= right front, RH = right hind, LF = left front, LH = left hind.

scrubbing, and separate pledged cotton was used for each teat.

Milk sample collection

During milk sample collection, teats towards sample collection were sampled first and then the far ones. The first 3 to 4 streams of milk were discarded. The collecting vial was held as near horizontal as possible, and by turning the teat to a near horizontal position, approximately 10 ml of milk was collected into a universal sample collection bottle. After collection, the samples were placed in icebox and taken to Holleta agricultural research center microbiology laboratory for bacterial culture and isolation within 7 to 10 days.

Bacterial culture and isolation

From the samples, a standard of 0.01 ml of milk was streaked on blood agar plate (Himedia Laboratories Pvt. Ltd) and incubated aerobically at 37°C and observed within 24 to 72 h for growth of bacteria causing mastitis. Identification of the bacteria on blood agar plate was done based on colony morphology, haemolysis (type of haemolysis, presence or absence of haemolysis), staining technique, coagulase test and catalase test. The colonies was sub-cultured on selective media such as Edward's media (India product) to identify *Streptococcus* bacteria, manitol salt agar base (product of DIFCO Laboratories Detroit 1 Michigan USA) for *Staphylococcus*. Other biochemical tests used to identify the predominant cause of bovine mastitis were used based on that of Quinn et al. (1994).

Data management and analysis

All collected data were entered in Microsoft excel sheet and analyzed by dividing positive cases for a total examined to determine the prevalence of mastitis and bacterial isolates in the study farm.

RESULTS

Prevalence of mastitis by clinical examination and CMT test

A total of 90 animals including only cross bred lactating cows were examined; out of which 73 (81.1%) cows were found to be affected either with clinical or sub clinical mastitis based on the clinical diagnosis and CMT. Likewise, CMT positive for the sub clinical mastitis were found to be 66 (73.3%) (Table 1). Out of the 360 quarters examined, 20 (5.56%) quarters were blind teat. Upon screening of the functional teats (340), a quarter of 275 (80.88%) were affected by clinical and Sub-clinical mastitis. The quarter prevalence of clinical and sub clinical mastitis of all teats were relatively affected equally and the overall quarter prevalence was 75.3% for sub clinical and 5.6% for clinical ones (Table 2).

Bacterial isolates

Milk sample of 271 at quarter level from positive cases were collected and cultured for microbiological examination and 180 (66.4%) were found or yielded bacteria in which 6 (2.2%) of them showed mixed growth; whereas 91 (33.58%) did not grow. From the positive samples, 11 (4.05%) were from clinical and 169 (62.4%) were from sub clinical cases (Table 3). The predominant isolated bacteria were *Staphylococcus* spp. with isolation rate of 47.2% and followed by *Streptococcus* spp., with isolation rate of 25.0%. *Micrococcus* spp. were the third

Table 3. Bacterial species isolated from Bovine clinical and sub clinical mastitis.

Bacterial isolates	Clinical mastitis	Sub clinical mastitis	Total
	No. (%)	No. (%)	No. (%)
Staphylococcus aureus	5(45.5)	73(43.2)	78(43.3)
CNS	0(0)	7(4.1)	7(3.9)
Micrococcus sp	0(0)	31(18.3)	31(17.2)
Streptococcus agalactiae	3(27.3)	19(11.2)	22(12.2)
Streptococcus dysglactiae	0(0)	13(7.7)	13(7.2)
Streptococcus uberis	0(0)	5(2.96)	5(2.8)
Streptococcus faecalis	2(18.2)	3(1.8)	5(2.8)
Actinomyces pyogenes	1(9.0)	6(3.6)	7(3.9)
Corynebactrium bovis	0(0)	6(3.6)	6(3.3)
Mixed growth	0(0)	6(3.6)	6(3.3)
Total	11(100)	169 (100)	180(100)

predominance isolated with isolation rate of 17.2%.

DISCUSSION

The current study showed high prevalence of mastitis 81.1%, which is relatively comparable with Mekibib et al. (2010) at Holleta area who indicated the cow level overall prevalence of 71.0%. However, it is higher than the reports of Lemma et al. (2001) who indicated that 64.5% were positive for mastitis at cows' level, 40% in South Ethiopia by Kerro and Tareke (2003), 44.1% by Girma (2010), The variability in the prevalence of bovine mastitis between reports could be attributed to differences in management of the farms, breeds considered, or technical know-how of the investigators (Radostits et al., 2007). The higher prevalence of bovine mastitis in the present study farm may be due to management practices and infectious agents, having different causes, degrees of intensity, and variations in duration and residual effects.

In this study, the clinical mastitis accounted for 7.8% whereas the sub-clinical mastitis was 73.3% of the share. The result agreed with 7.14% which was reported by Tsegai (1997), whereas the prevalence rate for clinical mastitis obtained in this study area is higher than the finding of Enyew (2004) (3.9%) from Bahir Dar, Ethiopia.

In case of sub clinical mastitis, the prevalence rate (73.3%) obtained in this study was comparable with the finding reported by Zerihun (1996) who reported 68.1%. Sub-clinical mastitis has been reported to be higher than clinical mastitis owing to the defense mechanism of the udder, which reduces the severity of the disease (Radostits et al., 2007). Another is little attention given to subclinical mastitis while treating clinical cases. Moreover, farmers in Ethiopia are not well informed about the silent cases of mastitis (Karimuribo et al., 2006). The quarter prevalence of 75.3% for sub clinical mastitis obtained by this study indicates the economic significance of the disease. The prevalent found in front and hind quarters showed no great difference which agrees to the finding of Gezahegne (1999). However, slight higher prevalence of hind quarters in the present study is due to general production quality of hind quarters.

The result obtained from bacteriological analysis of the sample revealed that the predominant organisms isolated from clinical and sub clinical mastitis were staphylococci, accounting for 47.2%. From a total of 180 isolates, *Staphylococcus aureus* was the most frequently encountered organism with an isolation rate of 43.3%. The predominance and primary role of *S. aureus* isolate in bovine mastitis has also been reported in other studies (Atyaib et al., 2006; Fadlelmoula et al., 2007; Mekbib et al., 2010). The reason for higher isolation rate of *S. aureus* is the wide ecological distribution inside the mammary gland and skin. In areas where hand milking and improper use of drug is practiced to treat mastitis case, its dominance has been suggested. *S. aureus* is adapted to survive in the udder and usually establishes mild sub clinical infection of long duration from which it is shed through milk serving as source of infection for other healthy cows and transmitted during the milking process (Radostits et al., 2007). Hence, the organism has been assuming apposition of major importance as a cause of bovine mastitis.

Streptococcus spp. was the second prevalent bacterial species isolated with isolation rate of 25%. Radostits et al. (1994) stated that *Streptococcus* spp. is the most prevalent along with *Staphylococcus* spp. However, the lower prevalence as compared to *Staphylococcus* spp. is because *Streptococcus agalactiae* survives poorly outside the udder, and established infections are eliminated by frequent use of penicillin and other antibiotics. *Micrococcus* spp. was isolated in the rate of 17.2%,

making it the third most prevalent isolate. *Micrococcus* spp. is considered as a normal teat flora with minor pathogenecity (Radostits et al., 1994) as was observed by Mekbib et al. (2010) in Central Ethiopia.

The isolation of *Corynebacreum* spp. 3.3% was lower than the report of Nejib (2008), who found (6.57). However, the present finding was higher than the finding of Shipigel (1998) and Hamir et al. (1978) who reported 1.3 and 2.5%, respectively. *Actinomyces pyogenes* was isolated at a rate of 3.9% which is comparable with Nejib (2008) who reported 2.92% from his study on survey and isolation of major bacteria causing mastitis in and around Western Harerghe of Ethiopia.

Conclusion

This study showed high prevalence of Bovine mastitis and is a major health problem of dairy cows in the study farm and undoubtedly will have an adverse effect on productivity of dairy industry and hence need serious attention. The major bacterial isolate from positive samples were *Staphylococcus* spp. followed by *Streptococcus* and *Micrococcus* spp. including some environmental pathogens. Based on this, proper mastitis control should be practiced by maintenance of an appropriate cow's environment and udder health management program, and further investigation should be continued with special emphasis on risk factors associated with prevalence of mastitis and antibiotic resistance test to undertake measurable control options of mastitis in the farm.

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Full Length Research Paper

Tail docking in dogs: Evaluation of current practices and ethical aspects in southwest Nigeria

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This study evaluated the current practices of tail docking in dogs routinely performed in southwest Nigeria, as well as their ethical issues. The data were collected by means of a structured questionnaire provided to breeders/owners besides an audit of retrospective case records. The results indicated that tail docking was performed and embraced by all practices and breeders/owners surveyed, with higher frequency of Rottweiler (76.7%) in comparison to PitBull (56.0%) and Boerboel (51.2%) breeds. Seventy four percent of breeders docked for customary/traditional reason while others did so for reasons which included improved appearance (53.6%), convenience and pleasure (46.4%), better hygiene (28.0%), ease of mating (14.2%), enhanced aggressiveness (7.1%) and prevention of injuries (7.1%). Most practices (97.4%) docked for non-therapeutic purposes. Sixty five percent of respondents docked at 2 to 3 weeks of age while others did at less than 2 weeks (11.6%) and above 3 weeks (23.3%), respectively. Infection/necrosis (37.2%) and self-mutilation (20.9%) were the most observed post-operative complications by respondents. Most practices (72.0%) performed tail docking without anaesthesia while 60.5% of practices never gave post-operative analgesic. Majority of respondents (72.0%) oppose abrogation of docking for non-therapeutic reasons. Primary legislation prohibiting docking of dogs' tails except for medical or surgical reasons is recommended.

Key words: Tail docking, dogs, southwest Nigeria.

INTRODUCTION

The World Small Animal Veterinary Association (WSAVA) defines tail docking as ''the amputation of a dog's tail at varying lengths to suit the recommendations of a breed standard'' (WSAVA, 2001).

The amputation of the puppy's tail is usually performed either with scissors, a knife or with a rubber band at between three to five days of age. Since docking involves interference with the sensitive tissues and bone structures of the animal, it is considered an act of mutilation by WSAVA, comparable to ear cropping and other non-therapeutic procedure inflicted on dogs.

Tail docking of dogs is justified on the basis that it prevents tail injury, particularly in working dogs such as: Spaniels, Terriers and Old English sheepdogs in the United Kingdom. This stance is maintained by breed clubs (Warman, 2004) and hunters alike (Dyer, 2004). Reports abound to the effect that complications from docking procedure contribute to the incidence of tail injuries (Diesel et al., 2010), acquired urinary/faecal incontinence and perennial hernia (Wansbrough, 1996), impaired locomotion (Bennett and Perini, 2004) and amputation neuromas (Gross and Carr, 1990). The controversy over whether tail docking and ear cropping on companion dogs should be made unlawful originated in 19th century in Britain (Delafenetre, 2009). Since then, the controversy has remained unabated as evidenced by

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the number of correspondence (Davidson, 2006; King, 2007; Penny, 2007) and submissions received by Parliament in the drafting of the Animal Welfare Bill (Willeberg,1996; Defra, 2002).

Different groups hold strong views about tail docking in domestic dogs. These range from veterinary associations and welfare organizations, which typically want the practice banned, to purebred dog associations and Kennel clubs, which vigorously oppose the anti-docking legislation.

In the 1980s, the veterinarians eventually joined forces with animal protection organizations to press for a ban against non-therapeutic tail docking in dogs (Ryder, 2000). The debate has centered on whether non-therapeutic tail docking reduces the risk of tail injuries sufficiently to justify the ethical concerns regarding this prophylactic intervention (Diesel et al., 2010). Today, opposition to tail docking in dogs for non-therapeutic reasons has heightened in countries like the United Kingdom (UK), United States of America (USA) and Canada. Many countries such as the European Union, Australia and South Africa have gone to the extent of outright ban on what they described as an archaic, barbaric and pointless act (AWVT, 2002). Tail docking has thus become a very emotive subject in many countries. Many organized bodies such as the kennel clubs of the UK and the USA and the Council of Docked Breeds (CDB) consider that docking is in the interest of the animal's welfare. This is in sharp contrast to the views held by the European Convention for the Protection of Pet Animals (ECPPA), The Royal College of Veterinary Surgeons, The British and Scottish Societies for the Prevention of Cruelty to Animals and the Advocates of Animals among others (AWVT, 2002).

To the best of the author's knowledge, report on the practice and legislation on tail docking in dogs in Nigeria has not been documented. In recent times, importation of exotic breeds of dogs by breeders into Nigeria has heightened due to increased demand and preference for dogs to meet security challenges. With pedigree and pure breeds being the preference, Nigeria will most likely be drawn into the docking controversy in not too distant future. An objective evaluation of the tail docking issue requires the integration of moral views with biological and behavioral facts. There is therefore the need for tail docking by vet practices and breeders in Nigeria to be evaluated with regard to current practices, ethical and welfare issues in line with standard practices. These are the objectives which the present study sought to achieve.

MATERIALS AND METHODS

The study was conducted between January and June, 2013 in two stages. In stage one, data were obtained through the administration of a questionnaire to clients who are dog breeders/owners that visited some selected private and state owned veterinary clinics/hospitals. The clinics/hospitals were drawn from Oyo, Ogun, Ondo, Osun, Ekiti and Lagos states of Southwest Nigeria. The areas surveyed has the highest concentration of small animal practices and over 50% of the exotic dog population in Nigeria. Respondents' were asked to freely provide answers to open questions on tail docking with respects to their years of experience as a dog breeders/owners, the breeds of dogs kept and commonly docked, why, where, when and who performed the tail docking. Information on post docking observation and complications were also obtained. Respondents' opinion on their awareness of the existence of and support for legislation against tail docking in Nigeria was also sought. All responses were freely given in written form, collated and stratified appropriately.

The second stage of the study involved a retrospective evaluation of the practice, ethics and welfare use of tail docking by practices in the study locations, over a five year period (2008 to 2012). Information on breeds, age at docking, indication for surgery, anaesthetic protocol, operative techniques and postoperative care were obtained for all documented tail docking procedure.

Data analysis

The data obtained in both stages of study were collated and subjected to appropriate descriptive statistical analysis.

RESULTS

Of the total number of 64 practices in private and public sectors listed for the study based on their scope of activities and type of practice, only 43 (67%) gave their consent to co-operate and facilitate the activity. Out of the 270 questionnaires sent out, 168 (62.2%) respondents were collected. Breeds of dogs most commonly docked at the study location included Rottweiler (76.7%), Pit-bull (56.0%), Boerboel (51.2%), Dobermann (25.6%), Bull-mastif (23.2%), Boxer (10.1%) and others (4.8%) (Figure 1). The reasons for tail docking from breeders and veterinary practices' viewpoints are presented in Figure 2. Significant number of breeders docked for reasons of custom/tradition (74.4%) while others did so to improve appearance (53.6%), convenience and pleasure (46.4%), better hygiene (28.0%), ease of mating (14.2%), enhanced ease of aggression (7.1%) and prevention of injuries (7.1%). Clinical records by practices on the other hand revealed that 97.7 and 2.3% were docked for elective and therapeutic purposes, respectively.

The age at docking varied from less than 2 weeks to above 8 weeks. Majority of respondents (65.1%) docked at 2 to 3 weeks of age while 11.6, 4.7 and 4.7% docked at less than 2 weeks, 4 to 8 weeks and above 8 weeks, respectively (Figure 3).

Infection/necrosis of the tail constituted the most frequently observed post-docking complication by respondents (36.9%). Other complications observed in decreasing order of frequency included self-mutilation (20.2%), increased aggression (8.3%), attack by other

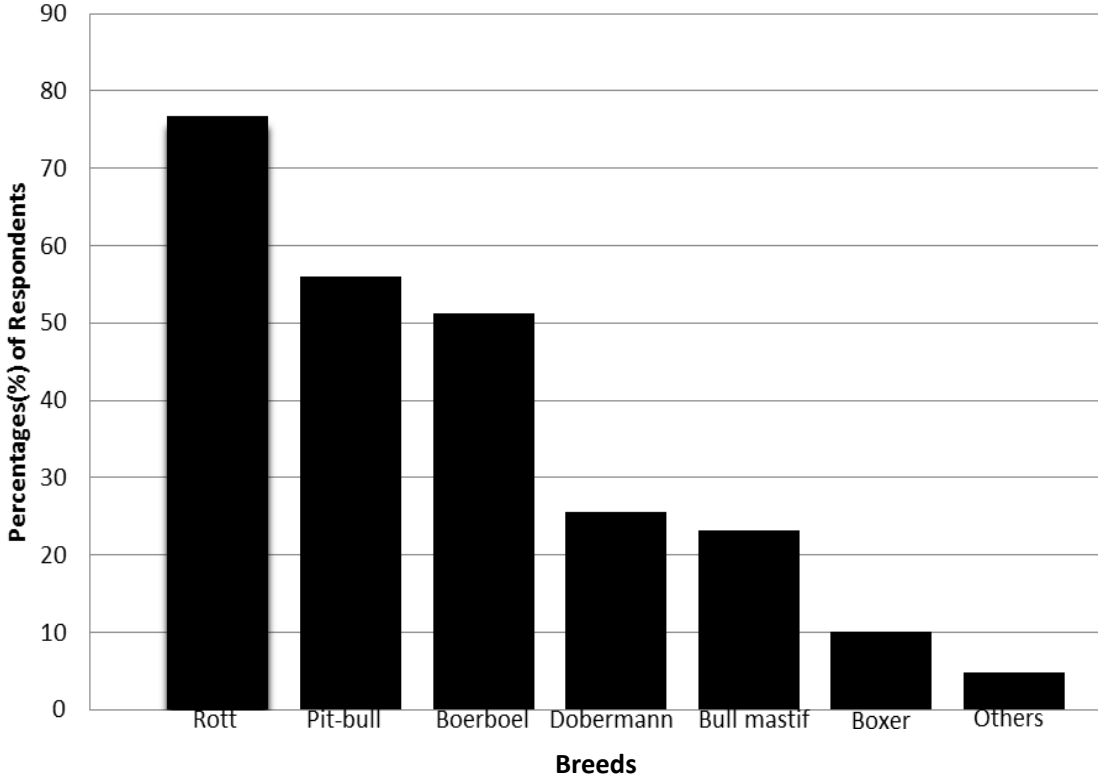

Figure 1. Breeds of dogs commonly docked by respondents in Southwest Nigeria.

dogs (5.4%), nervous signs (2.8%) and increased tendency to sleep (1.8%) (Figure 4).

Anaesthetic and surgical techniques employed by practices for tail docking are presented in Figure 5. Manual restraints and anaesthesia were employed by 72.0 and 28.0% of practices, respectively for tail docking while 60.5% of practices gave no analgesics post-operatively. The use of tourniquet to minimize blood loss was embraced by 81.4% of practices. Majority of practices (90.6%) docked at the level of the second coccygeal vertebral while others docked at the third (11.6%) and fourth (4.7%) coccygeal vertebral bones, respectively. The attitude of respondents to abrogation of tail docking for non-therapeutic reasons indicated that 10.7% are favourably disposed to such proposal while significant number (72.0%) are opposed to it, with 17.2% being indifferent to such procedure.

DISCUSSION

Expectedly, the results of this investigation have shown that the practice of tail docking in dogs is embraced by veterinary practices and breeders/pet owners in the study location, in line with the practice in most parts of the world (Morton, 1992). Rottweiler was the most commonly docked breed. Other breeds such as Boerboel, Pitbull, Dobermann, Bull mastiff and Boxers are docked with less frequency. It is worthy to note that all the breeds reported in this study are pedigree dogs that are customarily docked in their various places of origin. It is therefore not surprising that most respondents reported in this study docked for reason of custom or tradition and to a less extent for other reasons such as improved appearance, convenience and better hygiene. This is in agreement with findings from previous studies in the UK and Australia (Wansbrough, 1996; Bennett and Perini, 2003).

Findings from clinical records in this study also corroborated breeders/owners views to the effect that significant number of tail docking procedures in dogs were performed for non-therapeutic reasons. The docking of dog's tails is a practice which has been carried out for centuries in puppies between 5 to 10 days old because of the notion that neonates are less able to perceive pain at that age. This general belief has been proven not to be correct (Noonan et al., 1996). It was observed from the study that docking was done much later in life (2 to 3 weeks) in 65.1% of cases, without the use of anaesthetic and analgesics in 72.0 and 60.5%, respectively. This in the author's opinion is not in accordance with the current

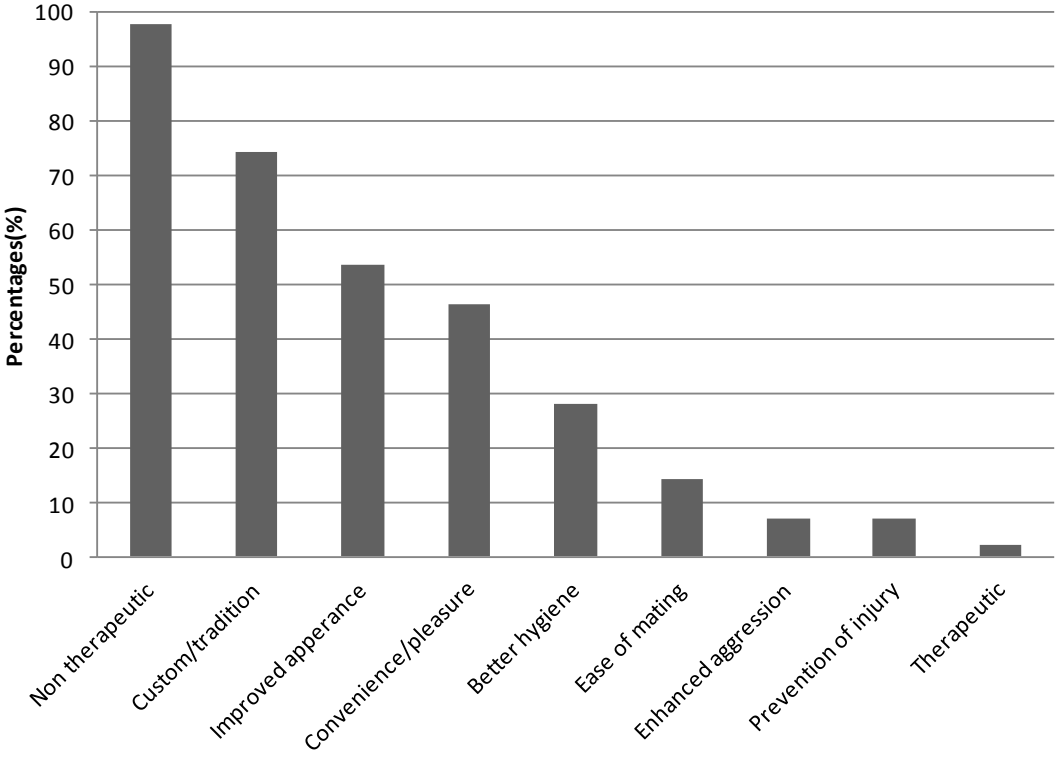

Figure 2. Reasons for tail docking from Breeders and Clinicians' view points.

knowledge and practices regarding pain management in dogs with docked tails (AWVT, 2002). Similarly, comparative detailed studies of pain caused by different methods of tail docking in young farm animals (Moloney and Kent, 1997) and puppies (Noonan et al., 1996) reported that these animals feel pain when tail-docked.

The use of manual restraint by most practices and non-administration of analgesics by 40% of practices post-operation in this study suggest that appropriate consideration was not accorded to the welfare of dogs with respect to alleviation of pain during and after docking, as required by standard and best practices (Miles, 2005; Lefebre et al., 2007).

The ECPPA signed by twelve countries prohibits surgical operations in which an animal will or is likely to experience severe pain (Lefebre et al., 2007). Similarly, the Companion Animal Welfare Council (CAWC) and the Societies for Prevention of Cruelty to Animals in the UK and Australia are opposed to docking on the basis of the pain associated with the procedure (AWVT, 2002).

In this study, some respondents observed an increased tendency of docked puppies to suckle and fall asleep within few minutes of tail docking. This may be an indication of pain, as the act of suckling has been reported to stimulate the release of endogenous opioids (endorphins) that produce analgesia (Bennett and Perini, 2003). Observation of infection/necrosis and self-mutilation by 37.2 and 20.9% of respondents respectively post-docking may suggest poor pain management on the part of the clinician and more importantly, inadequate post-operative care by dog owners who most frequently fail to honour follow-up appointments. It was also revealed from this study that docking was performed by veterinarians and non veterinarians alike. Detailed records of the procedure were not fully documented by most practices largely due to failure on the part of client to honour postoperative appointments.

Expectedly, the attitude of respondents to abrogation of tail docking for non-therapeutic purposes was unfavorable. A significant percentage of respondents consider docking as a harmless procedure that upholds the integrity of certain dog breeds as exemplified by Rottweiler, Boerboel and Dobermann in this study. At present, the level of awareness on welfare and legislation issues regarding tail docking in Nigeria is poor. Across a range of countries, routine tail docking is considered unacceptable to most veterinarians (83 to 92%) and the general public (68 to 88%), (Bennett and Perini, 2003). In contrast, many breeders with a prior commitment to this practice remain in favor of tail docking (CDB, 2007).

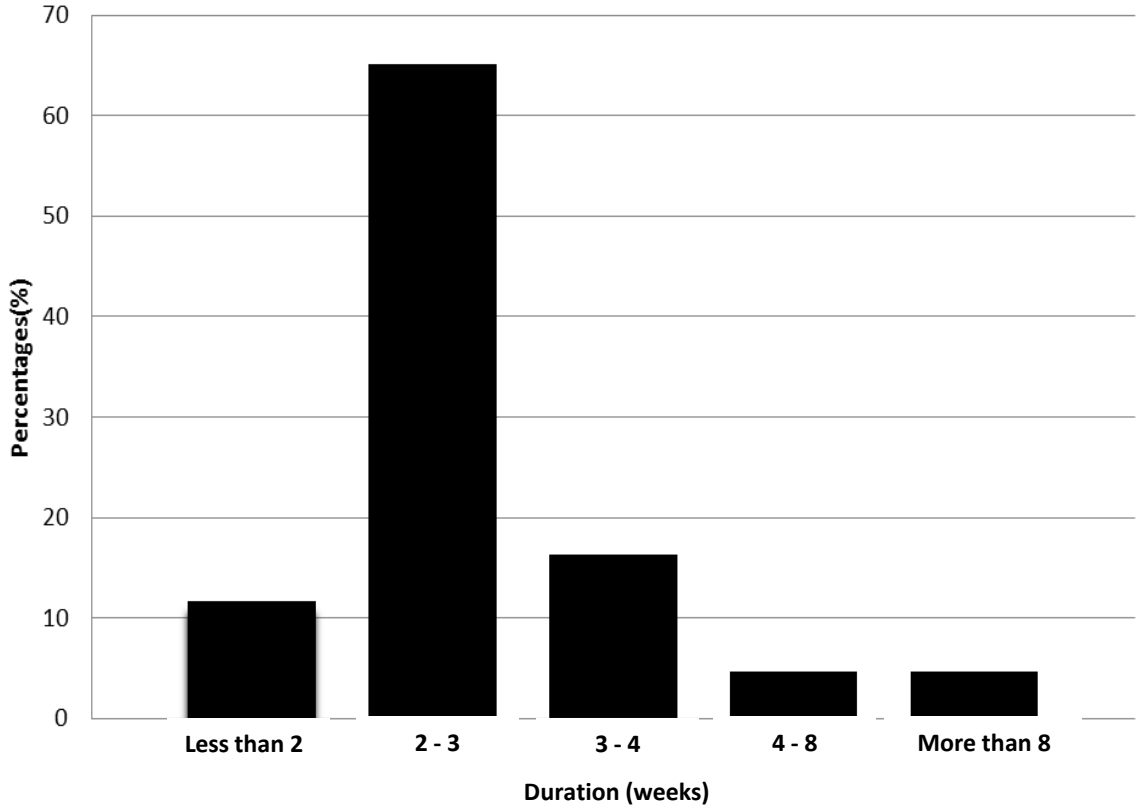

Figure 3. Age at which docking is done according to respondents.

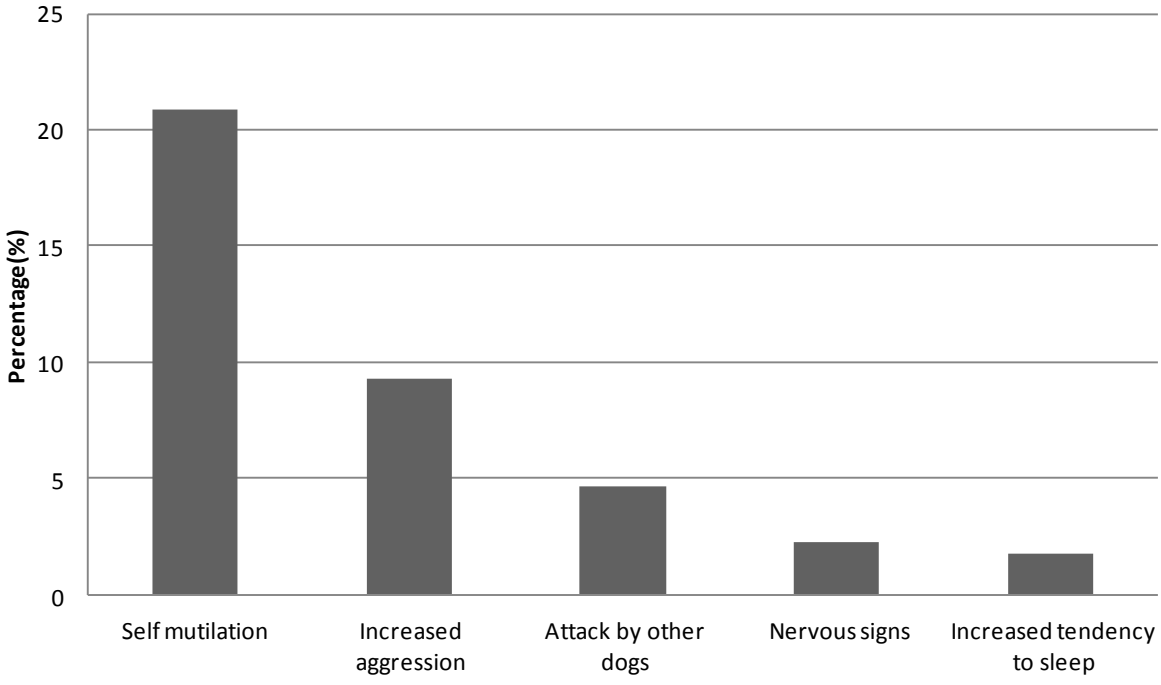

Figure 4. Post-docking complications observed by respondents.

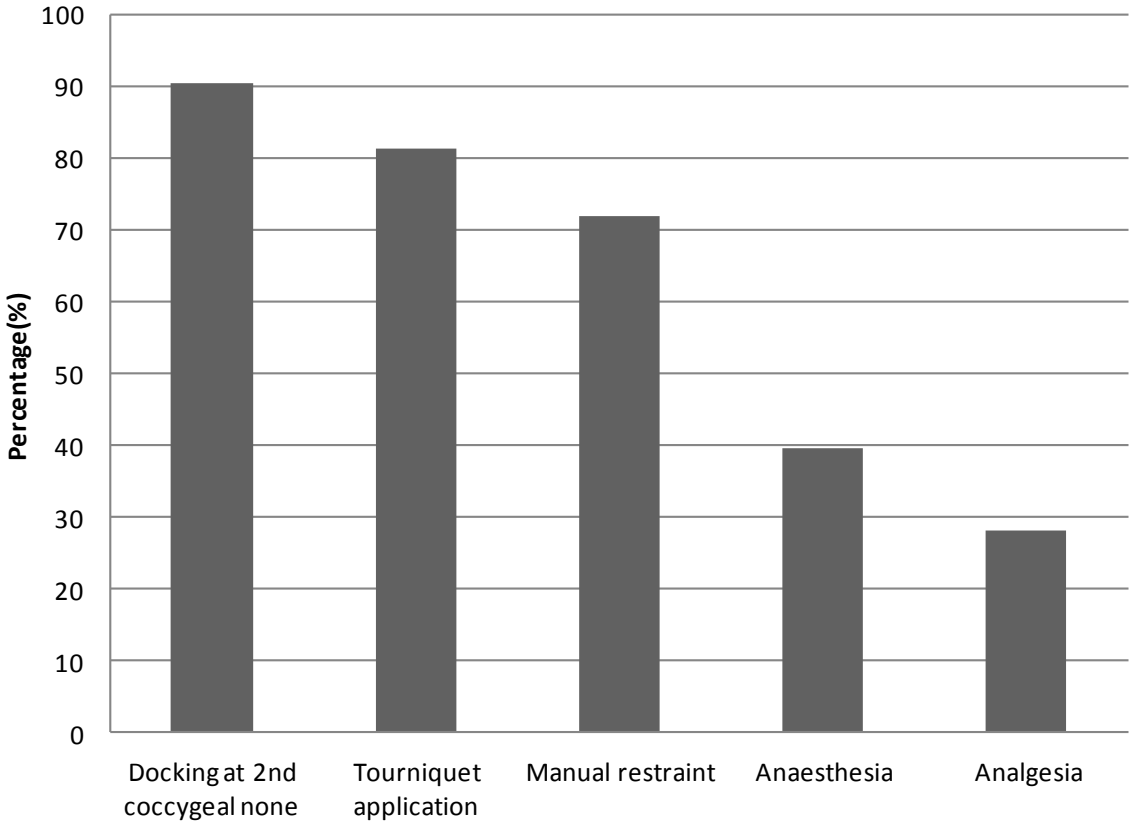

Figure 5. Anaesthetic and operative techniques employed by practices for tail docking.

Unlike in Nigeria which is yet to have a policy on tail docking in dogs, the procedure is not permitted or is highly restricted in many countries of the world.

The European Convention for the Protection of Pet Animals (ECPPA) prohibits surgical operations for non-curative purposes. An increasing number of countries have placed restrictions on canine tail docking including the UK, the USA, Germany, Norway, Sweden, the Netherlands, Australia, Finland and Denmark while others including Greece, Luxembourg, Switzerland and Austria have ratified the ECPPA Convention.

The outcome of this study suggests that an enactment of a law banning tail docking on welfare ground maybe inevitable in the near future in Nigeria. This will be in line with current trends in many parts of the world, like the European Union, Australia, South Africa and Israel (AWVT, 2002). It is the opinion of the author that tail docking cannot be described as prophylactic if it is undertaken merely on request, or just because the dog is of a particular breed, type or conformation, as reported in this study. The Veterinary Council of Nigeria as a regulatory body has legal and ethical duty to its members, to the animals under their care and to the general public, including breeders/pet owners, to ensure that the standard of the profession are maintained. It is highly imperative that surgical operations for the purpose of modifying the appearance of a pet animal for therapeutic and/or non-curative purposes must be performed by a veterinary surgeon. Operations including tail docking, in which the animal will or is likely to experience pain should be carried out under anaesthesia with appropriate analgesia. Primary legislation prohibiting docking of dogs' tails in Nigeria except for medical or surgical reasons is recommended.

It is important to be aware of the limitations of the present study. The numbers of veterinary practices selected in each states of the region sampled were not selected based on the probability to the size and scope of activity. A very high proportion of practices included in the study were based in the state capitals. The sample may be un-representative because not all cases of tail docking were documented by practices. Additionally, low response rate on the part of breeders/owners created a reduction in anticipated sample size. This may be due to low level of awareness on the issue of tail docking in Nigeria.

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Review

Ectoparasitism: Threat to Ethiopian small ruminant population and tanning industry

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Sheep and goats are important contributors to food production in Ethiopia providing meat, milk and income generation for the country. Skins are the most important items to generate foreign currency for developing countries like Ethiopia. However, the huge resource potential of sheep and goats populations of the country are constrained and threatened by compound effect of diseases, poor management and malnutrition. Parasitic skin diseases caused by ectoparasites such as mange mites, lice, keds and ticks are among these threats resulting in serious economic loss to the tanning industry and the country as a whole. The economic impact of ectoparasitism in Ethiopia is not well documented. Tanneries reported that 35% of sheep skin and 56% of goats' skin are rejected due to external parasites, and out of the reject groups of the processed skin, about 80 to 90% defects were believed to be due to external parasites. The estimated economic loss due to drop in quality of sheep and goat skin is around USD 25.8 million per year. It also takes time before disease affected animals after treatment could return to their normal body condition. Currently, ectoparasites are among major causes in decreased production, reproduction of these animals as well as leather quality deterioration, down grading and rejection of skins. As many as one-quarter to one third of all skins processed at tanneries in Ethiopia have various defects and are unsuitable for export purposes where most of these defects occur in the pre-slaughter stage of production while the animals are alive and are directly related to parasitic skin diseases. Information available so far in Ethiopia indicate that parasitic skin diseases of small ruminants are widely distributed in different agro-climatic areas, causing serious economic loss to the farming community, tanning and leather industry at large, seriously hampering the income generation and foreign currency flow to the country. The extent of the problem has increased continuously during the past few years, threatening the small ruminant population, health, production and reproduction that warrants cost effective control measures.

Key words: Control, Ethiopia, ectoparasites, small ruminants, tanning industry.

INTRODUCTION

The small ruminant population of Ethiopia is about 18.1 million sheep and 14.8 million goats (Community-supported agriculture (CSA), 2009). Owing to their high fertility, short generation interval and adaptation even in harsh environments, sheep and goats are considered as an investment and insurance to provide income for the

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purchase of food during seasons of crop failure. Furthermore, wool and manure are also important by-products of small ruminant productions (Ministry of Agriculture and Rural Development (MoARD), 2005).

Self-sufficiency in food production, increase in rural income and foreign currency earning of the country through improving the quality and quantity of export items which are among the main objectives of the current agricultural development polices of Ethiopia. Sheep and goats are important source of income for agricultural community and are also one of Ethiopia's major sources of foreign currency through exportation of live animals, meat and skin (Shiferaw et al., 2010).

Ectoparasites such as mange mites, lice, keds and ticks are widely distributed in all agro-ecological zones in Ethiopia, causing serious economic loss in small holder farms (Kumsa et al., 2012). They are also one of the most important causes of loss in production and mortality of animals in various part of the country through decrease in production and reproduction (Figure 2a, b), down grading and rejection of skins (Ayele et al*.,* 2003; Yacob et al., 2008a). It was reported that 35% of sheep and 56% of goat skin rejections in Ethiopia are attributed to ectoparasites (Kassa, 2006). All these established facts imply that ectoparasites pose serious economic losses to the farmer, the tanning industry and the country as a whole (Berhanu et al*.*, 2011). Skins from goats and sheep are important economic products contributing for the largest share to the total and agricultural export commodities (Food and Agriculture Organization (FAO), 2005) followed by live animals (Ayele et al*.,* 2003). The current utilization of hides and skins in Ethiopia is estimated to be 45% for cattle hide, 75% goat skin and 97% sheep skin with expected off take of 33, 35 and 7% for sheep, goats and cattle, respectively (Mohammed, 2000). However in recent years, this rank has been relegated to fifth level mainly because of rejection and down grading inflicted on hides and skin defects mainly due to infestation by external parasites (Kassa, 2006).

The control program against ectoparasites and skin diseases have been designed by the Ministry of Agriculture and Rural Development of Ethiopia (MoARD) in 2005 and launched in Tigray, Amhara and Afar regions. In Oromia regional state, this activity started in 2010 and is still ongoing.

Despite such national and regional emphasis given to the control programs against ectoparasites, the problem seems to be still alarming, questioning on the efficiency of this control program in the area. Reports from North-west Amhara region by Sisay et al. (2013) indicate the current overall prevalence of ectoparasites in the area is 44.9% in sheep and 43.5% in goats. As more recent report point out that ectoparasitic skin disease of small ruminants are still active and serious in northern part of the country. For instance, in Tigray Regional state, after realization of the control program, an overall ectoparasite prevalence of 55.5% in sheep and 58% in goats were reported by Mulugeta et al. (2010). Surprisingly, the overall prevalence of ectoparasites reported by Serste and Wossene (2007) was 50.5% in sheep and 56.4% in goats before control program was launched in eastern Amhara region. It is clear that re-infestation of flocks is very frequent and the control activity is not well internalized and properly realized.

in other regions, this control program is still going on in selected zones of Oromiya and Afar regions but no study was so far conducted on the impact of this control program on the current status of ectoparasites and related skin diseases. This paper addresses the current effect of ectoparasitism on health and production of sheep and goat in Ethiopia with particular emphasis to their distribution and impact to tanning industries as well as economy of the country.

STATUS OF ECTOPARASITES OF SMALL RUMINANTS IN ETHIOPIA

Ectoparasites are the major causes of skin diseases that hamper small ruminant production in many areas of Ethiopia. Studies conducted in different parts of the country in the past three decades have revealed that the occurrence and spread of skin diseases have been shown to correlate with feed scarcity host, poor husbandry, climatic factors and inadequate veterinary services including absence of national control strategies (Kassa, 1998; Teshome, 2002; Yacob et al., 2008a). According to report by Serste and Wossene (2007), ectoparasites, particularly sarcoptic mites along with other affects on the body is blamed to cause losses due to death of sheep and goats in north Amhara region in Ethiopia. Ectoparasites also have transmission ability for many infections due to blood sucking habit. Skin damage is the most important cause of losses in livestock industry (Tadesse et al., 2011).

Mange mites

Mange mites are common in Ethiopia and therefore are reported from many regions and different agroclimates. Based on the reports so far, mange mites are most prevalent in four national regional states of Ethiopia namely, the Amhara Oromia Tigray and Southern Nation and Nationalities regional states (Yacob et al., 2008a; Mulugeta et al., 2010; Asnake et al., 2013). In all reports, three genera of mites namely, *Sarcoptes*, *Psoroptes* and *Demodex* were reported to affect small ruminants in Ethiopia.

(a) (b)

Figure 1. Goat infested by generalized Sarcoptic mange (a) in Chiffra, Afar region (b) in Benatsemaye district of south Omo zone, Ethiopia. Source: Pictured by Yacob Hailu (2011).

(a) (b)

Figure 2. Alopecia (a) and Death due to sarcoptic mange (b) in Kamisse (Wollo). **Source**: Yacob HT (2012).

Sarcoptic mange

Sarcoptic scabiei var. *caprae* and *Sarcoptic scabiei* var. *ovis* have a wide geographic distribution in many goat (Figure 5) and sheep rearing in arid and semi-arid areas of Ethiopia, and it is more commonly seen in goats than sheep (Figures 1a, b, 3a, b and 4).. In Ethiopia, they are widely distributed in lowland mainly (Yacob et al., 2008a; Mulugeta et al., 2010; Asnake et al., 2013), low and midlands (Kumsa et al., 2012) as well as central midland part of the country (Yacob et al., 2008b). The highest prevalence of sarcoptic mites observed in sheep and goats were 30.32% in Tigray (Kedir, 2000) and 57.6% in Southern Ethiopia (Asnake et al., 2013), respectively.

Psoroptic mange

Psoroptic mange (sheep Scab), caused by *Psoroptes ovis*, which is common in Ethiopia, is reported from different regions. Mites of the genus *Psoroptes* cause psoroptic mange in sheep and goats(Figures 5, 6 and 7).. In sheep, its prevalence is found greater than in goats therefore, it causes greater damage in sheep than in goats. Etagegnehu (1992) and Nigatu (1992) have reported that *Psoroptes* has a prevalence of 42.9 and 32.87% from Cheffe State farm (Wollo). Recent studies indicate that in Ethiopia, Psoroptic mange is most common among small ruminants in lowland areas of north (Kassa, 2006; Mulugeta et al., 2010) and South

(a) (b)

Figure 3. Goats affected with generalized Sarcoptic mange (sever itching, alopecia and visible depression) in Kamisse (Wollo). Source: Yacob Hailu (2012)

Figure 4. Sheep affected with generalized sarcoptic mange (alopecia) in Kamisse (Wollo). Source: Yacob Hailu (2012).

(Dessie et al., 2010) as well as central lowland areas (Yacob et al., 2008b). Its prevalence is highly decreasing compared to previous studies as reported recently, 2.63% in sheep and 5.13% in goats by Shibeshi et al. (2013) in Guto-Gida district of Eastern Wollega zone.

Demodectic mange

Demodectic mange has been reported in sheep (*Demodex ovis*) and goats (*Demodex caprae*). It is one of the major skin diseases of sheep and goats (Figure 8a, b). Demodectic mange is distributed in different agro-ecological zones in Ethiopia as reported by Yacob et al. (2008a) in central lowland of Oromiya; by Serste and Wossene (2007) in midland and highlands of Amhara region, and Asnake et al. (2013) in lowland and midland areas in southern part of the country. The highest prevalence was 6.8% in goats by Mulugeta et al. (2010) in and around Mekele, followed by 2.83% by Asnake et al. (2013) in southern Ethiopia.

Pediculosis

Lice infestation in Ethiopia is the most frequently reported and the most important skin disease of small ruminants this is because lice are found to be the cause of cockle. According to Tefera and Abebe (2007), *Bovicola ovis* and *Linognathus* spp. are the two species with prevalences in sheep of 38.5 and 2.4%, respectively while in goats *Linognathus* species has prevalence of 28.3%. Nowadays, pediculosis is a serious health problem of small ruminants in Ethiopia (Figure 9). The highest prevalence was recently reported in sheep from Assela by Hailu (2010), who identified *Linognathus* spp (75.5%), *B. ovis* (67.1%), *Linognathus ovillus* (14.6%) and *B. ovis* (36.1%), this last one was reported by Asnake et al. (2013). Other reports were *B. ovis* in sheep 15.3 and 27.9% in goats, *L. ovillus* (27.9%) from Tigray by Mulugeta et al. (2010) and *B. ovis* (26.64%) in sheep from Wolayta Sodo (Yacob et al., 2008a). The louse species identified in many studies conducted so far in Ethiopia were *B. ovis and L. stenopsis.* Results obtained by Ermias (2000) from examination of fresh sheep pelts also showed a much higher infestation rate of 89.55%. In Ethiopia, most lice populations on animals vary seasonally, depending on the condition of the host. Lice populations on animals are greater during the rainy months (Hailu, 2010).

Figure 5. Goat affected with generalized sarcoptic mange (lameness and unthriftyness) in Kamisse (Wollo). Source: Yacob Hailu (2012).

Figure 6. Psoroptic mange in sheep. Thick crusts on bridge of nose. Source: Ethiopian Sheep and Goat Productivity Program ESGPIP (2010).

Figure 7. Severe inching due to *Psoroptes communis var canciculi* affecting the external ear canal. Source: Ethiopian Sheep and Goat Productivity Program ESGPIP (2010).

Sheep keds (*Melophagus ovinus*)

In Ethiopia, few works are available on ecological distribution of sheep ked. Recent reports on sheep ked of small ruminants indicated that the parasite is most common in sheep mainly in cooler high altitudes (Figure 10). According to Enquebaher and Etsay (2010), the prevalence varies from 1.84 to 19.48% in Tigray regional state. Other reports were in sheep. 65% from Assela highlands (Hailu, 2010) (Oromyia region); 19.1% from Mekele midlands (Mulugeta et al., 2010); 14.2% from central highlands of Oromyia regional state (Kumsa et al., 2012) and 20.14% from Gondar highlands (Tewodros et al., 2012). In all cases, the identified species was *Melophagus ovinus.* Infestation of sheep with *M. ovinus* leads to the development of cockle and those results in downgrading and rejection of skins. The prevalence of cockle lesion in *M. ovinus* infested groups of sheep skin

(a) (b)

Figure 8. (a) Demodectic Mange in goats with thickened epidermis in Chiffra, Afar region Source: Yacob Hailu (2011) (b) Papules and nodules on face. Source: ESGPIP (2010).

(a) (b)

Figure 9. Partition for collecttion of lice from haevely infected sheep (a) and spraying highly emaciated sheep due to heavey lice infestation in Assela. Source: Yacob Hailu and Hailu Wondimu (2012).

(a) (b)

Figure 10. Adult keds on the sheep wool (a) and collection of keds (b) Source: ESGPIP (2010).

was found to be 100 and 95%, respectively (Tefera and Abebe, 2007). Examination of fresh sheep pelts also indicated the prevalence rate of 32.7% infection rates (Ermias, 2000). Both lice and keds are considered as cause of cockle in Ethiopian sheep pelts (Kassa, 1998). According to Serste and Wossene (2007), about 70.8% of the pickled sheep pelt and 42.3% of the wet blue goat pelt were downgraded and rejected due to cockle caused by both lice and sheep ked.

Ticks

Ticks are one of the most serious ectoparasites in Ethiopia. They cause the greatest economic losses in livestock production. Their effects are various including reduced growth, milk and meat production, damaged hides and skins, transmission of tick-borne diseases of various types and predispose animals to secondary attacks from other parasites such as screw worm flies and infection by pathogens such as *Dermatophilus congolensis*, the causative agent of streptothricosis (Ethiopia Sheep and Goat Productivity Improvement Program (ESGPIP), 2010). Reports from different areas of Ethiopia indicated that highest overall prevalence of ticks infestation are, 23.8% in sheep and 10% in goats (Teshome, 2002) from Sidama zone; 31.78% in sheep and18.63% in goats from Wolayta Sodo (Yacob et al., 2008b); 16% in sheep and 29.7% in goats from Tigray region (Mulugeta et al., 2010) and 57.6% in goats from three agro-ecological zones of southern rangeland of Ethiopia (Asnake et al., 2013). In all these studies, it was observed that about four genuses namely, *Amblyomma*, *Hyaloma*, *Boophilus and Rhipiciphalus* were known to affect sheep and goats in different agro-ecological zones in the country. The high prevalence of ticks in different areas seems to be related to absence of national campaign for strategic control of these ectoparasites.

Ectoparasitism

Ethiopian small ruminant skins especially sheep skins traditionally have good reputation for quality in the world leather market due to their fine grain and compact structure. The leather industry sector is one of the fast growing economic sectors in Ethiopia (ESGPIP, 2009). Until recently, Ethiopia's second largest source of foreign income was the hides and skins sector. However, the percentage of skins having defects that downgrade quality has increased tremendously. Tanneries state that currently only 10 to 15% of harvested skins qualify for top grades, with the rest downgraded and rejected mainly due to deterioration of skin quality due to ectoparasitic skin diseases and various defects (ESGPIP, 2009).

Hides and skins products were supplied to domestic and export markets and contributed significantly to the country's economy by providing 14 to 18% of the foreign exchange earnings (FAO, 2005). According to data from ESGPIP (2009), the leather and leather product exports increased from 67 million USD to 104 million USD between 2010/11. As reported by Berhanu et al. (2007), on average, the leather and leather products industry contributed 5.9% to the total export earnings for the years 2010/11. But this is much lower than would be expected, given the huge size of the livestock population in the country.

In Ethiopia, large numbers of sheep and goats are slaughtered throughout the year. However, the numbers of skins that reach the tanneries for processing is much lower than expected (Ermias, 2000; Asfaw, 2002; Numery, 2001). The Ethiopian tanning industry has long complained about the grades of small ruminant skins, which resulted in poor quality of processed skins. As many as one-quarter to one third of all skins processed at tanneries have various defects and are unsuitable for export purposes (Kassa, 1998; Degume, 2002). Up to 65% of these defects occur in the pre-slaughter stage of production while the animals are alive while considerably large portions of these pre-slaughter defects are directly related to parasitic and/or to secondary self-inflicted damages (Haffize, 2001). Post-slaughter defects related to poor management and treatments of skins after slaughter are also among important problems (Hagos et al., 2013). This, therefore, creates a serious problem for competition in international markets through the export of processed skin. Almost all commercial tanneries have indicated rejections of 20 to 24% of purchased skins from sheep and goat, which has resulted in a loss of $6.9 million (Belachew, 2004).

Skin problems caused by lice, keds, mange and ticks are among the major pre-slaughter defects that reduce skin qualities and results in rejections (Kassa, 2006; Tefera and Abebe, 2007). The predominant causes of downgrading and rejection of skin from sheep and goat were said to be cockle in the early processing stage (Heath et al., 1995a, b). Tick bites leave small but distinct blemish lesion on the skin, which appears as a small hole in the leather. Such skins give "ticked" leather, which is of inferior quality (Henderson, 1991). Lice infestations are hazardous particularly that of great damage to the grain of skin (Mullen and O'Connor, 2002). The lesion cockle would not heal quickly. It will take about three months to heal after treatment (Kassa, 1998).

In Ethiopia, keds and lice are considered a major cause of cockle and are visible on the skin surface of affected animals (Kassa, 1998; Ermias, 2000). It is an allergic skin hypersensitivity reaction due to lice infestation and this defect appears on the grain side of semi-processed and crust leather after pickling that cannot be detected when the skin is examined raw or unprocessed. It results in

huge economic loss to tanneries and the country at large since the damage is recognized after a lot of cost is incurred on the processing after which the damaged skins have to be rejected or downgraded (Kassa, 2006). According to Yisehak (2000) and Abdulhamid (2001), studies conducted at Sebeta tannery on sheep skin and Kombolcha tannery on goat skins on routine production system indicate 89% of cockle in pickled sheep pelts and 71.16% in goat pelts, respectively. According to Demissie et al. (2000), the estimated economic loss due to drop in quality of sheep and goat skin is around USD 14 million per year.

Many studies in Ethiopia underlined that the effect of ectoparasites on small ruminant health and production as well as skin quality is multifaceted. Each parasite has adopted its own way of feeding and consequently affecting these animals. Ticks affect sheep and goat health and skin quality in three ways. The penetration of the skin by the piercing mouth parts by ticks makes holes which are defects in processed skins. When feeding, ticks can allow bacteria to pass through the skin leading to the development of local abscesses which damage skin quality more extensively than the holes caused by feeding (ESGPIP, 2010). The economic impact of tick infestations is enormous in Ethiopia with a conservative estimate of 1 million Ethiopian Birr (over 55 thousand USD) loss annually was made through rejection and downgrading of hides and skins due to effect of ticks (Kassa, 2006).

Lice are easily overlooked because of their small size. They can multiply very fast before being discovered. By this time, the animal might be too anaemic and emaciated and difficult to recover. An allergic skin hypersensitivity reaction due to lice is another cause for “Cockle” in processed sheep skins (Kassa, 2006). Skin puncture by blood sucking keds causes an inflammatory response of the skin to the presence of keds and their saliva known as cockles. This is recognized after the wool or hair has been removed from the skin. Cockle causes down grading of the skin because it weakens and discolours it (Kassa, 1998). In some parts of Southern Ethiopia, Amhara and Afar region mite infestation, mainly sarcoptic mites were blamed to cause heavy mortality (Demissie et al., 2000, Asnake et al., 2013). Death might be due to dehydration, a direct result of the feeding of huge number of mites, inability to move and feed due to severe lesions on the face, muzzle and on the joints or to secondary causes such as pneumonia or bacterial septicmia introduced through self inflicted bite and scratch wounds.

CONCLUSION AND RECOMMENDATIONS

The contribution of these animals to the Ethiopian export income and food production is far below the existing potential being hampered by ectoparasites that play a very destructive role by depressing the productivity of sheep and goats. These parasites also seriously damage sheep and goat skins, resulting in the rejection or downgrading of the skins. Export earnings from this important commodity are therefore drastically reduced. Even though, control programs started in few regions such as Amhara, Tigray and Oromiya, still, reports indicate that these programs are far from recorded expected control and reduction of impact excreted by ectoparasites. The problem is still very serious and there are still animals suffering from ectoparasitism in ectoparasites control campaign regions, threatening the national economy, sheep and goat population and tanning industries. Lack of awareness creation and absence of control on animal movement and poor quarantine policy might have resulted in ineffectiveness of the control campaigns. This threat of ectoparasites on overall sheep productivity and tanning industry in Ethiopia warrants urgent strategic control intervention based on peculiar characteristic of each agro-ecology.

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Retrospective study of clinical cases presented at veterinary hospitals in Khartoum State, Sudan

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The study was conducted in Veterinary Hospitals in Khartoum state in order to determine the clinical cases in different animal species. Many Bovine diseases were diagnosed in different Veterinary Hospitals in Khartoum State from 2010 to 2012. A total of (204) cases were recorded all over the state and the highest overall prevalence rate was observed for surgical interferences 35.78% (n = 73), parasitic diseases 33.33% (n = 68) and bacterial and viral diseases 20.09% (n = 41), while the lowest overall prevalence rate was obtained for disorder of digestive system 5.39% (n = 11) and metabolic diseases 5.39% (n = 11). The most important bacterial and viral diseases that were diagnosed in all Veterinary Hospitals were contagious bovine pleuro pneumonia (CBPP), mastitis and foot and mouth disease (FMD) given an overall prevalence rate of 48.78, 19.51 and 12.20% (n = 20, 8 and 5, respectively). Internal parasites were recorded as the most frequent parasitic diseases 45.59% (n = 31). The clinical cases which required surgical interference were uterine prolapsed 9.59%, retained placenta 23.29%, foreign bodies 5.48%, dystocias 21.92%, (out of 73), (n = 7, 17, 4 and 16, respectively). High morbidity rate of bacterial, viral and parasitic diseases as well as disorder of digestive system were observed for ovine in Omdurman Veterinary Hospital with prevalence rate of 35.02, 35.83 and 17.21% (out of 494), (n = 173, 177 and 85, respectively). Surgical interferences and metabolic diseases were also prevalent in the same species in all veterinary clinics 12.13 and 4.20% (out of 643) (n = 78 and 27, respectively). The major caprine diseases diagnosed in Khartoum Veterinary Hospital were bacterial, viral and parasitic diseases as well as disorder of digestive system 30.12, 22.93 and 16.54% (out of 2171) (n = 654, 498 and 359, respectively). High morbidity rate of surgical interferences and metabolic disease 22.80 and 7.60% (out of 2171) (n = 495 and 165, respectively) were also observed. Among the bacterial, viral and parasitic diseases of caprine, contagious caprine pleuro pneumonia (CCPP), mastitis, internal parasites and tick infestation were recorded as a common clinical cases with prevalence rate of 57.19, 27.68, 97.52 and 18.67% (out of 654 and 498) (n = 374, 181, 396 and 93, respectively). There were 1442 clinical cases observed for equine. Surgical interferences and parasitic diseases were dominant with an overall prevalence rate of 43.41% (n = 626) and 21.08% (n = 304), respectively. The most frequent bacterial, viral and parasitic diseases (out of 182 and 304) that diagnosed in Khartoum Veterinary Hospital were pneumonia, tetanus, coccidiosis, babesiosis, external parasites and internal parasites with prevalence rate 91.2% (n = 160), 3.85% (n = 7), 0.66% (n = 2), 19.41% (n = 59), 13.82% (n = 42) and 59.54% (n = 181), respectively. Surgical interferences in equine (626 cases) most probably due to wound, fracture and trauma 59.11% (n = 370), sharp teeth 14.70% (n = 92), tendonitis 10.06% (n = 63), arthritis 5.9% (n = 37), tumors 4.95% (n = 31) and lameness 2.56% (n = 16).

Key words: Clinical cases, veterinary hospitals, Khartoum state, Sudan.

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INTRODUCTION

The economic importance of sheep, cattle and poultry depends on the value of production and services which include meat, milk, wool and skins. Horse and donkey are steadily increasing in Sudan rather than many other African countries due to poverty. They play an important role in the provision of energy for agricultural production by way of traction of cultivation and transport of products.

The production of livestock in Sudan faces many problems including infectious disease caused by bacterial disease, viral and parasitic agents. Bacterial and viral disease has almost been brought under control either by drug therapy or vaccination. Parasitic disease, however, have largely been neglected primarily because they do not often cause acute fetal disease. Blood parasites are living organisms which inhabit on blood and feed on its constituents or nutrients. The blood parasites are difficult to control due to the resistance of some parasites to drugs, and there is no successful vaccine against most of blood parasites due to several factors such as antigenic variation and difficulties in propagation of these organisms in artificial media. The infection with blood parasites can be suspected from general symptoms of disease such as decrease in production, emaciation, loss of appetite and jaundice. Animal also take time to reach the peak of production after recovery (Herenda, 1994).

Objectives

1. To classify nature and type of diseases and disease conditions in animals presenting to the veterinary clinics.
2. To identify prevalent disease of economic importance or zoonotic nature diagnosed in the veterinary clinics.
3. To suggest plans for controlling of diseases.

MATERIALS AND METHODS

Study area

The study was conducted in Khartoum State which is situated in northern Sudan between latitude 15° 38`N and longitude 32° 26`E. The total area extends over approximately 21,000 square kilometer. The climate of Khartoum is an arid type which is characterized by a wide range in daily and seasonal temperatures. During cool season between December to February, the weather is cool and dry with minimum daily temperature of 24°C. The season is characterized by low humidity. A hot dry weather prevails between March to October, a temperature of 45°C may occur during the day. The maximum rainfall is during the period from mid July to September, in this season there is an increase in relative humidity with a maximum of 68% in August. It is more convenient to divide the year into a cool dry season, hot dry season and hot wet season. Khartoum state is divided into three administration governorates:

1. Khartoum.
2. Omdurman.
3. Khartoum North.

Veterinary hospitals in Khartoum state include:

1. Omdurman Veterinary Hospital.
2. Khartoum Veterinary Hospital (Abu hamama).
3. Khartoum North Veterinary Hospital.

Study population

The study populations were bovine, caprine, ovine, poultry, equine, canine and feline that presented in Khartoum Veterinary Hospital.

Data collection

Data was collected from annual report of the Veterinary Hospitals in Khartoum state from 2010 to 2012. The records include all animal information, owner name, sex, species, case history, tentative, final diagnosis and treatment.

Type of diagnosis

Clinical examinations (tentative diagnosis)

The clinical examination of sick animal utilized various methods of examination. These methods are applicable to both the preliminary general examination of the sick animal and the detailed examination of the individual body systems. These methods as follows:

Inspection: This is a visual examination of the whole animal. It includes a detailed inspection of individual tissue and organs.

Palpation: This is an act of handling the tissue. Palpation consists of the application of firm but gentle pressure with the fingers. This method may be obtained by regarding the presence or absence of pain in particular tissue. By palpation, it may be possible to demonstrate abnormalities in shape, size or consistency of organ or tissue.

Percussion: This is an act of striking a short sharp blew on a part of the body with the object of response. When the part is struck directly with the finger tips, the procedure is termed immediate percussion.

Auscultation: This is an act of listening to the sounds produced by functional activity in various parts of the body. It is a direct application of the ear to the part by a stethoscope.

Sense of smell: The sense of smell is frequently of value to the veterinary surgeons such that certain diseases are associated with the development of characteristic odors associate with them.

Other diagnostic procedures: The site of the disease process includes the passage of sounds, catheters, puncture, rectal examination, oesophagoscope, ophthalmoscope and mechanical aids to diagnosis such as (X-ray).

Laboratory examinations

Allergic reactions

These tests are applied to the individual animal. It is a skin test by detection of sub clinical cases of a specific infection.

Clinical chemistry

This involves estimation of the blood content such as urea, glucose, calcium and magnesium. The blood sample is taken from sick animal before treatment.

Bacteriological examinations

The identification of causal organism can be achieved by microscopic examination of stained smears, culture.

Parasitological examination

Skin scarping permit the identification of ecto parasites. Eggs of parasitic infection are identified by the number of eggs in a given weight of faeces.

Serological examinations

1. Agglutination test.
2. Complement fixation test (CFT).
3. Gel diffusion test.
4. ELIZA.

Haematological examinations

A simple estimation of the hemoglobin level may be sufficient to confirm a tentative diagnosis of anemia. Investigation of white blood cell picture may indicate the type of response associated with the illness and may indicate a defensive reaction to infection.

Analysis for poisons

Confirmation of a tentative diagnosis of poisoning can be based on the chemical identification of suspected poison in material obtained from the animal.

Mechanical aids to diagnosis

This include radiological examination for small animals like dog and cat.

RESULTS

Many bovine diseases were diagnosed in different Veterinary Hospitals in Khartoum State from 2010 to 2012. A total of (204) cases were recorded all over the state and the highest overall prevalence rate was observed for surgical interferences 35.78% (n = 73), parasitic diseases 33.33% (n = 68) and bacterial and viral diseases 20.09% (n = 41). While the lowest overall prevalence rate was obtained for disorder of digestive system 5.39% (n = 11) and metabolic diseases 5.39% (n = 11). The details of the results are presented in Table 1. The most important bacterial and viral diseases that were diagnosed in all Veterinary Hospitals were contagious bovine pleuro pneumonia (CBPP), mastitis and foot and mouth disease (FMD) given an overall prevalence rate of 48.78, 19.51 and 12.20% (n = 20, 8 and 5, respectively). Internal parasites were recorded as the most frequent parasitic diseases 45.59% (n = 31) (Table 2). The clinical cases which required surgical interference were uterine prolapsed 9.59%, retained placenta 23.29%, foreign bodies 5.48%, dystocias 21.92% (out of 73) (n = 7, 17, 4 and 16, respectively).

High morbidity rate of bacterial, viral and parasitic diseases as well as disorder of digestive system were observed for ovine in Omdurman Veterinary Hospital with prevalence rate of 35.02, 35.83 and 17.21% (out of 494) (n = 173, 177 and 85, respectively). Surgical interferences and metabolic diseases were also prevalent in the same species in all veterinary clinics 12.13 and 4.20% (out of 643) (n = 78 and 27, respectively). The rest of the results are presented in Table 3. Maycoplasma, mastitis, heart water, sheep pox, arthritis and internal parasites were considered as the most important clinical cases of ovine in Veterinary Clinics of Khartoum State 74.79, 10.68, 3.85, 2.56, 1.71 and 81.19% (out of 234 and 202) (n = 175, 25, 9, 6, 4 and 164, respectively) (Table 4). The common cases which need further surgical interference were tumors 29.49% and abscess 15.38% (out of 78) (n = 23 and 12, respectively).

The major caprine diseases diagnosed in Khartoum Veterinary Hospital were bacterial, viral and parasitic diseases as well as disorder of digestive system 30.12, 22.93 and 16.54% (out of 2171) (n = 654, 498 and 359, respectively). High morbidity rate of surgical interferences and metabolic disease 22.80 and 7.60% (out of 2171) (n = 495 and 165, respectively) were observed in (Table 5). Among the bacterial, viral and parasitic diseases of caprine, CCPP, mastitis, internal parasites and tick infestation were recorded as a common clinical cases with prevalence rate of 57.19, 27.68, 97.52 and 18.67% (out of 654 and 498) (n = 374, 181, 396 and 93, respectively) (Table 6). Clinical cases associated with disorder of digestive system were most probably due to enteritis, bloat and diarrhea with prevalence rate of 49.30, 12.53 and 24.79% (out of 359) (n = 177, 45 and 89, respectively). Metabolic diseases were due to pregnant toxemia, hypoglasemia, vitamin deficiency and acidosis 36.79, 9.09, 32.12 and 4.85% (out of 165) (n = 61, 15, 53 and 8, respectively). The most frequent cases due to surgical interference were wound, fracture and trauma 22.02%, foreign bodies 20.60%, dystocia 20.00%, abscess 9.49%, retained placenta 8.28%, tumors 7.47% and uterine prolapsed 5.66% (out of 495) (n = 109, 102, 99, 47, 41, 37 and 38, respectively).

A total of 277 clinical cases of the poultry were diagnosed in Khartoum Veterinary Hospitals. These clinical cases are as follows: bacterial and viral diseases

Table 1. Bovine diseases diagnosed in Khartoum Veterinary Hospitals (2010, 2011, 2012).

Study site	No. examined	Bacterial and viral diseases	Disorder of digestive system	Parasitic diseases	Metabolic diseases	Surgical interferences
			Frequency (%)			
Khartoum Veterinary Hospital	143	28 (19.28)	10 (6.99)	33 (23.08)	8 (5.59)	64 (44.75)
Khartoum North Veterinary Hospital	29	1 (3.45)	0 (0.0)	24 (82.76)	0 (0.0)	4 (13.79)
Omdurman Veterinary Hospital	32	12 (37.5)	1 (3.13)	11 (34.375)	3 (9.38)	5 (15.63)
Total	204	41 (20.10)	11 (5.40%)	68 (33.33)	11 (5.39)	73 (35.78)

Table 2. Bacterial, viral and parasitic diseases of bovine diagnosed in the Khartoum Veterinary Hospitals (2010, 2011, 2012).

Clinical cases	Khartoum Veterinary Hospital	Omdurman Veterinary Hospital	Khartoum North Veterinary Hospital	Total
		Frequency (%)		
Bacterial and viral diseases				
Contagious Bovine pleuro pneumonia (CBPP)	15 (36.59)	5 (12.20)	0 (0.0)	20 (48.78)
Mastitis	6 (14.63)	2 (4.9)	0 (0.0)	8 (19.51)
Metritis	3 (7.32)	0 (0.0)	0 (0.0)	3 (7.31)
Brucellosis	1 (2.44)	1 (2.43)	0 (0.0)	2 (4.88)
Foot and mouth disease (FMD)	0 (0.0)	5 (12.20)	0 (0.0)	5 (12.20)
Arthritis	2 (4.88)	0 (0.0)	0 (0.0)	2 (4.88)
Eye Infection	1 (2.44)	0 (0.0)	0 (0.0)	1 (2.44)
Subtotal	28 (68.29)	13 (31.71)	0 (0.0)	41 (100)
Parasitic diseases				
Internal parasites	12 (17.65)	4 (5.88)	15 (22.06)	31 (45.59)
Tick Infestation	5 (7.35)	2 (2.94)	9 (13.24)	16 (23.53)
Thieleriosis	16 (23.53)	5 (7.35)	0 (0.0)	21 (30.88)
Subtotal	33 (48.52)	11 (16.18)	24 (35.29)	68 (100)

53.79% (n = 149), parasitic disease 28.52% (n = 97), disorder of digestive system 5.42% (n = 15) and metabolic diseases 5.78% (n = 16) (Figure 1). The most common bacterial, viral and parasitic disease of poultry (out of 149 and 97) were *Escherichia coli*, New Castle infections, pneumonia, salmonellosis, coccidiosis, tick infestation and internal parasites with prevalence rate 1.34% (n = 2), 13.40% (n = 20), 40.26%

Table 3. Ovine diseases diagnosed in Khartoum Veterinary Hospitals (2010, 2011, 2012).

Study site	No. examined	Bacterial and viral diseases	Disorder of digestive system	Parasitic diseases	Metabolic diseases	Surgical interferences
			Frequency (%)			
Khartoum Veterinary Hospital	133	49 (36.84)	17 (12.78)	23 (17.29)	13 (9.77)	31 (23.31)
Khartoum North Veterinary Hospital	16	12 (75.00)	0 (0.0)	2 (12.5)	0 (0.0)	2 (12.5)
Omdurman Veterinary Hospital	494	173 (35.02)	85 (17.21)	177 (35.83)	14 (2.83)	45 (9.11)
Total	643	234 (36.39)	102 (15.86)	202 (31.42)	27 (4.20)	78 (12.13)

Table 4. Bacterial, viral and parasitic diseases of Ovine diagnosed in Khartoum Veterinary Hospitals (2010, 2011, 2012).

Clinical cases	Khartoum Veterinary Hospital	Omdurman Veterinary Hospital	Khartoum North Veterinary Hospital	Total
		Frequency (%)		
Bacterial and viral diseases				
1. Mycoplasmosis	29 (12.39)	134 (57.26)	12 (5.13)	175 (74.79)
2. Mastitis	7 (2.99)	18 (7.69)	0 (0.0)	25 (10.68)
3. Metritis	0 (0.0)	3 (1.28)	0 (0.0)	3 (1.28)
4. Brucellosis	2 (0.85)	0 (0.0)	0 (0.0)	2 (0.85)
5. Arthritis	4 (1.71)	0 (0.0)	0 (0.0)	4 (1.71)
6. Rabies	1 (0.43)	2 (0.85)	0 (0.0)	3 (1.28)
7. Peste de petites(ppr)	1 (0.43)	1 (0.43)	0 (0.0)	2 (0.85)
8. Sheep pox	1 (0.43)	5 (2.14)	0 (0.0)	6 (2.56)
9. Tetanus	4 (1.71)	1 (0.43)	0 (0.0)	5 (2.14)
10. Heart water	0 (0.0)	9 (3.85)	0 (0.0)	9 (3.85)
Subtotal	49(20.94)	173 (73.93)	12 (5.13)	234 (100)
Parasitic Diseases				
1. Internal parasite	19 (9.41)	145 (71.78)	0 (0.0)	164 (81.19)
2. Ticks Infestation	4 (1.98)	24 (11.88)	0 (0.0)	28 (13.86)
3. Thieleriosis	0 (0.0)	2 (0.99)	2 (0.99)	4 (1.98)
4. Mange	0 (0.0)	2 (0.99)	0 (0.0)	2 (0.99)
5. Coccidiosis	0 (0.0)	4 (1.98)	0 (0.0)	4 (1.98)
Subtotal	23 (11.39)	177 (87.62)	2 (0.99)	202 (100)

Table 5. Caprine diseases diagnosed in Khartoum Veterinary Hospitals (2010, 2011, 2012).

Study site	No. examined	Bacterial and viral disease	Disorder of digestive system	Parasitic diseases	Metabolic diseases	Surgical interferences
		Frequency (%)				
Khartoum Veterinary Hospital	842	258 (30.64)	124 (14.73)	143 (15.92)	79 (9.38)	238 (28.27)
Khartoum North Veterinary Hospital	40	9 (22.5)	16 (40.00)	7 (17.5)	8 (20.5)	0 (0.0)
Omdurman Veterinary Hospital	1289	387 (30.02)	219 (16.99)	348 (27.00)	78 (6.05)	257 (19.95)
Total	2171	654 (30.12)	359 (16.54)	498 (22.93)	165 (7.60)	495 (22.80)

Table 6. Bacterial, viral and parasitic diseases of Caprine diagnosed in Khartoum Veterinary Hospitals (2010, 2011, 2012).

Clinical cases	Khartoum Veterinary Hospital	Omdurman Veterinary Hospital	Khartoum North Veterinary Hospital	Total
	Frequency (%)			
Bacterial and viral diseases				
Contagious caprine pleuro pneumonia (CCPP)	175 (26.76)	196 (29.97)	3 (0.46)	374 (57.19)
Mastitis	53 (8.10)	122 (18.65)	6 (0.92)	181 (27.68)
Metritis	10 (1.53)	28 (4.28)	0 (0.0)	38 (5.81)
Brucellosis	6 (0.92)	3 (0.46)	0 (0.0)	9 (1.38)
Arthritis	0 (0.0)	15 (2.30)	0 (0.0)	15 (2.30)
Eye infections	0 (0.0)	9 (1.38)	0 (0.0)	9 (1.38)
Sheep pox	10 (1.53)	3 (0.46)	0 (0.0)	13 (0.46)
Rabies	0 (0.0)	3 (0.46)	0 (0.0)	3 (0.46)
Tetanus	0 (0.0)	3 (0.46)	0 (0.0)	3 (0.46)
Black leg	0 (0.0)	1 (0.15)	0 (0.0)	1 (0.15)
Heart water	0 (0.0)	1 (0.15)	0 (0.0)	1 (0.15)
Peste de petites (PPR)	4 (0.61)	3 (0.46)	0 (0.0)	7 (1.07)
Subtotal	258 (39.45)	387 (59.17)	9 (1.38)	654 (100)
Parasitic disease				
Internal parasites	81 (16.27)	308 (61.85)	7 (1.41)	396 (79.52)
Ticks infestation	61 (12.25)	32 (6.43)	0 (0.0)	93 (18.67)
Mange	1 (0.20)	6 (1.21)	0 (0.0)	7 (1.41)
Coccidiosis	0 (0.0)	2 (0.40)	0 (0.0)	2 (0.40)
Subtotal	143 (28.72)	346 (69.48)	7 (1.41)	498 (100)

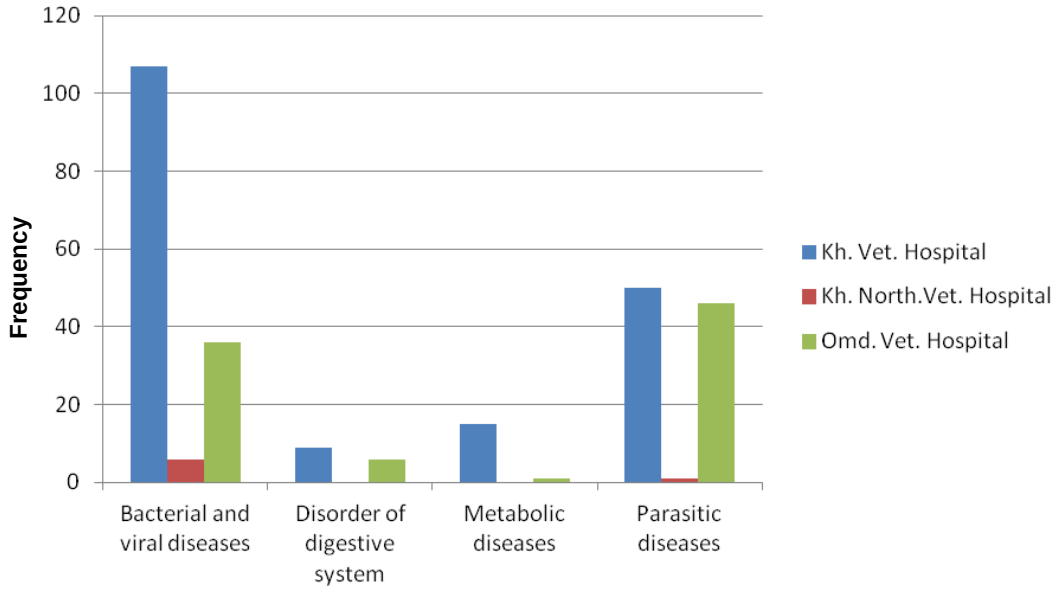

Figure 1. Poultry diseases diagnosed in Khartoum Veterinary Hospitals (2010, 2011, 2012).

(n = 60), 16.11% (n = 24), 7.22% (n = 7), 12.37% (n = 12) and 78.35% (n = 76), respectively (Table 7).

There were 1442 clinical cases observed for equine. Surgical interferences and parasitic diseases were dominant with an overall prevalence rate of 43.41% (n = 626) and 21.08% (n = 304), respectively (Table 8). The most frequent bacterial, viral and parasitic diseases (out of 182 and 304) that diagnosed in Khartoum Veterinary Hospital were pneumonia, tetanus, coccidiosis, babesiosis, external parasites and internal parasite with prevalence rate 91.2% (n = 160), 3.85% (n = 7), 0.66% (n = 2), 19.41% (n = 59), 13.82% (n = 42) and 59.54% (n = 181), respectively. The rest of the results are shown in Table 9. Surgical interferences in equine (626 cases) were most probably due to wound, fracture and trauma 59.11% (n = 370), sharp teeth 14.70% (n = 92), tendonitis 10.06% (n = 63), arthritis 5.9% (n = 37), tumors 4.95% (n = 31) and lameness 2.56% (n = 16).

There were a number of clinical cases (n = 585) that were diagnosed in canine such as parasitic diseases 48.89% (n = 286), surgical interferences 15.56% (n = 91), bacterial and viral diseases 14.19% (n = 83) (Table 10). The most prevalent diseases were canine distemper 37.55% (n = 31), pneumonia 13.33% (n = 26), rabies 6.02% (n = 5) and tick infestation 83.22% (n = 238). Many clinical cases (n = 92) of feline were observed in the Veterinary Clinics of Khartoum State. High overall prevalence rate was obtained for surgical interferences 32.61% (n = 30), bacterial and viral diseases 20.65% (n = 19) and disorder of digestive system 19.57% (n = 18) (Table 11). The most common clinical cases of feline were pneumonia 73.68% (n = 14) and rabies 5.26% (n = 1).

DISCUSSION

The study was conducted in veterinary clinics in Khartoum State. Many clinical cases in different species were observed from 2010 to 2012. As seen from the results, bacterial, viral and parasitic diseases were found the most dominants clinical cases diagnosed in bovine in Veterinary Hospitals. Similarly, Siham et al. (2008) stated that the bacterial and viral diseases represented 45.3% of the cases among the animals admitted to Hillat Kuku Veterinary Teaching Hospital (HKVTH), College of Veterinary Medicine and Animal Production, Sudan University of Science and Technology during period 1997 to 2006. Among these diseases, mastitis, conjunctivitis, tetanus, rabies, pneumonia and arthritis were recorded. An increase in the prevalence rate of bovine mastitis was also recorded (33%) by Noul (2009) in dairy farms of Kuku area. He mentioned that there were many risk factors associated with occurrence of bovine mastitis in dairy farms such as age, parity, stage of lactation and lesions on the udder as well as general hygienic conditions in the farms. Moreover, Saluiemi (1980) reported that it there was mastitis problem with cows in a loose horse, the cause is as a result of poor milking hygiene or milking machine. Our results regarding foot and mouth disease (FMD) is in agreement with Niema (2005) who found 4 serotypes in serum samples from

Table 7. Bacterial, viral, fungal and parasitic diseases of Poultry diagnosed in Khartoum Veterinary Hospitals (2010, 2011, 2012).

Clinical cases	Khartoum Veterinary Hospital	Omdurman Veterinary Hospital	Khartoum North Veterinary Hospital	Total
	Frequency (%)			
Bacterial , viral and fungal diseases				
Escherichia coli infection	0 (0.0)	2 (1.34)	0 (0.0)	2 (1.34)
Newcastle disease (NCD)	19 (12.75)	0 (0.0)	1 (0.67)	20 (13.42)
Fowl Pox	13 (0.67)	0 (0.0)	0 (0.0)	13 (8.72)
Infectious coryaza	3 (2.01)	0 (0.0)	0 (0.0)	3 (2.01)
Arthritis	0 (0.0)	1 (0.67)	0 (0.0)	1 (0.67)
Leuokosis	1 (0.67)	0 (0.0)	0 (0.0)	1 (0.67)
Pnemonia	30 (20.13)	25 (16.78)	5 (3.36)	60 (40.27)
Fowl typhoid	2 (1.34)	0 (0.0)	0 (0.0)	2 (1.34)
Salmonellosis	24 (16.11)	0 (0.0)	0 (0.0)	24 (16.11)
Trichomons	7 (4.70)	0 (0.0)	0 (0.0)	7 (4.70)
Bacterial infection	8 (5.37)	0 (0.0)	0 (0.0)	8 (53.70)
Fungal diseases	0 (0.0)	8 (5.37)	0 (0.0)	8 (53.70)
Subtotal	107 (71.82)	36 (24.16)	6 (4.03)	149 (100)
Parasitic diseases				
Coccidiosis	6 (6.19)	1 (1.03)	0 (0.0)	7 (7.22)
Tick infestation	10 (10.31)	1 (1.03)	1 (1.03)	12 (12.37)
Internal parasites	34 (35.05)	42 (43.30)	0 (0.0)	76 (78.35)
Mange	0 (0.0)	2 (2.06)	0 (0.0)	2 (2.06)
Subtotal	50 (51.55)	46 (47.42)	1 (1.03)	97 (100)

Table 8. Equine diseases diagnosed in Khartoum Veterinary Hospitals (2010, 2011, 2012).

Study site	No. examined	Bacterial and viral diseases	Disorder of digestive system	Metabolic diseases	Surgical interferences	Parasitic diseases	Uorogenital diseases
				Frequency (%)			
Khartoum Veterinary Hospital	293	34 (11.60)	26 (8.87)	11 (3.75)	145 (49.49)	67 (22.87)	10 (3.41)
Khartoum North Veterinary Hospital	42	0 (0.0)	1 (2.38)	1 (2.38)	40 (95.24)	0 (0.0)	0 (0.0)
Omdurman Veterinary Hospital	1107	148 (13.37)	152 (13.73)	102 (9.21)	441 (39.83)	237 (21.41)	27 (2.44)
Total	1442	182 (12.62)	179 (12.14)	114 (7.91)	626 (43.41)	304 (21.08)	37 (2.57)

Table 9. Bacterial, viral diseases and parasitic diseases of equine diagnosed in the Khartoum Veterinary Hospitals (2010, 2011, 2012).

Clinical cases	Khartoum Veterinary Hospital	Omdurman Veterinary Hospital	Khartoum North Veterinary Hospital	Total
	Frequency (%)			
Bacterial and viral diseases				
Pneumonia	34 (18.68)	132 (72.53)	0 (0.0)	166 (91.21)
Tetanus	0 (0.0)	7 (3.85)	0 (0.0)	7 (3.85)
Pharyngitis	0 (0.0)	1 (0.55)	0 (0.0)	1 (0.55)
Eye Infections	0 (0.0)	5 (2.75)	0 (0.0)	5 (2.75)
Foot rot	0 (0.0)	3 (1.65)	0 (0.0)	3 (1.65)
Subtotal	34 (18.68)	148 (81.32)	0 (0.0)	182 (100)
Parasitic Diseases				
Coccidiosis	0 (0.0)	2 (0.60)	0 (0.0)	2 (0.60)
Babesiosis	0 (0.0)	59 (19.41)	0 (0.0)	59 (19.41)
External parasite	18 (5.92)	24 (7.89)	0 (0.0)	42 (13.82)
Internal parasite	47 (15.46)	134 (44.08)	0 (0.0)	181 (59.54)
Mange	2 (0.66)	18 (5.92)	0 (0.0)	20 (6.58)
Subtotal	67 (22.04)	237 (77.96)	0 (0.0)	304 (100)

Khartoum State. It is worth to mention that internal parasites were the highest cases. These findings are in agreement with Siham et al. (2008) who stated that interval parasites were common among the cases of alimentary tract disorders in all species especially during the summer and autumn. The presence of interval parasitic could be attributed to bad management and poor hygiene.

Low prevalence rate of bovine brucellosis was observed in this study. Similarly, Osman and Adalan (1986) stated that prevalence rate of brucellosis was high among the cattle and camels but rare among goats and sheep. Study by El-Ansary et al. (2001) also confirmed low prevalence rate of brucellosis in sheep. Low infection rate of brucellosis in sheep could be attributed to good healthy status of these animals as well as good management practice. As seen from the results, external parasites, particularly tick infestation, was found with high prevalence rate in ovine in different Veterinary Hospitals in Khartoum State. Badria (2004) previously identified the four tick genera and different species. Occurrences of tick infestation are most probably due to fact that most of the owner did not consider using of insecticides for control of ticks and other flies.

The highest percentage of clinical cases that diagnosed in Khartoum Veterinary hospital in Khartoum State was recorded for *Caprine* species. This is due to the importance of caprine for traditional breeding as well as meat and milk production to some residents. On the other hand, lacking good environment and health care might lead to spreading of the diseases among these animals. The second large amounts of clinical cases diagnosed in Veterinary Clinics of Khartoum State were determined for equine (horse and donkey) and this explains the importance of these animals for transportation for some people in Khartoum State. Surgical interferences such as wound, fracture, trauma, arthritis and tendonitis were recorded as high prevalence rate for equine species. This finding was previously confirmed by Siham et al. (2008) and attributed to the increase work load put on these animals together with poor feeding programs. Sharp teeth were other important clinical cases for equine in this study. Radostits et al. (2007) mentioned that sharp teeth are considered to be the main cause of stomatitis.

Parasitic diseases, canine distemper and some form of rabies were observed for canine in Veterinary Clinics of Khartoum State. Few studies on canine disease were achieved in Sudan. For instance, Nahid (2005) examined two hundred and eleven dogs using faecal examination and she found high prevalence rate of Giardia infection (59%). Bacterial, viral and parasitic diseases were common diseases that were observed for poultry in Khartoum State. High prevalence rate among these diseases was observed for Newcastle and this might be due to availability of vaccine. Internal parasites were also prevalent with high infection rate in poultry in Khartoum State. The results are in agreement with Somia (2008) who examined the local breed of poultry for helminthes and her results revealed that two species of cestodes were present in local breed chicken in Khartoum State.

Table 10. Canine diseases diagnosed in Khartoum Veterinary Hospitals (2010, 2011, 2012).

Study site	No. Examined	Bacterial and viral diseases	Disorder of digestive system	Metabolic diseases	Parasitic diseases	Surgical interferences	Poisoning	Urogenital diseases
				Frequency (%)				
Khartoum Veterinary Hospital	369	45 (12.20)	33 (8.94)	20 (5.42)	176 (47.70)	74 (20.05)	19 (5.15)	2 (0.54)
Khartoum North Veterinary Hospital	17	4 (23.53)	0 (0.0)	0 (0.0)	10 (28.82)	2 (11.76)	1 (5.88)	0 (0.0)
Omdurman Veterinary Hospital	199	34 (17.09)	14 (7.04)	20 (10.05)	100 (50.25)	15 (7.54)	11 (5.53)	5 (2.51)
Total	585	83 (14.19)	47 (8.03)	40 (6.84)	286 (48.89)	91 (15.55)	31 (5.30)	7 (1.20)

Table 11. Feline diseases diagnosed in Khartoum Veterinary Hospitals (2010, 2011, 2012).

Study site	No. examined	Bacterial and viral disease	Disorder of digestive system	Metabolic diseases	Surgical interferences	Parasitic diseases	Uorogenital diseases
				Frequency (%)			
Khartoum Veterinary Hospital	57	17 (29.82)	10 (17.54)	3 (5.26)	21 (36.84)	3 (5.26)	3 (5.26)
Khartoum North Veterinary Hospital	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Omdurman Veterinary Hospital	35	2 (5.71)	8 (22.86)	6 (17.14)	9 (25.71)	4 (11.43)	6 (17.14)
Total	92	19 (20.65)	18 (19.57)	9 (9.78)	30 (32.61)	7 (7.61)	9 (9.78)

Conclusion

Many clinical cases including bacterial, viral, parasitic and metabolic diseases as well as surgical interferences were observed in different species of the animals in Veterinary Hospitals in Khartoum State. Therefore, the veterinary authority must improve management, husbandry, feeding and veterinary services all over the country.

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Full Length Research Paper

Sensitivity of *Trypanosoma congolense* field isolates in experimentally infected calves in Konso district, Southern Ethiopia to isometamidium and diminazene

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Study on sensitivity to diminazene aceturate 3.5 mg/kg and isometamidium chloride 0.5 mg/kg in tenzebu calves experimentally infected with two field isolates of *Trypanosoma congolense* (ET/07/Konso 59 and ET/07/Konso 114) was undertaken in Konso district, Southern Ethiopia. Calves were monitored for clinical and parasitological parameters during three months. At day 15 post-infection, corresponding to peak parasitaemia, they were treated with Diminasan® 3.5 mg/kg body weight via deep intramuscular route. Out of ten calves, only two remained parasitologically negative for 12 and 15 days after treatment with Diminasan®. Once relapse/breakthrough infection was detected in two calves, parasitemia persisted until they get second treatment with Veridium® 0.5 mg/kg body weight. However, linear regression analysis of the effects of persistent trypanosomal infections on mean packed cell volume (PCV) and loss of body condition in relation to the initial recordings in the relapsed calves was not statistically significant. Results of the trypanocidal drug sensitivity study revealed the presence of *T. congolense* populations exhibiting resistance to diminazene aceturate. It is strongly recommended that legislations be devised and implemented to ensure that only quality and effective trypanocidal drugs should get access to the market.

Key words: *Trypanosoma congolense*, trypanocidal drugs, sensitivity test, Southern Ethiopia, calves.

INTRODUCTION

Trypanosomosis is one of the major constraints on animal production in areas of Africa which have the greatest potential for significant increases in domestic livestock populations and livestock productivity. The disease affects animals and man, with direct and indirect losses estimated in billions of dollars annually. Control of animal trypanosomosis is one of the key components to improve the productive opportunities of rural communities in tsetse-infested areas. This has been addressed using trypanocidal drugs which are limited in number and have been under extensive use for over 40 years with little or no regular monitoring (Stein et al., 2011; Chitanga et al., 2011; Mungube et al., 2012; Sow et al., 2012).

Consequently, recent case surveys conducted in some African sub-Saharan countries, including Ethiopia, revealed that almost all of the commercially available trypanocidal drugs are gradually losing their efficacy due to the development of multiple drug resistance. For instance trypanocidal drug resistance was observed for isometamidium chloride and diminazene aceturate against *Trypanosoma congolense*, *Trypanosoma vivax* and *Trypanosoma evansi* (Mungube et al., 2012; Sow et al., 2012; Kumar et al., 2012). The high infestation of low-lying areas by tsetse flies as well as *T. congolense*, *T. vivax* and *T. brucei*was also reported more than a decade back in Southern parts of Ethiopia (Abebe, 2005; Miruk et

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al., 2008). *Glossina pallidipes* was found to be the only tsetse species prevalent in the study area and the greater section of the southern rift valley system of Ethiopia (Miruk et al., 2008; Moti et al., 2012).

Experimental studies conducted in different tsetse-infested zones of Ethiopia, using tests in ruminants, indicated the occurrence of varying degrees of resistance in trypanosomes to the commonly applied trypanocidal drugs (Yeshitila et al., 2006; Miruk et al., 2008; Moti et al., 2012). According to Kone (1999) there is no relation between curative and prophylactic doses for an individual trypanosome isolate in cattle and mice. Hence, it is necessary to ascertain whether or not treatment with a manufacturer's recommended dosage is likely to be successful in cattle. As a prerequisite it was, therefore, essential to undertake study on sensitivity of selected trypanocidal drugs against field isolates of *T. congolense* in experimentally infected calves in Konso district, Southern Ethiopia.

MATERIALS AND METHODS

Description of study area

The present study was conducted in Konso district of Southern Ethiopia, located about 600 km away from Addis Ababa on the way to South Omo with an altitude of 550 to 2300 m above sea level. The population of the area is estimated to more than 250,000 where people secure subsistence livelihood through mixed agricultural farming practices. More than 150,000 heads of small east African zebu cattle and more than 500,000 heads of small ruminants (sheep and goats) maintained under traditional village management system with multiple ownership are raised mainly in the low lying areas (Neuromuscular Medicine Self-Assessment Examination (NMSAE), 2012). Tsetse transmitted animal trypanosomosis has been reported as the main impediment to the development of agriculture in the area.

Study design

Ten local East African zebu calves (*Bos Indicus*) 5 to 6 months old were obtained from Durro site (2,268 m above sea level) from a place where tsetse and trypanosomosis is not present and then randomly included in one of the two groups. One month prior to the challenge, calves were moved to a fly proof facility and treated with anthelmintics (ivermectin 0.2 mg/kg subcutaneously) and diminazene aceturate (3.5 mg/kg body weight via deep intramuscular route). After two weeks, the animals were examined for *Trypanosoma* infection by thin blood smears stained with rapid differential Diff quick staining solution. The first group received intravenously 0.2 ml solution containing approximately 5×10^4 *T. congolense* diluted in phosphate saline glucose (PSG) solution.

Calves were monitored regularly three times per week for a 90 days period to monitor packed cell volume (PCV) and parasitaemia level using the phase contrast buffy coat method (Murray et al., 1977). The calves from treated group received diminazene aceturate at 3.5 mg/kg body weight with deep intramuscular route of injection (Diminasan®, Batch DG/20337 Kuipersweg 9, 3449 JA Woerden, Holland). Relapsed cases were treated with Isometamidium chloride (Veridium®, Lot No. 113A2; Libourne, France) Veridium® at 0.5 mg/kg body weight intramuscularly. In order to detect any clinical relapse and to confirm the appearance of trypanosomes in blood, all the calves were bled and examined three times per week for 90 days post treatment please put the sentence in the good position

Parasite isolation and infection of calves

Two isolates of *T. congolense* (ET/07/Konso-59 and ET/07/Konso-114) were obtained from two trypanosomosis infected calves with high parasitemia score 5×10^4 in Konso, Southern Ethiopia. Thin blood smears were prepared and air dried, then stained with rapid differential Diff quick staining solution. Following, *T. congolense* was identified morphologically based on absence of free flagellum, marginal and medium size kinetoplast (OIE, 2004: Urquhart et al., 1996). Eight week aged Swiss white mice, weighing 25 to 30 g, were used to amplify the two field isolates of *T. congolense*, they were maintained on a commercial pelleted ration and water *ad libitum* in a fly-proof room at Konso district veterinary clinic. Mice were infected with 0.2 ml of fresh blood containing trypanosomes through intra-peritoneal route; the strain was passaged twice on mice. One milliliter of blood was aseptically collected from ether anaesthetized donor mouse by cardiac puncture, corresponding to 5×10^6 trypanosomes (Paris et al., 1982). Each calf received intravenously 0.2 ml solution containing approximately 5×10^4 trypanosomes diluted in phosphate saline glucose (PSG) solution (Eisler et al., 2001).

The present experimental study involving infection of claves with two isolates of *T. congolense* was authorized by the Ethical Clearance Committee of the College of Veterinary Medicine and Agriculture of the Addis Ababa University.

Data analysis

The rate of relapse/breakthrough infections was calculated as the number of animals with parasitemia on the day of monitoring divided by the total number of animals. Interpretation of the results was made according to the descriptions given by Eister et al. (2001). Data analysis was performed with Statistical Package for Social Sciences (SPSS 11.5) software. The 95% confidence level was estimated and a $P<0.05$ was considered as statistically significant difference.

RESULTS

Peak parasitemia was reached in the experimentally infected calves between 13 and 15 days and treated with Diminasan® exactly at day 15 post-infection. Infected calves manifested typical clinical signs of trypanosomosis (between days 9 and 15 post-infection), such as depression, fever, inappetence, swelling of pre-scapular and pre-femoral lymph nodes, rough hair coat, and overall reduction in mean PCV below 20%.

Calves remained parasitologically negative only for 9 days after treatment with Diminasan®. However, after 12 and 15 days treatment with Diminasan®, relapse/ breakthrough infection was detected in two calves. Parasitemia in these two calves persisted until they get second treatment with Veridium® on day 15.

On the contrary, no relapse/breakthrough trypanosomal infections were detected in any of the remaining eight calves which received Diminasan® and two calves treated with Veridium® until the end of the experiment.

The overall relapse/breakthrough infection rate and mean relapse duration was found to be 2/10 and 13.5 days, respectively. Patterns of infections of *T. congolense* isolates in experimentally infected ten calves after treatment with Diminasan® revealed that only two animals showed relapse/breakthrough infection between days 12 and 15 post-infection. Calves with relapse/breakthrough infections revealed reduced PCV and loss of body condition until they were treated with Veridium®. However, linear regression analysis of the effects of persistent trypanosomal infections on mean PCV and loss of body weight in relation to the initial recordings in the relapsed calves was not statistically significant (P>0.05).

DISCUSSION

T. congolense the identified species in the present study area, is in accordance with most of the previously conducted studies in the southern rift valley of Ethiopia (Abebe, 2005; Miruk et al., 2008) and in the Ghibe valley (Rowlands et al., 2001; Moti et al., 2012) where it is the dominant prevailing species. In general, it has been proved that *T. congolense* is the most prevalent and virulent trypanosome species in Eastern Africa, although certain hemorrhagic *T. vivax* strains still prevail in Eastern African countries (Taylor and Authie, 2004). An *in-vivo* experimental study was carried out to assess the of trypanocidal activities of Diminasan® and Veridium® most frequently used drugs in the study area. This approach had the advantage that it could generate direct information about the success of treatment with the recommended drug dosage in cattle infected with trypanosomes. And this is in accordance with the standardized test protocols described for drug sensitivity in tsetse-transmitted trypanosomes of African domestic cattle (Eisler et al., 2001).

The fact that the present test was conducted in a fly-proof accommodation and in tsetse free area has reliably avoided the confounding effects attributed to the risk of vector-borne infection during the study period. It was essential to include a relatively large number of experimental calves, since previous studies show that results obtained on reduced animal groups are not always reliable (Eisler et al., 2001).

In this trial, the detection of relapse infections in some of the experimental calves as revealed by parasitemia in direct smear following treatment with Diminasan® is clearly indicative of the presence of a drug resistant sub-population. This conclusion steams from the fact that Diminasan® could maintain therapeutic blood levels until 22 days following treatment, unless resistance is present (Gilbert and Newton, 1982). The relapse delay in resistant strains is comparable with inferences drawn from a recent study at the Ghibe valley, where trypanosomes resistant to Diminasan® have relapsed more than 14 days following treatment (Moti et al., 2012). As there is an increasing number of case reports from other trypanosomosis endemic areas of Ethiopia, disclosing range of prevalence of *T. congolense* resistant to Diminasan® and Veridium® (Codjia et al., 1993; Mulugeta et al., 1997; Rowlands et al., 2001; Afework et al., 2004; Tewelde et al., 2004), the demonstration of resistance to Diminasan® (about 33% from the present study) manifested by the current *T. congolense* isolates at Jarso, was unsureprisingly an expected outcome. Furthermore, it has been observed under longitudinal studies that there was an association between the initial trypanosome prevalence and the occurrence, and thus the degree, of drug resistance (Mungube et al., 2012).

Despite a considerable initial deterioration in mean PCV of the relapsed calves, this study revealed a significant improvement in mean PCV following administration of Diminasan® and Veridium® (P<0.01). Firstly, the trypanosome isolates under investigation might have entailed a heterogeneous population of trypanosomes and treatment with Diminasan® could have eliminated the sensitive sub-population through its therapeutic effects, so that the parasite burden was limited to the resistant population. Furthermore, re-treatment of the calves with Veridium® could have resulted in a complete elimination of the sub-population that revealed resistance to Diminasan®. Initial treatment with Diminasan® followed by Veridium® could trigger better improvements in the relapse conditions. Even the sub-population resistant to Diminasan® may be less pathogenic, with insignificant impacts on productive performances of the calves. Only a limited number of studies have demonstrated a loss of virulence and/or loss of fitness in drug resistant trypanosomes (Mulugeta et al., 1997). A useful study that assessed this important issue was conducted in the Ghibe valley, where *T. congolense* strains demonstrated multiple resistance to all available drugs. In that study, it was deduced that, despite the occurrence of high degrees of drug resistance, local zebu cattle could yield profitable productivity, so that attractive economic returns were generated for herd owners (International Livestock Research Institute (ILRI), 2002; Stein et al., 2011; Moti et al., 2012).

In the present trial, the relapsed calves were treated with Veridium®, 45 days later, and no calves relapsed post-treatment. This observation is in accordance with the currently available information indicating the trypanocidal effects of treatment with Veridium® in cattle (Stevenson et al., 2000). Delaying of Veridium® treatment by 45 days after the administration of Diminasan® was a reasonable process in light with the possible side effects that could be associated with the injection of the second

drug in a short period following the administration of the first (Eisler et al., 2001; Stein et al., 2011; Mungube et al., 2012). The sensitivity of the isolates to Veridium® is conclusive. The possible effects of selection biases are of crucial importance, since the trypanosome population against which the second drug was administered might not be a complete representative of the original field population. This can be further explained by the fact that the initial treatment with Diminasan® might have eliminated the sub-population resistant to Veridium® (Eisler et al., 2001). *T. congolense* isolated from Konso district Southern Ethiopia exhibited resistance to Diminasan®, which could also be Veridium®. However, this need to be confirmed by deriving clones from the trypanosome population in cattle or mice (Eisler et al., 2001; Stein et al., 2011). Nevertheless, the chemotherapy is still the most convenient way of fighting against the disease. In that way, trypanocidal drug sensitivity tests should be conducted before application in field.

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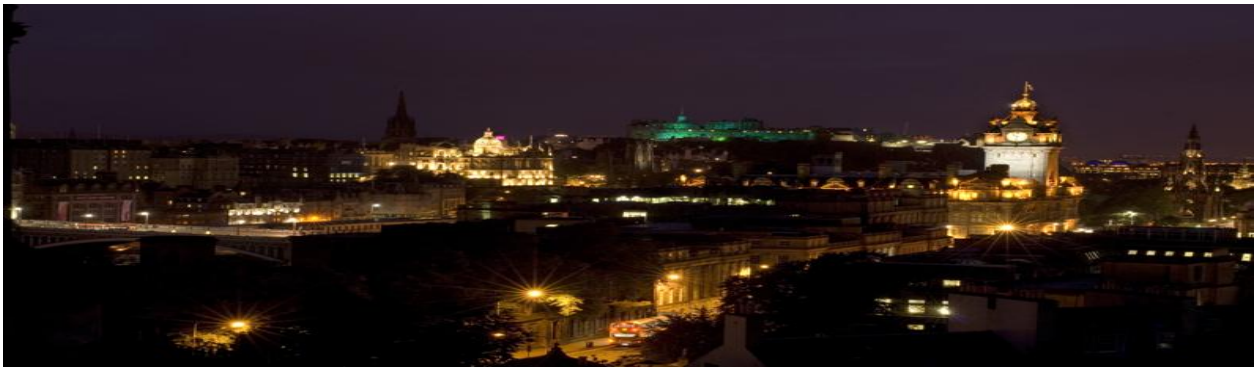

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