Bovine Trypanosomosis: Infection Rate, its Risk Factors, and the Relationship between Packed Cell Volume and Infection Rate in Humbo District, Southern Ethiopia

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Abstract

Background: Tsetse transmitted animal trypanosomosis still remains as one of the largest causes of livestock production losses in Ethiopia. The study was conducted from April, 2018 to June, 2018 in Humbo district of southern Ethiopia to determine current infection rate of bovine trypanosomosis, to identify trypanosome species responsible for infection, to assess potential risk factors of the disease, and to evaluate the relationship between infection rate and packed cell volume. Blood samples were collected from 306 randomly selected cattle from the study peasant associations (PAs) and evaluated through conventional parasitological methods.

Results: The overall trypanosomosis infection rate during the study period was 13.4% (95% CI 9.8-17.7). The prevailing trypanosome species in the area were T. congolense and T. vivax with predominance of T. congolense (90.24%). The areal distribution of trypanosomosis infection was found to be 4.8%, 0%, 18.9%, 20% and 21.6% in Mareka, Gafata, Chokare, Bisare and Gurucho peasant associations (PAs) respectively. There was a significant variation in infection rate among different PAs, age groups and body condition scores (p<0.05). That is the odds of trypanosomosis infection was significantly higher (p = 0.009, OR = 5.44, 95% CI = 1.52-19.46) in Gurucho PA than Maraka, Gafata, Chokare, and Bisare PAs. Similarly, the odds of trypanosomosis infection was significantly higher (p = 0.001, OR = 4.47, 95% CI = 1.78-11.25) in animals with poor body condition score (24.5%) than in animals with medium body condition (15.8%) and good body condition scores (6.7%). Moreover, the odds of trypanosomosis infection was significantly lower (p = 0.039, OR = 0.47, 95% CI = 0.23-0.96) in young animals than the older ones. Trypanosomosis infection rate was higher in male animals (14.4%) than female animals (12.7%) with no significant variation between the sexes (p > 0.05). The mean PCV of infected animals (14.4±4 SD) was significantly (P<0.05) lower than non-infected animals (20.17%±4.67 SD). One-way ANOVA analysis for comparison of mean PCV among the three categories (negative, T. Congolese positive and T. vivax positive) revealed highly significant association (p = 0.000, F = 20.37) among the categories. Moreover, the Bonferoni multiple comparison test revealed the existence of significant mean PCV variation between negative category and T. congolense positive category (p = 0.000, F = 20.37) as well as between negative category and T. vivax positive category (p=0.039). However, the mean PCV variation between T. congolense positive category and T. vivax positive category was non-significant (p>0.05). Out of 306 examined cattle, 257 were anaemic with PCV <25% and the overall anaemia prevalence was 83.98% (95% CI 79.85-88.11). The prevalence of anaemia in parasitaemic animals (100%) was significantly (p<0.05) higher compared to the aparasitaemic ones (81.5%).

Conclusion: Bovine trypanosomosis is a major disease that remains to be a potential threat to cattle production in Humbo district. Hence, appropriate disease prevention and control methods should be implemented to improve cattle production in the area.

Keywords: Trypanosomosis, Humbo, cattle, infection rate, PCV

Abbreviations: ANOVA = Analysis of Variance, masl = meters above sea level, PAs = Peasant Associations, PCV = Packed Cell volume, SD = Standard Deviation, SE = Standard Error, BCS = Body Score; CI = Confidence Interval; OR = Odds Ratio

1. INTRODUCTION

Trypanosomosis is a parasitic disease caused by unicellular protozoan parasites of the genus trypanosome and family trypanosomatidae they multiply in blood stream, lymphatic vessels and tissue, including cardiac muscle and the central
Bovine Trypanosomosis: Infection Rate, its Risk Factors, and the Relationship between Packed Cell Volume and Infection Rate in Humbo District, Southern Ethiopia

nervous system (Souls by, 1992). Trypanosomosis is transmitted by tsetse flies (Glossinidae) and believed to be the most important infectious disease holding back development of livestock production in Africa (Itard, 1981).

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 productivity (D’Ieteren et al., 1998). Tsetse flies occur over some 10 million square kilometer of Africa (Jordan, 1986) affecting a total of 38 countries. Currently, about 37% of the 147 million cattle in countries affected by tsetse are exposed to the disease. Africa produces 70 times less animal protein per unit area than Europe (Nantulya, 1986). In Africa the overall loss (both direct and indirect) is estimated at US 500 billion dollars a year (ILRAD, 1993/94). Currently the livestock production and productivity of southern region is highly affected by the high incidence of the trypanosomosis. Ethiopia is believed to have the largest livestock population in Africa, which is currently estimated to be 54 million cattle, 25.5 million sheep and 24.1 million goats (CSA, 2013). However, about 240,000km² of arable land located in the Southern, South Western, Western and North Western parts is infested with tsetse flies (STEP, 2012) precludes farmers from rearing livestock. Morbidity and mortality losses from ruminant livestock alone are estimated to be USD 200 million (Abebe and Jobre, 1996). In Ethiopia above 14 million heads of cattle are exposed to the risk of trypanosomosis, 20,000 heads of which die every year. Taking 200 birr per animal, the total loss will be 4,000,000 birr per year (As faw, 1986). In the years 1978-1982 a total of 9,675,575 doses of trypanocidal drugs were purchased with 17,920,780.70 birr (MoA, 1982/3). Although tsetse flies have existed in Ethiopia for a very long time, it has been noted by early explorer, who lost their transport animals in the fly challenge belts. In 1885, Donald and Smith made the earliest record of Gendi (Nangana) in their transport animals which were crossing tsetse fly belts in southern Ethiopia (Maclennan, 1980). Later in 1895 Corti identified an insect collected in 1893 by Captain Bottogo, along the Walma River which is the upper tributary of Shebelle River (Lang ridge, 1976). In 1962, the cattle survey in Southern Ethiopia by the livestock division, established that bovine trypanosomosis had become a major cattle disease in the Omo valley. It was stated that the problem of trypanosomosis is the main cause of decline in the number of cattle and particularly draught oxen (Abebe and Jobere, 1996). The most important trypanosomes in terms of economic loss in domestic livestock are the tsetse transmitted species: T. congolense, T. vivax and T.b. brucei (Getachew, 2005). Report from the tsetse infested area of Ethiopia indicated that T. congolense is the most prevalent trypanosome species (Abebe and Jobre, 1996; Rowland et al., 1993).

Currently the livestock production and productivity of southern region is highly affected by the high incidence of trypanosomosis. Therefore, taking in to account the above-mentioned statements, the following objectives were designed to conduct the study:

- To determine the prevalence of bovine trypanosomosis on the basis of area, age, sex, and body condition score of the animals.
- To determine the prevailing trypanosome species affecting cattle in the study area.
- To evaluate the relationship between trypanosomosis infection rate and packed cell volume

2. MATERIALS AND METHODS

2.1. Description of the Study Area

The study was conducted in Humbo district which is one of the districts in the Southern Nations, Nationalities and Peoples region of Ethiopia. Humbo is bordered on the southeast by Lake Abaya which separates it from the Oromia Region, on the south by the Gamo Gofa Zone, on the west by Ofa, on the northwest by Sodo Zuria, on the northeast by Damot Woyde, and on the east by the Bilate River which separates it from the Sidama Zone. Humbo is located 322 km south of the capital, Addis Ababa. According to zonal statistical data (2010), the total human population is 163705; and the total area of the woreda is 866.46km². Humbo woreda lies between 6°51’14”N and 6°79’ 25”N latitudes, and 37°59’41” E and38°05’54”E longitudes.

The altitude ranges from 1100m to 2355 meters above sea level. Moreover, the altitude of lowlands varies from 1100 to 1600 meters above sea level. The area is sub divided into two agro ecological zones: lowland (kola) with an altitude below 1500m.a.s.l and midland (weina dega)
with an altitude range of 1500-2355 meters above sea level. The mean annual temperature is 22°C. The rainfall is erratic with an annual average rainfall of 843 to 1403 mm. The vegetation of the study peasant associations (PAs) is dominantly occupied by bush land and shrubs. The prevailing production system in the area is mixed crop and livestock production (WZSEP, 2010).

2.2. Study Population

The survey was conducted in five peasant associations (PAs) of Humbo district namely, Mareka, Gafata, Chokare, Bisare, and Guricho. The study population was comprised of 306 zebu cattle of different ages and both sexes owned by local farmers. The cattle were reared with the traditional extensive grazing system.

2.3. Study Design

A cross-sectional type of study is conducted from April, 2018 to June, 2018 in the selected PAs in which blood samples were collected to measure PCV and to examine the presence of motile trypanosome parasites. Additionally, the age, sex, body condition and PA data of every sample animal was collected at the time of sampling. The age was categorized into two groups: young (≤3years) and adult (>3years) whereas the body condition score was grouped into good, medium and poor based on the appearance of ribs and dorsal spines applied for zebu cattle (Nicholson and Butterworth, 1986).

2.4. Sample Size and Sampling Method

The five PAs (villages) were purposively selected due to higher tsetse challenge and animals from each PA were selected using systematic random sampling of animals caught at sample collection points. A 95% confidence interval and 5% desired absolute precision and expected prevalence of 14.2% from previous study (Feyisa et al., 2011) in the area were used to determine the sample size for this particular study. The sample size was determined using the following formula (Thrusfield, 2005).

\[
  n = \frac{1.96^2 \times P_{exp} (1 - P_{exp})}{d^2}
\]

Where:
- \( n \) = required sample size
- \( P_{exp} \) = expected prevalence = 14.2%
- \( d \) = desired absolute precision = 0.05

Accordingly, the sample size was determined to be 187. However, a total of 306 samples were collected due to availability of sample animals.

2.5. Parasitological and Hematological Techniques

The parasitological diagnostic tests used were those described by Paris et al., (1982). In brief, blood was collected from peripheral ear vein into heparin zed capillary tubes. Each capillary tube was filled to its last third and sealed with crystal seal at one end and centrifuged immediately in a micro hemocrit centrifuge for five minutes at 12000rpm. After centrifugation, the packed cell volume (PCV) was determined. Animal with PCV less than or equal to 24% were considered to be anemic (Radostitis et al., 2007). After PCV determination, the capillary tube was cut using a diamond tipped pen 1mm below the Buffy coat
3. DATA ANALYSIS

The collected raw data was fed into Microsoft excel spread sheets and analysis was done using STATA® (version 14.0) software program from STATA Corporation, College Station, Texas. Moreover, descriptive statistics like frequency and percentages were used to summarize the results. The prevalence of trypanosomia infection was calculated as the number of animals tested positive by Buffy coat method divided by the total number of animals examined at that particular time. The association between trypanosomosis infection status and different risk factors were assessed using unavailable binomial logistic regression and mean PCV values of parasitaemic and aparasitaemic cattle were compared by using two sample student t-tests. Likewise, one-way ANOVA analysis was employed to compare the mean PCV among the three categories (negative, T. congolense positive and T. vivax positive). Moreover, Bonfereon multiple comparison test was employed to identify the category with significant mean PCV variation among the three categories. Differences between parameters were tested for significance at probability level of p<0.05 and 95% confidence interval.

4. RESULTS

4.1. Parasitological Findings and Risk Factors

Analysis

Out of 306 examined cattle, 41 were positive for trypanosomosis and the overall infection rate was 13.4% (95% CI, 9.8-17.7). Out of the 41 positive animals, 37 (90.24%) were found to be positive for T. congolense while 4 (9.76%) were positive with T. vivax. This indicated that 90% of infection was caused by T. congolense while only 10% was by T. vivax (Table 1).

### Table 1: Species prevalence of bovine trypanosomosis during the study period

<table>
<thead>
<tr>
<th>Trypanosome species</th>
<th>No of positives</th>
<th>Species prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T. congolense</td>
<td>37</td>
<td>90.24</td>
</tr>
<tr>
<td>T. vivax</td>
<td>4</td>
<td>9.76</td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>100%</td>
</tr>
</tbody>
</table>

The areal distribution of trypanosomosis infection was found to be 4.8%, 0%, 18.9%, 20% and 21.6% in Mareka, Gafata, Chokare, Bisare and Gurucio PAs respectively.

Trypanosomosis infection rate differed significantly among different PAs (p<0.05). That is, the odds of trypanosomosis infection was significantly higher (p = 0.009, OR = 5.44, 95% CI = 1.52-19.46) in Gurucio PA than Maraka, Gafata, Chokare, and Bisare PAs. Moreover, analysis of trypanosomosis infection rate among different body condition categories revealed 6.7%, 15.8% and 24.5% infection rate in good, medium and poor body conditioned animals respectively. There was a significant variation in trypanosomosis infection rate among different body condition categories; i.e. the odds of trypanosomosis infection was significantly higher (p = 0.001, OR = 4.47, 95% CI = 1.78-11.25) in animals with poor body condition score than in animals with medium and good body condition scores (p>0.05; i.e. the odds of trypanosomosis infection was significantly lower (p = 0.039, OR = 0.47, 95% CI = 0.23-0.96) in young animals than the older ones. Higher trypanosomosis infection rate was observed in male animals (14.4%) compared to female animals (12.7%) with no significant difference between the sexes (p > 0.05) (Table 2).

### Table 2: Univariable logistic regression analysis of trypanosomosis infection rate based on hypothesized risk factors.

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Category</th>
<th>No Examined</th>
<th>No Positive</th>
<th>Infection rate (%)</th>
<th>95% CI</th>
<th>OR[95% CI]</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA</td>
<td>Maraka</td>
<td>83</td>
<td>4</td>
<td>4.8</td>
<td>1.32-11.8</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gafata</td>
<td>37</td>
<td>0</td>
<td>0</td>
<td>0.0-9.48</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Chokare</td>
<td>74</td>
<td>14</td>
<td>18.9</td>
<td>9.78-28.05</td>
<td>4.6 [1.44-14.71]</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>Bisare</td>
<td>75</td>
<td>15</td>
<td>20</td>
<td>11.64-30.83</td>
<td>4.94[1.56-15.64]</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>Gurucio</td>
<td>37</td>
<td>8</td>
<td>21.6</td>
<td>8.82-38.21</td>
<td>5.44[1.52-19.46]</td>
<td>0.009</td>
</tr>
</tbody>
</table>
### 4.2. Hematological Results

Packed cell volume of parasitemic animals was in the range of 8-24%, while in aparasitemic cattle the PCV was in the range of 6-30% (Figure 2). The overall mean PCV of examined animals was 19.52±4.87SD. All parasitaemic animals (100%) had PCV < 25% which is below the normal range. The mean PCV of parasitic animals is 14.4±4SD which is lower than the lower limit of normal PCV for cattle. The mean PCV for aparasitemicanimals, is 20.17±4.67SD which is also below normal PCV value range (Table 3). There was a statistically significant difference in the mean PCV value between the infected and non-infected animals (p<0.05). Additionally, the mean PCV value of the three categories of examined animals (Negative, T. congolense positive and T. vivax positive) was compared using one-way ANOVA analysis (Table 4). Accordingly, one-way ANOVA analysis revealed a mean PCV of 20.17±4.67SD for negative, 15.37±3.82SD for T. congolense positive and 14.25±6.13SD for T. vivax positive with significant (p = 0.000, F = 20.37) difference in mean PCV values among the three categories. Likewise, the Bonferroni multiple comparison test was employed to identify the category with mean difference. Accordingly, the test indicated existence of significant difference in the mean PCV value between negative category and T. congolense positive category (p=0.000) as well as negative category and T. vivax positive category (p=0.033) (Table 5). No significant difference in the mean PCV value between T.congolense positive category and T.vivax positive category was observed (p=1.000) (Table 5).

### Table 3: Mean PCV value for parasitaemic and aparasitaemic animals

<table>
<thead>
<tr>
<th>Infection status</th>
<th>Frequency</th>
<th>Mean PCV ±SD</th>
<th>95% CI</th>
<th>SE</th>
<th>t-test</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aparasitaemic</td>
<td>265</td>
<td>20.17±4.67</td>
<td>19.61-20.74</td>
<td>0.28</td>
<td>7.47</td>
<td>0.000</td>
</tr>
<tr>
<td>Parasitaemic</td>
<td>41</td>
<td>15.27±4.00</td>
<td>14.16-15.33</td>
<td>0.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>306</td>
<td>19.52±4.87</td>
<td>18.97-20.07</td>
<td>0.278</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PCV = Packed Cell Volume; SD = Standard Deviation; CI = Confidence Interval; SE = Standard Error

### Table 4: One-way ANOVA analysis of mean PCV based on trypanosome infection and species.

<table>
<thead>
<tr>
<th>Infection Status</th>
<th>Frequency</th>
<th>Mean PCV</th>
<th>SD</th>
<th>F</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td>265</td>
<td>20.17</td>
<td>4.67</td>
<td>27.85</td>
<td>0.000</td>
</tr>
<tr>
<td>Positive for T. congolense</td>
<td>37</td>
<td>15.37</td>
<td>3.82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive for T. vivax</td>
<td>4</td>
<td>14.25</td>
<td>6.13</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

BCS = Body Condition Score; CI = Confidence Interval; OR = Odds Ratio; PA = Peasant Association
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Table 5: Bonferroni multiple comparison test for identification of category with mean PCV difference

<table>
<thead>
<tr>
<th>Comparison categories</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative category and T. congolense positive category</td>
<td>0.000</td>
</tr>
<tr>
<td>Negative category and T. vivax positive category</td>
<td>0.033</td>
</tr>
<tr>
<td>T. congolense positive category and T. vivax positive category</td>
<td>1.000</td>
</tr>
</tbody>
</table>

PCV = Packed Cell Volume; CI = Confidence Interval; SD = Standard Deviation; T = Trypanosoma

From the total of 306 examined animals, 83.98% (257/306) were anemic with mean PCV of 18.18% (95% CI 16.67-18.68) while 16.02% (49/306) were non-anemic and their mean PCV was 26.38% (95% CI 25.95-26.8) (Table 6). The overall anemia prevalence was found to be 83.98% (95% CI 79.85-88.11). Comparison of trypanosomosis prevalence between anaemic and non-anaemic animals revealed that out of 257 anaemic animals, 41 (15.95%) were parasitaemic while, none (0%) of non-anaemic animals are parasitaemic.

The proportion of parasitaemic animals among the anemic ones (15.95%) was significantly (P<0.05) higher compared to the proportion of parasitaemic animals among the non-anemic ones (0%) (Table 6). Furthermore, comparison of anaemia prevalence between parasitaemic and aparasitaemic animals revealed that all parasitaemic animals (100%) are anaemic; while among the 265 aparasitaemic animals, 216 (81.5%) were anaemic with PCV value <25. The proportion of anemic animals among the parasitaemic ones (100%) was significantly higher compared to the proportion of anemic animals among the parasitemic ones (81.5%) (P<0.05) (Table 7).

Table 6: Comparison of trypanosomosis infection between anaemic and non-anaemic cattle

<table>
<thead>
<tr>
<th>Category</th>
<th>No of examined</th>
<th>No of positives</th>
<th>Proportion of Positives [95% CI]</th>
<th>Mean PCV [95% CI]</th>
<th>χ²</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-anaemic</td>
<td>49</td>
<td>0</td>
<td>0 [0-3.62]</td>
<td>26.38 [25.95-26.8]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PCV = Packed Cell Volume; CI = Confidence Interval

Table 7: Comparison of anaemia prevalence between parasitaemic and aparasitaemic cattle

<table>
<thead>
<tr>
<th>Infection status</th>
<th>No of examined</th>
<th>PCV≤24</th>
<th>PCV&gt;24</th>
<th>No of anaemic</th>
<th>Prevalence of anaemia(%)</th>
<th>χ²</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parasitaemic</td>
<td>41</td>
<td>41</td>
<td>-</td>
<td>41</td>
<td>100</td>
<td>9.02</td>
<td>0.003</td>
</tr>
<tr>
<td>Aparasitaemic</td>
<td>265</td>
<td>216</td>
<td>49</td>
<td>216</td>
<td>81.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>306</td>
<td>257</td>
<td>49</td>
<td>257</td>
<td>83.98</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PCV = Packed Cell Volume

5. DISCUSSION

During the present study, an overall trypanosomosis infection rate of 13.4% (95% CI=9.8-17.7) resulted. The present finding was in line with results of Feyisa et al (2011), Degneh et al (2016), Yibrah and Simeamlak (2013), and Gemtessa, T and Dera KL (2017) which found an overall prevalence of 14.2% in Humbo district, 14.1% in Gidami district, 15.57% in Eastern Wollega, and 12.28% in Dale Wabera district, respectively. On the other hand, this finding was significantly lower than the reports of Zekarias and Zeryehun (2011), Belete (2017), Abera et al (2015), and Amare (1995) who reported 27.5%, 26.3%, 21.33%, and 21.0% prevalence of bovine trypanosomosis respectively at Wozeka, Nyangatom woreda, Konta special distrct, and Omo river basin of South Western Ethiopia. The possible explanation for the lower report in the current study could be attributed to concerted efforts of tsetse suppression and trypanosomosis control by Arbam in chisetse fly and trypanosomosis investigation and control center, disturbance of tsetse ecology due to bush clearing for expansion of cultivation area which could have significantly reduced tsetse population in the study area. However, this finding is only slightly lower than the recent finding in the same district by Feyisa et al (2011) which found 14.2% infection rate. The hypothesized reason for this is the availability of dense vegetation harboring tsetse flies in Bisare, Chokare and Gurucho PAs where cattle graze regularly thereby incurring tsetse fly bite.
Out of 41 trypanosome positive animals, 37 (90.24%) were found to be infected with *T. congolense* and the rest 4 (9.76%) were infected with *T. vivax*. The higher proportion of *T. congolense* in the study area is in line with findings of Feyisa et al. (2011), Biyazen et al. (2014), Abera et al. (2015) and Gona et al. (2016). The predominance of *T. congolense* in the study area suggests that grassland species are more efficient transmitters of *T. congolense* than *T. vivax* in East Africa (Langridge, 1976) and also due to the high number of serodems of *T. congolense* as compared to *T. vivax* and the development of better immune response to *T. vivax* by infected animals (Rowlands et al., 1993).

The infection rate of trypanosomosis was higher in Guruco PA (21.6%) followed by Bisare PA (20%) and Chokare PA (18.9%) and there was a significant difference in trypanosomosis infection rate among PAs (study villages) (p<0.05). This result is in conformity with findings obtained by Getnet (2008) at Soddo Zuria district, Feyisa et al. (2011) in Humbo district, and Abera et al. (2015) in Konta special district. The possible reason for the difference among PAs could be attributed to higher tsetse challenge in Guruco and Bisareand Chokare PAs due to availability of dense bush land which serves as suitable pocket area for tsetse reproduction. However, no positive animals were found in Gafata PA and the prevalence of trypanosomosis was lower in Mareka PA in comparison to the other study PAs. This could be due to relatively lower vulnerability to tsetse fly challenge in these PAs in comparison to the other study PA due to sustainable tsetse and trypanosomosis suppression based on the rolling carpet principle and establishment of natural barrier with expansion of cultivation land in Mareka PA.

In the present study, trypanosomosis infection rate varied significantly (p<0.05) among different body condition categories with high prevalence recorded in animals with poor body condition (24.5%). Animals with poor body condition score were more associated with disease compared to animals with medium and good body condition. This finding was similar with Habtwolde (1995), Dawud and Molalegne (2011) and Abiy (2002). Obviously, the disease itself results in progressive emaciation of the infected animals; nevertheless, non-infected animals under good body condition have well developed immune status that can respond to any foreign protein better than those of non-infected cattle with poor body condition score which can be immuno-compromised due to other diseases or malnutrition and concurrent infections depress the immune responsiveness in the same cases (Collins, 1994).

The infection rate of trypanosomosis was slightly higher in male animals (14.4%) than the female ones (12.7%) though it was not statistically significant (p>0.05). Similar results have been reported by different works (Afework, 1998; Muturi, 1999; Tewolde, 2001; Mulugeta et al., 2013). The possible explanation for the present finding would be that male animals are more exposed to traction power and also cross different vegetation for grazing and watering where tsetse challenge is higher.

In the present study, age was considered to be one of the risk factors for trypanosome infection. Accordingly, higher infection rate (17%) was observed in adult animals (>3yrs) than young animals (≤3yrs) (8.8%) in the study area. This result is in conformity with findings of Feyisa et al. (2011), Yigzaw et al. (2017), and Ayana et al. (2012). There was statistically significant difference among different age groups (P<0.05). The possible reason for this is natural protection mounted by maternal antibodies which are abundant in young animals and depleted in the older counterparts (Fimmen et al, 1999).

The mean PCV of non-infected animals was 20.17±4.67SD; that of *T. congolense* positive was 15.37±3.82SD where as *T. vivax* positive animals had mean PCV of 14.25±6.13SD. There was a significant difference in mean PCV between non-infected animals and *T. congolense* positive animals (p<0.05) as well as between non-infected animals and *T. vivax* positive animals (p<0.05). This indicates that though both parasitaemic and aparasitaemic animals are anaemic (with mean PCV <25%), the mean PCV of parasitaemic animals was still lower than the aparasitaemic ones. This could be attributed to the fact that trypanosomosis predisposes infected animals to other concurrent infection due to immuno suppression (Radostitis et al., 2007) which in turn could have caused a lower mean PCV in infected animals compared to non-infected ones.

Out of the 306 examined animals, 257 were anaemic with over all anaemia prevalence of 83.98%. This finding is higher than the previous
studies by Haile et al (2016), Yigzaw et al (2017), Zecharias and Zeryhun(2012) which found 19.27%, 19.67%, and 41% at Dale Wabera, Yayo and Arbaminch districts respectively. The mean PCV of parasitaemic and aparasitaemic animals was 14.4±4SD and 20.17±4.67SD respectively. There was a significant variation of mean PCV values between parasitaemic and aparasitaemic cattle (p<0.05). This result is in agreement with Rowlands et al. (1999) who observed that an increase in PCV value will result in decrease in proportions of positivity and hence mean PCV was a good indicator for the health status of animals in an endemic area.

This finding is in line with the results of Leak et al (1999), Afework (1998), Muturi (1999) and Tewolde (2001). Moreover, all (100%) of parasitaemic animals are anaemic while (81.5%) of aparasitaemic animals are anaemic. The proportion of anaemic animals among the parasitaemic ones (100%) was significantly (P<0.05) higher than the proportion of anemic animals among the aparasitaemic ones (81.5%). This finding conforms with previous studies by Zekarias and Zeryhun (2012) at Arbaminch (85%), Degeneh et al (2017) at Gidami district ((92.3% in early dry and 91.3% in early rainy seasons). This suggests that anaemia distribution was higher in infected cattle than in the non-infected ones. This is attributed to the fact that anaemia is useful indicator of trypanosomosis infection in endemic areas (Radostitis et al, 2007). Moreover, among the 257 anaemic animals 41 (15.95%) were parasitaemic while none (0%) of non-anaemic animals are parasitaemic.

The proportion of parasitaemic animals among the anemic ones (15.95%) was significantly higher compared to the proportion of parasitemic animals among the non-anemic ones (0%) (P<0.05). This finding further strengthens the fact that anaemia is characteristic of trypanosomosis infection. The result also showed that majority of aparasitaemic animals 216(81.5%) had PCV value < 25. This suggests that although anaemia is characteristic of trypanosomosis, other concurrent infections are also anticipated to affect the PCV profile of animals. Diseases such as gastrointestinal parasitism, vector-borne diseases and nutritional deficiencies can also cause reduction in PCV (Van den Bossche and Rowlands, 2001).

6. CONCLUSION

In the present study, trypanosomosis infection rate in the study area is slightly lower than it is before due to implementation of tsetse fly and trypanosomosis control by Arbaminch Tsetse fly and trypanosomosis investigation and control center. However, the current trypanosomosis infection rates is still significant to the level that it hinders cattle production in Humbo district. The prevailing trypanosome species in the study area were T. congolense and T. vivax with predominance of T. congolense. The study revealed that peasant association (PA), body condition and age of animals were found to be potential risk factors for trypanosomosis infection. Anemia was characteristic of trypanosomosis infection in the area. Therefore, further integrated control approaches particularly application of ground suppression and deployment of insecticide impregnated targets on tsetse pocket areas, application of adequate pour-on insecticide on vulnerable cattle needs to be implemented to significantly lower the infection rate. Moreover, further season-based studies should be conducted to determine apparent density of tsetse flies and to observe seasonal dynamics of trypanosomosis infection in the area.

ACKNOWLEDGEMENT

We would like to acknowledge Arbaminch Tsetse and Trypanosomosis Investigation and Control Center for material support.

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