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Review Article

Review on Small Ruminants Trypanosomosis in Ethiopia

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Abstract

Small ruminants are important sources of income that vary among different cultures, socio-economies, agro ecologies and locations. These resources are affected by different constraints. High number of sheep and goat are at risk of trypanosomosis in Ethiopia. The objectives of this paper are to review the epidemiological information of small ruminant trypanosomosis in Ethiopia. Trypanosomosis is caused by the protozoan parasite of a genus Trypanosomes. Tsetse flies are the main vectors responsible for the transmission of trypanosomes. The life cycle of trypanosome in tsetse involves cyclical development for varying length of time, depending on species and temperatures. Trypanosomes release haemolysins and enzymes, which cause damage of the cell membranes of erythrocytes. They also mechanically damage the cells. There are different risk factors that affect the distribution of trypanosomes such as altitude, species of the host, age, sex, treatment intervention, and herd size. The prevalence of trypanosomosis in small ruminants in Ethiopia was recorded in different study areas. According to different research scholars the prevalence ranges from 1% to 8%. *T.congolense* and *T.vivax* are higly circulating in sheep and goat of Ethiopia. *T.brucei* is also reported. Trypanosome can be diagnosed by epidemiological feature, clinical sign and different laboratory techniques such as parasite identification and serological methods. Trypanosome is usually leads to reduced reproduction and quality, low feed conversion ratio and possible death of animals, hence, affecting the farmer's overall profit. *Homidium bromide, quinapyramine methyl sulphate* and *diminazene aceturate* are used for the treatment of trypanosome infections in small ruminants. The control of *Trypanosomosis* is achieved by Curative and prophylactic trypanocidal drugs, controlling Vectors tsetse fly and there by breaking the disease transmission cycle. Therefore, an integrated control measures and further epidemiological studies are very important.

Keyword: Small ruminant; Trypanosome; Ethiopia

Introduction

Livestock is backbone of the socio-economic system of the most rural communities of Africa [1]. Ethiopia has huge and diverse livestock population that plays an important role in the economy and livelihoods of farmers, and pastoralists. Livestock are a 'living bank' or 'living account' for rural and urban poor farmers and livestock owners. They serve as financial reserves during period of economic distress such as crop failure as well as primary cash income. Despite the large animal population, productivity in Ethiopia is low and even below the average for most countries in eastern and sub-Saharan African countries, due to poor nutrition, reproduction insufficiency, management constraints and prevailing animal diseases [2].

Ethiopia has huge number of sheep and goat population, which is estimated as 39,894,394 sheep and 50,501,672 goats which are distributed across the different agro-ecological zones of the country [3].

Small ruminants in Ethiopia are important sources of both tangible (income, meat, milk, skins and manure) and intangible (saving, insurance against emergency, cultural and ceremonial) benefits that vary among different cultures, socio-economies, agro-ecologies and locations [4]. Small ruminants are playing an important role in the food and nutritional security, especially in the landless, marginal and small farmers in arid and semiarid rain fed regions [5]. Sheep and goats have many advantages over large ruminants for most smallholder farmers, including lower feed costs, quicker turnover, easy management and appropriate size at slaughter [4].

African Animal Trypanosomosis is one of the major impediments to livestock development and agricultural production in Ethiopia, which negatively affect the overall development in agriculture in general, and to food self-reliance efforts in particular. Ethiopia covers an area of 1.1 million km^2 with 240,000 km2 of fertile areas under threat of trypanosomosis. Particularly affected are the western and southern lowlands, preventing agricultural activities. In Ethiopia around 6.1 million sheep and goats are at risk of trypanosomosis in recently settled south-western region [6].

Studies on trypanotolerant sheep and goats also indicate that the main impacts of trypanosomosis are lambing rates reduced by 4-38% and kidding rates reduced by 37% [7]. Tsetse flies and trypanosomes are trill abundant and widely distributed in Ethiopia despite decades of control efforts and their abundance is influenced by factors such as altitude, river drainage system, presence of game reserves and land use and encroachment. This review paper underlined that tsetse transmitted trypanosomosis is a major animal health constraint in the country and found distributed in many parts of tsetse infested areas [8].

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Ethiopia roughly lost from around 1.12 billion ETB (66.4 million USD) to 2.13 billion ETB (125.8 million USD) worth of livestock value due to trypanosomosis. This lost income would have lifted from 15 million to 28.4 million rural persons out of poverty from their current income level [9].

The objectives of this review:

- To review the epidemiological information of small ruminant trypanosomosis in Ethiopia.
- To review information of the most commonly used and effective control and preventive strategies against small ruminant trypanosomosis.

Literature Review

Etiology

The causative agent of trypanosomosis is the protozoan parasite of a genus Trypanosomes dwelling in blood and various tissue fluids [10]. Trypanosoma belongs to the protozoan branch, order Kinetoplastida, family Trypanosomatidae genus Trypanosoma. These parasites are motile due to the undulatory motion of their flagellum. The genus Trypanosoma is subdivided into two sections: namely the Stercoraria and Salivaria, based on how the parasites are transmitted from the insect vector to the mammalian host [11]. The development of stercoraria parasites takes place in the intestinal track of the invertebrate vector and the infection to the vertebrate is via feces. *T.cruzi,* the causative agent of Chagas' disease, is an example of the stercoraria group. Salivarian parasites colonize the stomach of their invertebrate vector, but never pass to the intestinal track. Rather, they migrate towards the salivary gland of the vector where the infectious form for vertebrate host develops. Infection of the vertebrate occurs via saliva when the vector bites in order to take the blood meal. The African parasites, *T.brucei*, *T.congolense*, *T.evansi,* and *T.equiperdum* all belong to the salavarian group. *T.brucei* has three subgenera; while *T.b.brucei* is the causative agent of Nagana, a cattle disease in Africa, *T.b.rhodesiense* and *T.b.gambiense* are the causative agents of the sleeping sickness in human. The other two species T. congolense and *T.vivax* are the major causative agents of animal trypanosomiasis in Africa. *T.equiperdum* is the causative agent of an equine venereal disease that is called "dourine" where the parasites are transmitted during coitus. *T.evansi* causes a livestock disease called "surra" [10]. *T.congolense* and *T.vivax* are the main species associated with clinical trypanosomosis in small ruminants in the sub-Saharan region. *T.brucei* and *T.simiae* are frequently encountered as asymptomatic infections in goats although the latter can cause an acute and fatal disease in sheep [12].

Transmission

Tsetse flies are the main vectors responsible for the transmission of African Animal Trypanosomosis (AAT) and Human African Trypanosomosis (HAT) in the 37 sub-Saharan African countries between latitudes 14°N and 29°S. Tsetse flies comprise about 30 species and subspecies [13]. They are classified into (i) savannah, (ii) riverine and (iii) forest groups [14].

Tsetse flies (Glossina spp) are the principal vectors of trypanosomosis in sub-Saharan Africa and *G.morsitans* and *G.pallidipes* are the most commonly involved in the transmission of the disease. Other blood sucking flies such as Stomoxys spp and Tabanus spp may also transmit the disease. Wild animals such as bush pigs, bush bucks, kudus, warthogs and buffaloes act as reservoirs of the infection in endemic areas. Stress favours such as malnutrition, intense heat and intercurrent infections have been shown to render animals more susceptible to the disease. Animals in endemic areas show some trypanotolerance while exotic breeds are much more susceptible [12].

Trypanosomes can be transmitted mechanically and cyclically. In cyclical transmission trypanosomes are transmitted through the bite of an infected tsetse fly. Tsetse flies get the infection when feeding on an infected animal; after implementation of the parasitic cycle in the fly (15–21 days) it becomes infective and may remain infective for the rest of its life. Transmission occurs in the early stage of the blood feeding, when the fly inject some saliva before sucking the blood of its host.

Mechanical transmission: Biting flies, especially tabanids and stomoxes, but possibly other biting insects (including tsetse flies) are the mechanical vectors of *T.vivax*. Mechanical transmission can occur when interrupted feeding is re-started on a new host; thus it is efficient inside a group of animals but has little chance to occur at distance.

Vertical transmission can also occur intra-uterine and during parturition. Trypanosomes can also be spread by fomites and mechanical vectors including surgical instruments, needles, syringes and various biting flies. Transmission *T.brucei* can even occur after the birth, when contaminant blood or other fluids can be ingested by the calf. Per oral transmission is also common for carnivore when eating fresh infected prey [12]

Life Cycle

Trypanosomes have a complex life cycle. Bloodstream forms proliferate in the blood of the infected mammalian host and are ingested by tsetse during the blood meal.

In the fly's mid gut, the parasites transform into procyclic trypomastigotes, multiply by binary fission, leave the midgut, and transform into epimastigotes. The epimastigotes reach the fly's salivary glands and continue multiplication by binary fission [15].

The life cycle of trypanosome in tsetse involves cyclical development for varying length of time, depending on species and ambient temperatures. Most tsetse-transmission begins when blood from a trypanosome-infected animal is ingested by the tsetse fly the trypanosome loses its surface coat, multiplies in the fly, then reacquires a surface coat and becomes infective.

Trypanosoma brucei species migrate from the gut to the proventriculus to the pharynx and eventually to the salivary glands; the cycle for *T.congolense* stops at the hypo pharynx and the salivary glands are not invaded; the entire cycle for *T.vivax* occurs in the proboscis. The animal-infective form in the tsetse salivary gland is referred to as the metacyclic form. The life cycle in the tsetse may be as short as one week with *T.vivax* or extend to a few weeks for *T.brucei* species. The animal-infective form in the tsetse salivary gland is referred to as the metacyclic form [15].

Pathogenesis

Infected tsetse inoculates metacyclic trypanosomes into the skin of animals, where the trypanosomes reside for a few days and cause localized inflammation which is called chancres. They enter the lymph and lymph nodes, then the bloodstream, where they divide rapidly by binary fission.

During the parasitaemic stage, trypanosomes release haemolysins and enzymes such as phospholipases, proteases and neuraminidases, which cause damage of the cell membranes of erythrocytes. Damage to the red blood cells is followed by disseminated intravascular coagulation. The trypanosomes may also block capillaries causing ischaemia and anaemia [12].

In *T.congolense* infection; the organisms attach to endothelial cells and localize in capillaries and small blood vessels. *T. brucei* species and *T.vivax* invade tissues and cause tissue damage in several organs.

Epidemiology

The distribution of trypanosomosis in sheep and goats in sub-Saharan Africa is closely related to the ecology and distribution of the vector tsetse flies of the genus Glossina. Increased tsetse fly activity particularly during the rainy season is associated with increased incidence of the disease. Tsetse flies (Glossina spp) are the principal vectors of trypanosomosis in sub-Saharan Africa and G. morsitans and G. pallidipes are the most commonly involved in the transmission of the disease. Other blood sucking flies such as Stomoxys spp and Tabanus spp may also transmit the disease [12].

In Ethiopia, trypanosomosis is widely spread in domestic livestock in the western, south and southwestern low land region and the associated river systems (Abay, Ghibe, Omo and Baro/Akobo) [8].

Southern, southwestern and northwestern are tsetse infested regions, where there are five species of tsetse fly namely, G. morsitans submorsitans, G. pallidipes, G. fuscipes fuscipes, G. tachnoids and G. longipennis. Among these species the first four are widespread and most important due to their wide distribution in most grazing lands and cattle rearing areas; while G. longipennis is of minor economic importance because it its limited to forest lands not used for livestock grazing [16].

Different studies indicate that trypanosomosis is an important disease of livestock in Ethiopia which negatively affect the overall agricultural production [17].

Risk Factors

Understanding the risk factors for trypanosomosis is essential for developing proper control strategies of the infection. There are different risk factors that affect the distribution of trypanosomosis such as altitude, species of the host; age, sex, treatment intervention, and herd size as potential risk factors. Season variation and land cover in grazing areas are also have a role in the epidemiology of trypanosomosis.

Altitude: Altitude is a limiting factor for cattle trypanosomosis. The altitudinal difference in trypanosomosis burden is most often explained by the significant variation in tsetse densities across altitudes. Tsetse burden is higher in the altitude of less than 1200 Meters [6].

Species of the Host: The prevalence of trypanosomosis is higher in sheep than goats but this variation is statistically insignificant [18-22]. This is usually related to tsetse feeding that means the anti-feeding behavior of goats and the docile nature and wool cover of the sheep [7].

Age: Age had significant effect on the prevalence of trypanosomosis because statistically significant result was obtained among age groups in different studies. The significant difference might be due to the grazing pattern difference among different age groups. In the study area lambs and kids usually roam around homestead this reduce contact with tsetse flies, in addition their body size is too small to be attacked by tsetse flies [21].

Animal Coat Color: There was a significant difference in prevalence rate between small ruminants coat color. Black and red coat color attractive to tsetse species, but the strongest landing responses were found to be on black surface [21].

Herd Size: In cattle Herd size is observed to have a significant effect impact on trypanosome infections. Medium size and small size herd were observed to positively influence the rate of infection with trypanosomes in cattle. The highest infection rates were reported in smaller and medium size herds than larger size herds [23].

Diagnosis

The epidemiology, particularly the presence of tsetse flies in the area, clinical and pathological features may be useful in a provisional diagnosis of the disease [12].

Beside clinical and epidemiological diagnosis direct and indirect laboratory techniques are employed in the diagnosis of tryanosomosis which have different sensitivity and specificity, easy to manipulate and cost [24].

Wet blood smears are useful in field diagnosis of the disease but they may be unreliable for the detection of light infections. Air-dried thin or thick blood smears stained with 10% Giemsa for 20 minutes are used for specific diagnosis of trypanosomes. In light infections with *T.congolense* and *T.vivax*, the trypanosomes can be concentrated by centrifugation and demonstrated by examination of cells at the leucocyte/plasma interface of heparinised blood by dark ground illumination. This is considered to be the most sensitive method of diagnosis of trypanosomosis. If EDTA is used as anticoagulant, trypanosomes can be demonstrated in Giemsa-stained smears of cells from the buffy coat region.

The common serological methods of diagnosis are indirect haemaglutination test and ELISA. Monoclonal antibodies against *T.congolense, T.vivax and T.brucei* are available. The differential diagnosis of trypanosomosis includes haemonchosis and malnutrition. Demonstration of trypanosomes in blood circulation is required to rule out helminthosis [12]. Reliable diagnosis may be achieved by combining appropriate diagnostic tests. Reliable interpretation of results from diagnostic tests will depend on test validity as well as on proper sample selection/collection, the sample size, and the way the diagnostic tests are conducted [24].

Treatment

There are different chemotherapeutic and chemprophylactic dugs used for the treatment of clinical trypanosomosis and for prophylactic purposes. Homidium bromide (1 mg/kg), quinapyramine methyl sulphate (5 mg/kg) and diminazene aceturate (3.5 mg/kg) are used for the treatment of T. congolense and T. vivax infections in small ruminants. Chemoprophylaxis is an important control strategy in endemic areas and isometamidium (0.5 mg/kg) and pyrithidium bromide (2 mg/kg) are the drugs commonly used in small ruminants [12].

Economic Importance

Trypanosomosis is usually leads to reduced reproduction and quality, low feed conversion ratio and possible death of animals, hence, affecting the farmer's overall profit. Studies on trypanosome infection rate and its impact on livestock production have revealed that they vary with sex, age, species of trypanosomes and the tsetse fly, locality, season and depend largely on the level of interaction between tsetse flies and domestic [25].

Control

The control of Trypanosomosis is achieved by different mechanisms such as control of disease and control of vectors. Curative and prophylactic trypanocidal drugs used for the control of disease. Trypanosomosis also controlled by controlling tsetse fly and there by breaking the disease transmission cycle. These control techniques of tsetse fly include clearing of vegetation, elimination/exclusion, Insecticides Ground spraying, Sequential aerial technique, Traps and targets and use of sterile insect technique [26].

The Ethiopian government through National Institute for the Control and Eradication of Tsetse and Trypanosomosis organizes tsetse control program. Their strategies comprise the use of insecticidal pour Ons and insecticide impregnated traps and targets. Complementary to those vector control activities, trypanocidal drug treatment remains the most widely used control strategy because it is available and most affordable for livestock breeders. Trypanocides minimize the impact of the parasite on animal health and reduce the period that the animal is infectious for possible vectors

Control of the disease depends on the prevention of contact between susceptible animals and vectors particularly tsetse flies. The methods of control of tsetse flies include bush clearing, spraying of animals and habitats with effective insecticides and the use of tsetse fly traps. The use of trypanotolerant breeds of goats and sheep is also being adopted in some countries. Avoidance of stress factors such as malnutrition, intense heat and inter current infections can reduce the incidence of clinical cases in endemic areas [27].

Distribution of Small Ruminant Trypanomosis in Ethiopia

In Ethiopia, trypanosomosis is widely spread in domestic livestock in the western, south and southwestern low land region and the associated river systems (Abay, Ghibe, Omo and Baro/Akobo) [8]. As compared to cattle, the distribution, economic impact and risk factors of trypanosomosis in sheep and goat of Ethiopia is not well documented. However, there are reports on the prevalence of trypanosomosis in sheep and goat. The prevalence of trypanosomosis in small ruminants in Ethiopia was ranges from 1% [28] to 8% [29].

Higher prevalence of trypanosomosis was reported in sheep when compared to that of goat [18,19,21,30]. On the other hand, there is a report which show higher prevalence in goat than sheep [20,29,31]. These variations are statistically insignificant (Table 1).

Different reports indicate that among the different species of trypanosomes; *T.congolense* and *T.vivax* are higly circulating in sheep and goat of Ethiopia [18,20,30]. Additionally, in some reports *T.brucei* were found [19,21,23]. Mixed infection of *T.congolense* and *T.vivax* in sheep and goats were also reported by different researchers [19,21].

Table 1: The prevalence of Trypanosomosis in small ruminants in some areas of Ethiopia.

Study area	No animal tested		Positive Animals		Prevalence		Overall prevalence	Reference
	Sheep	Goat	Sheep	Goat	Sheep	Goat		
Guto gida	145	234	4	4	2.76	1.75	2.1	[18]
Dangur	108	204	4	4	3.7	3.9	2.56	[20]
Mareka	222	178	20	13	7.2	9	8	[29]
Asosa	210	200	15	13	3.6	3.17	6.8	[19]
Yayo	230	171	10	3	4.35	1.75	3.24	[30]
Dembecha	256	144	20	5	7.8	3.5	6.3	[22]
Dawro	126	103	5	6	4	5.8	4.8	[31]
Didesa	66	654	3	24	4.5	3.5	3.75	[21]
Nono district		400		4		1	1	[28]

Table 2: The prevalence of different trypanosome species in small ruminants in Ethiopia.

Study area	Species identified	Prevalence	Reference
Assosa	*T. congolense*	42.9	[19]
	T. vivax	25	
	T. brucei	10.7	
	Mixed(T.congolense and T.vivax)	14.3	
	Mixed(T.congolense and T.brucei)	7.14	
Didesa	*T. congolense*	66.7	[21]
	T. vivax	20.8	
	T. brucei	8.3	
	Mixed(T.congolense and T.vivax)	4.2	
Dawro	*T. congolense*	36.36	[31]
	T. vivax	45.45	
	T. brucei	18.18	
Guto Gida	*T. congolense*	50	[18]
	T. vivax	50	
Mareka(Dawro)	*T. congolense*	93.75	[29]
	T. vivax	6.25	
Dangur	*T. congolense*	50	[20]
	T. vivax	50	
Yayo	*T. congolense*	53.85	[30]
	T. vivax	46.15	
Dembecha	*T. congolense*	64	[22]
	T. vivax	36	
Nono district	*T.congolense*	100	[28]

Small ruminant trypanosomosis are found in different part of the country and affect the economy of the small holders of rural society. Event though, the small ruminants are considered as trypanolerant, it is better to think about their potential reservoir of trypanosome infection to other animals and its impact on economy by itself [19] (Table 2).

Conclusion

According to different reports; Small ruminant trypanosomosis is the main economic impact of small holders of rural areas. Even though its mortality rate is low the disease resulted in serious economic losses because of morbidity which poses production loss and treatment expenses specially in western and southwestern parts of Ethiopia posing a significant impact on the country development. Small ruminants are also serves as potential reservoir hosts of animal infective trypanosome species in endemic areas. The diagnosis of trypanosomosis based on epidemiological situation and clinical sign of the disease. The practical laboratory diagnosis is mainly relies on parasitological diagnosis techniques which are less sensitive. Both the prophylactic and curative drugs can be used to treat small ruminant trypanosomosis.

Based on the above conclusion, the following recommendations are forwarded.

- Using Sensitive and specific diagnostic tools such as Parasite concentration techniques which have the capability to identify light infection during the treatment, epidemiological surveys, and control program of small ruminant trypanosomosis is very important.

- An integrated control measures, using modern methods of fly control like SIT, reservoir animal control and using of trypanocidal drug treatment for infected animals is important to improve the Productivity of small ruminants.

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