Potential anti-trypanosomal plants against African animal trypanosomiasis

Solomon Assefa

Abstract
The genus Trypanosoma, which is a flagellated protozoan, causes trypanosomiasis. The disease can be occurred in human and animals in Africa and South America. African animal trypanosomiasis (AAT) has a multidimensional impact in Africa. Treatment of AAT is currently facing a number of problems including toxicity of trypanocidal drugs and development of resistance by the parasites. These limitations have prompted the search for alternative active substances (such as of natural origin). There are many plants indicated for their use against the disease. In different ethnobotanical studies conducted in Africa, large number plants have been reported. Some of these plants has been tested and confirmed for their anti-trypanosomal activity against different species of trypanosome using in vivo and in vitro method. Different literatures were surveyed on antitrypanosomal activity published after the year 2005.

Keywords: African trypanosomiasis, medicinal plants, trypanocidal, anti-trypanosomal

1. Introduction
Trypanosomiasis is a parasitic disease caused by flagellated protozoan belonging to the genus Trypanosoma (Abebe, 2005) [4], this genus causes potentially fatal human and animal trypanosomiasis in Africa (African trypanosomiasis) and South America (American trypanosomiasis) (Pascal et al., 2009; Lima et al., 2010) [75, 41]. African trypanosomes cause African animal trypanosomiasis (AAT), a debilitating disease of domestic animals in the humid and sub-humid zones of Africa (Muhanguzi et al., 2015) [57]. AAT also called nagana in Zululand (Connor RJ, 1998) [20] is caused by different species of the genus Trypanosoma. Trypanosoma vivax, Trypanosoma congoense and to a lesser extent Trypanosoma brucei brucei are the main species responsible for AAT (D’Archivio et al., 2011) [21]. Cattles are the primary victim of trypanosomiasis in West and East Africa. Sometimes epidemics can also occur in other species: horses, goat, dog, sheep and camel (Emma, 2008) [23]. Surra in camels and Dourine in horses are caused by the other trypanosome species of Trypanosoma evansi and Trypanosoma equiperdum, respectively (D’Archivio et al., 2011) [21].

The disease is majorly transmitted through the bite of tsetse fly (Glossina species) which introduces the causative agent, trypanosome, into the blood (WHO, 2003; D’Archivio et al., 2011) [96, 21]. The tsetse belt extends from Sahara in the North to South Africa in the South (OIE, 2013) [69]. Large areas of Africa, approximately 4 million km², have been rendered unsuitable for livestock production by trypanosomes (Emma, 2008) [23]. This makes AAT to be one of the vector-borne parasitic diseases which are causing major health and economic problems in rural sub-Saharan Africa (Molyneux, 1997) [54].

The impacts of AAT are multidimensional. The disease affects human health, livestock production, agricultural production, rural socio-economic development, national economies (import and export of animal products), and the environment (insecticide applications) (Abd-Alla et al., 2013) [1].

Trypanosoma is furthermore known to render approximately a quarter of African arable land mass unsuitable for profitable livestock farming (Molyneux, 1997) [54]. Hence, it causes the death of 3 million cattle annually with an estimated lost potential of $ 6-12 billion US dollars (Maikai, 2010) [46].

Commonly employed control methods of trypanosomiasis are chemotherapy and control of tsetse fly vectors (Magez et al., 2010) [43]. Accordingly, Programmes are under way to free Africa of the disease either by massive control and eradication of the tsetse fly (Abd-Alla et al., 2013) [1]. Vaccination is also considered to be one of the best methods of controlling infections. However, continuous antigenic variation and memory-cell destruction by trypanosomes limited the development of viable vaccines (Magez et al., 2010) [43].
The problem of drug resistance in trypanosomes chemotherapy appears to be spreading geographically to different regions, in which trypanosomiasis occurs. So far, resistance to one or more of the three trypanocidal drugs (Homidium, Diminazene, Isometamidium) used in cattle has been reported in at least 11 countries in sub-Saharan Africa (Burkina Faso, Chad, Côte d'Ivoire, Ethiopia, Kenya, Nigeria, Somalia, Sudan, Tanzania, Uganda, and Zimbabwe) (Afework et al., 2000; Melaku and Birasa, 2013; Chitanga et al., 2011) [9, 51, 19]. Moreover, Current treatments of animal trypanosomiasis possess several limitations, such as limited efficacy as well as severe side effects due to toxicity, including mortality (Onyekwelu, 1999; Faria et al., 2014) [72, 69].

Due to the above obstacles of chemotherapy, trypanosomiasis therapy urgently necessitated the development of alternative new molecules that are safe, effective and affordable. In this respect, different literature surveys and field studies have shown that plants are used in traditional medicine of Africa to treat trypanosomes in humans and animals (Freiburghaus et al., 1996; Nibret and Wink, 2011) [29, 60, 63, 65]. At least 80% of the world population is estimated to be employing traditional medicines that commonly use natural products in primary health care (Verpoorte et al., 2006) [93]. Plants, animals and micro-organisms represent a reservoir of natural products, the so called “natural sources deriving compounds” (Brusotti et al., 2011) [18]. Plants are the major component of traditional medicine, including 40,000-70,000 medicinal plants, out of which 20% of them are higher-plant species (Verpoorte et al., 2006) [93].

In an effort to discover new lead compounds for infectious diseases, researchers are focusing on plant materials which contain array of diverse chemical substances with biological and physiological properties (Maikai, 2010) [46]. Developing drugs from natural products created a consensus among the scientific community (Newman et al., 2003). Hence, this review tries to overview medicinal plants that are promising to develop anti-trypanosomal agents, particularly used in African trypanosomiasis.

PubMed, Sciencedirect, Medline and Google scholar were used for searching of the relevant literatures published after 2005 that dictates about medicinal plants used in the management of AAT. Certain articles were found through tracking citations from other publications. The keywords combinations for the search were: anti-trypanosomal, trypanocidal, medicinal plant and Africatrypanosomiasis. The research articles obtained on the ethnobotanical study and in vitro and in vivo antityranosomal activities are presented in this review.

**Plants used in traditional medicine against African Animal Trypanosomiasis**

With different attempts made in the past thirty years, failures in control measures and treatment regimes have caused the impact of this parasite to increase markedly (WHO, 2003) [90]. In poor countries, the healthcare is often sustained by practices based on cultural alternatives (Willcox and Bodeker, 2004) [94]. It has also been observed that natural products derived from plants offer novel possibilities to obtain new drugs that are active against trypanosomes. Many investigators targeted finding new anti-trypanosomal agents to combat the trypanosomiasis by screening extracts of medicinal plants (Mann and Ogbadoyi, 2012) [48]. There are many reports about the screening of herbal extracts against *T. brucei brucei*, *T. congolense* (Kayser et al., 2003) [37] and *T. evansi* (Kumar et al., 2014) [40]. However, these investigations are in their infant stages. These review compile and present a recent information on various plant used against AAT.

Maikai, et al. (2010) [40] in their ethnobotanical study has reported that *Khaya senegalensis* (23.3%) had the highest percentage of traditional use against AAT followed by *Terminalia Avicennioides* (16.3%), *Ximenia Americana* (12.7%), *Anona senegalensis* (10.7%) and *Azadirachta indica* (9.3%) in Kaduna State, Nigeria. The authors also added that the leaves, bark and roots were the main parts of the plant used traditionally. Besides the above plants, The leaves of *Guiera senegalensis*, leaves of *Tamarindus indica* and bark of *Prosopis africana* has also been stated to be used in the traditional medicine of Nigeria (Maikai et al., 2010) [46].

In other regions of Nigeria called *Lavan* local Government area of Niger State, Mann and Ogbadoyi (2012) [48] collected plants based on the description made by the traditional healers for their use in AAT traditionally. The plant materials used traditionally include: *Acacia nilotica* (stem bark), *Bombax buonopozense* (stem bark), *Heterotisrotun diphila* (whole plant), *Pterocarpus erinaceus* (stem bark), *T. avicennioides* (round fruit), and *Zanthoxylum zanthoxyloides* (stem bark). Maikai et al. (2010) [46] also reported that *Terminalia brownii*, *Acacia refiscens*, *Claroendorum species*, *Afzelia africana*, *Cordia myxa*, *Eugenia uniflora*, *Acacia artaxacantha*, *Terminalia sorensis* and *Strophanthus sarmentosus* are used in Kenya, Nigeria and other countries by herdsmen to locally treat their animals.

Salihu et al. (2014) [77] has interviewed 64 Fulani herdsmen in Taraba, Nigeria, and they reported that *K. senegalensis* was the most frequently (20.93%) used anti-trypanosomal plant. In addition, *A. senegalensis* and *Prosopis africana* were used by some of the herdsmen. The common plant parts used as remedies by the Fulani herdsmen interviewed were leaves, stem and root. As it is indicated earlier (Maikai et al., 2010) K. *sengalensis* is also found to be the major plant against the disease in other part of Nigeria (Kaduna).

Several plant species have been used to treat trypanosomiasis in East Africa. These include *Adenia volkensii*, *Fagara chalybea* and *Salvadora persica*, which are used in Kenya (Ole-Miaron, 2003).

In the first stage, plant extracts are evaluated in vitro against bloodstream forms (Kayser et al 2003) [37]. These plants are also investigated in animal models, which are infected with trypanosome parasite. Accordingly, those plants reported to be used in traditional medicine has been investigated for their *in vitro/in vivo* anti-trypanosomal activity; the following are some of them.

**Plants evaluated for their anti-African trypanosomal activity**

Plant extracts have been extensively screened for their antityranosomal activity in the recent years and some have shown promising anti-trypanosomal potential (Habila et al., 2011; Nwodo et al., 2015) [33, 67].

Atowadi (2005) has tested about forty tropical plants harvested from the savannah against *T. brucei brucei*. Among the plants studied, extracts of *Adenium obesum* (stem bark), *Afromosia laxiflora* (leaves and stem bark), *Cochlospermum planchonii* (stem bark), *P. africana* (stem and root barks), *Striga spp* (leaves), *T. avicennioides* (root and stem bark) and *Swartzia madagascariensis* (fruit pulp) exhibited the highest trypanocidal activity. These results suggested that tropical plants could be a very promising source of new generations of trypanocidal agents.
In the *in vitro* anti-trypanosomal study, the crude extract of *Ocimum gratissimum* Linn that is used in folk medicine of Benin were found to be more active than its essential oils and their major compounds against *T. brucei brucei*. The most active extracts were obtained from seeds and leaves in full flowering stage (IC50=2 mg/mL) ([Bénédicte et al., 2014](#)).

In study conducted by Awobode et al. (2015) [13], the antitypansomal activity of combined methanolic stem bark extracts of *K. senegalensis* and *A. leiocarpus* were determined in vivo using suppressive and repository tests. The combined extracts were administered at 250 mg/kg to *T. brucei brucei* infected rats in ratios 1:4, 2:3, 1:1, 3:2 and 4:1 (*K. senegalensis* to *A. leiocarpus*). Trypanocidal activity was recorded in all four ratios with the highest being in the 4:1 ratio for both tests. All ratios in repository test had varying levels of prophylactic activity which were significantly higher (p<0.05) than the negative control group. Chemo-prophylactic activity in the 4:1 ratio compared favorably with the positive control.

*K. senegalensis* root bark was extracted with methanol and screened against *T. evansi* for *in vitro* trypanocidal activity. At 250 µg/mL, there was immobilization, reduction of average trypanosomes counts and complete killing of trypanosomes at 6 h of incubation, which was equivalent to diminazene aceturate 50 µg/mL at 4 h (Shaba et al., 2011).

At 250 µg/mL, trypanocidal activity of methanolic extract of *K. senegalensis* tree bark at 6 h of incubation is equivalent to 4 h of diminazene aceturate (standard drug). The study indicated the potency of methanolic extract of *K. senegalensis* in comparison to pure compound of diminazene aceturate (Shaba et al., 2011).

Aqueous and methanol extracts of different parts of *A. leiocarpus* were analyzed for *in vitro* antitypansomal activity against *T. brucei brucei*. Extracts of the different parts of the plant were found to possess *in vitro* antitypansomal activity against *T. brucei brucei*. Different parts of the plant showed variations in their anti-trypanosomal activity. Methanolic and aqueous extracts of the plant bark had the highest *in vitro* activity against the parasite (Wurochekke and Anyanwu, 2012) [99].

The *in vitro* effect of *A. leiocarpus* was evaluated by other researchers. Their reports showed that the active butanolic fractions and the isolated compounds exhibited minimum inhibitory concentration (MIC) values ranging from 25 to 50 µg/mL and 7.5 to 31.5 µg/mL, respectively, against *T. evansi*. This confirmed the activity of the plant against *T. evansi*. In addition to the above showed activity against *T. brucei brucei* (Shuaibu et al., 2008) [83], Antia et al. (2009) [11] has reported the result obtained from the anti-trypanosomal activity of some medicinal plants from Nigeria. It was noted that the stem and root bark extracts of *Terminalia superba* caused complete cessation of motility of parasites at 3.1 mg/ml extract concentration. While the leaf extracts of the same plants only caused cessation at a higher concentration of 6.3 mg/ml. The root bark and leaf extracts of *Africanana* also caused completed cessation of motility at 6.3 and 3.1 mg/ml respectively. *T. superba* root extract also exhibited appreciable activity *in vivo* in rats and mice used in their study.

Water, methanol and dichloromethane extracts of the leaves of *T. avicennioides* was tested, but only methanolic extracts were found to be active against *T. Brucei brucei*. In addition, the round fruit extract of *T. avicennioides* tested for its *in vivo* antitypansomal activity and gave a good anti-trypanosomal result (Mann and Ogbadoyi, 2012) [48]. This finding was similar to other study done on the activity of this plant (Bizimana et al., 2006) [17] in which statistically significant (p<0.002) reduction of parasitemia was observed compared to the negative control. Mann and Ogbadoyi (2012) [48] also investigated the anti-trypanosomal activity of Stem bark of *Z. zanthoxyloides*, and it was found to exhibit trypanostatic activity.

At doses of 10, 20 and 40 mg/kg, the crude extract *Abru precatorius* seeds showed a sharp reduction in the level of parasitemia in mice compared with untreated group against resistant strain of *T. brucei brucei*. In addition, one of the fractions, which contained mainly alkaloids, was screened for its pharmacological activity. This fraction at doses of 5 and 10 mg/Kg showed a sharp reduction in the level of parasitemia to zero in day 9 and gradual recovery from the 12th day of treatment. This effect of the fraction was found to be comparable to diminazene aceturate (Nwodo and Nwodo, 2012) [48].

Certain medicinal plants from central Africa have been reported to exhibit activities *in vitro*, including *Garcinia lucida* (Fotie et al., 2007) [56]. The stem bark crude extract of *G. lucida* displayed significant activity against *T. brucei brucei* (IC50 =4.9 µg/mL) with no toxicity on the Vero cell. Moreover, the aqueous extract from *Isolona hexaloba* stem bark showed pronounced activity against *T. brucei brucei* (IC50 = 1.95 µg/mL) while stem bark of *Enanatia chlorantha* has good anti-trypanosomal activity (IC50 = 8.36 µg/mL) (Muganza et al., 2012) [55].

Abedo et al (2013) [3] showed the activity of nine extracts recovered from plant materials of *Tapananthus globiferus* and *G. latifolium* against *T. congolense* *in vitro* at various concentrations (2.5, 5 and 10mg/ml). The methanolic leaf extract of *T. globiferus* showed highest activity by ceasing the motility of the parasite within 5 minutes, followed by methanolic stem bark extract of *G. latifolium*, which ceased motility at 10 minutes. All the extract obtained from both plants was trypanocidal except the aqueous extracts of Leaf, stem bark of *G. latifolium* and stem bark *T. globiferus*.

Preliminary Screening of *X. americana* using stem bark extract has been done for anti-trypanosomal activity against blood stream forms, the results showed that methanol extract had *in vitro* activity against *T. congolense*. Aqueous and methanolic extracts reduced motility of the parasite in various concentrations (Maikai et al., 2008) [45]. According to Bero et al. (2011), the best growth inhibitions of *T. brucei brucei* were observed with the Dichloromethane extracts of *Acanthospermum hispidum*, *Byrsocarpus coccineus*, *Carpolobia lutea*, and *Keetialeucantha* twigs with IC50 value of 14.5, 14.7, 18.3 and 5.8µg/mL, respectively. The methanol and water extracts of *Anchomanes diffirmos* has also exhibited IC50 value of 14.7 µg/ml against *T. brucei brucei*. In addition to these plants, the authors has tested *Pupatialapacea*, *Samseveria libericia*, *schrankia leptocarpa* for their anti-trypanosomal action based on their traditional claim in Benin, but they did not show any strong antiparasitic activity (Bero et al., 2011).

50 mg/kg Cold water whole plant extract of *Peristrophealyculata* immobilized 90% of the parasites after 60 min of incubation, and its solvent fraction 2c completely immobilized the parasites after 35 min. It significantly increased packed cell volume (PCV) in *T. brucei brucei*infected rats (Abimbola et al., 2013) [5].

In 2009 Adeiza et al has tested the *in vitro* trypanocidal activity of *A. senegalensis* and found that the crude extract immobilized *T. evansi* at 10 mg/mL. The same year Adeyemi
et al (2009) [7] reported the results obtained from treatment with ethanolic extract of P. guajava which leaf indicated the leaf extract could be effective in the management of AAT, since P. guajava has trypanocidal properties as well as the ability to extend the life span of T. brucei-infected rats. Alhaji et al (2014) [10] evaluated the in vitro anti-trypanosomal activity of the aqueous extracts of nine Nigerian medicinal plants. From their study, it was discovered that the stem bark extracts of Acacia albida and Pericopsis laxiflora were most active against both T. evansi and T. congolense. There was complete cessation of motility in both trypanosomes within 5 min at 40 mg/mL of the stem bark extract of A. albida. Complete cessation of motility was observed within 25 min and 40 min at 40 mg/ml with P. laxiflora stem bark extract for T. congolense and T. evansi, respectively.

Table 1 summarizes other plants reported to have pharmacological activity against African trypanosomiasis either in vivo or in vitro against different species of the African trypanosoma.

**Ethiopian plants claimed against AAT**

In Ethiopia, a substantial amount of the national resource is spent annually for the control of trypanosomiasis (Tikubet, 2000) [90], which is also known as gendi locally (Gidey and Ameni, 2003) [91]. Modern veterinary medicines are not well developed in Ethiopia, nor are modern drugs available adequately to fight animal diseases (Ketema et al., 2013) [92]. In the country about 90% of livestock depends on traditional herbal medicine for treatment of various ailments (Birhan et al., 2011) [93]. According to the ethnopharmacological study done by Tekle (2014) [83], 4 plants were found to be used in the traditional medicine for the treatment of AAT in Kochre district of southern Ethiopia. The plants named Virginia sp. (Kellea), which belongs to Fabaceas family leaves is used for the treatment of the disease. Moreover, The root, bark and leaves of Zeheneria scabra lin. (keite), Erythena brucei (giena), Irseine herbstili, respectively is reported to have traditional use in the management of the disease in Gedeo zone (Tekle, 2014) [87].

In afar, Balanties aegytiaca root also known as uda is indicated for the management of camel trypanosomiasis (locally termed geremole) (Gidey and Teklehaymanot, 2013) [32], Clutia abbysinica plant has been reported to have several medicinal uses in the treatment of infectious disease including trypanosomiasis, in Dek highlands (Teklehaymanot, 2009) [89] and other areas of Ethiopia (Fullas, 2010) [90]. Allium cepa (qey shiknurt), phytolacca dodendcandra (arenji), Rumex nepahleisis (yewsha tej), Verbas cumintinacum (kutina) (Woldegirma et al., 2008) [97], and Claussenia anisata (limch) (Fullas, 2010) [90] has also been reported to be used as a traditional remedy of AAT in different part of the country. In Jimma zone, Ethiopia, leaves of Ocimum lamifolium Benth.(Lamiaceae) and croton macrostachys (euphorbiaceae) also locally known as, Damakase and Bisana, respectively are pounded and extract is given to cattle (2 teaspoons/dose) administered nasally. The other traditional remedy for AAT in the zone is plant Verbascum sinaiiticum (Yigeza et al 2014) [102]. V. sinaiiticum has been also stated in other reports to have anti-trypanosomal use in other part of the nation (Woldegirma et al., 2008) [97].

Tadesse et al (2014) [84] has reported about the traditional use of A. indica (Meliaceae) in the management of AAT in East Wollega Zone, Western Ethiopia. In trypanosomiasis, the leaf of the plant is administered orally. Root of Solanum anguiv Lam.( Solanaceae) is mixed with water and given One bottle for three days in the treatment of AAT, in Wayu Tuka District, East Welega Zone of Oromia Regional State, West Ethiopia (Megersa et al., 2013) [50].

A total of 18 types of medicinal plants have been reported to be used in control and prevention of trypanosomiasis by Shilema et al (2013) [64]., 7 (38.9 %) of the medicinal plants were indicated for AAT treatment, 4 (22.2%) as a tsetse fly repellent and 7 (38.9 %) for both AAT treatment and tsetse fly repellent. Lepidium sativum L. (Sibaka), Echinops Kebericho (Borace), Allium sativum (Tuma), Withania somnifera (Tiro), and Myrica salicifolia (Bundo) are the five most common plant species for the treatment of animal trypanosomiasis respectively as indicated by the respondents in Amaro district in southern Ethiopia (Shilema et al., 2013) [64].

In other area of southern Ethiopia (Bensa woreda) different plants were reported to be used in traditional veterinary medicine. Among these plants, leaves of Clerodendrum myricoides (Malasinch), Ranunculus glandulosus (Qenta/qinta), and Plectranthus multifidas are used in the treatment of AAT (Tekle, 2015) [88].

In Ethiopia, modern investigation on herbal remedies for human ailments has been going on for a while. On the other hand, similar efforts in the area of research on plant remedies for livestock diseases seem to be lagging behind (Fullas, 2010) [38]. Therefore scientific evaluation of these plants may provide modern medicine with lead compounds for the development of new drugs. Some of the plants have been evaluated for their pharmacological activity.

**Ethiopian plants authenticated for their anti-trypanosomal activity**

Trypanocidal effects of dichloromethane and methanol extracts of traditionally used 30 Ethiopian medicinal plants species were evaluated on bloodstream forms of T. b. brucei. Of all, dichloromethane extracts from five plants showed better trypanocidal activity, including: Doyvalis abyssinica (Flacourtiaceae), Albizia schimperiana (Fabaceae), Ocimum urticifolium (Lamiaceae), Acokanthera schimperi (Apopynaeaceae), and Chenopodium ambrosioides (Chenopodiaceae), with IC50 of 1.4, 7.2, 14.0, 16.6 and 17.1 μg/ml, respectively. The researchers speculated that D. abyssinica might be a promising candidate for phytotherapy of trypanosomiasis (Nibret and Wink, 2011) [80, 81, 85]. Some of these plants have been tested for their in vivo activity (Tadesse et al., 2015, Tesfaye et al., 2015) [85, 86].

Nibret et al (2009) [99] determined the in-vitro effect of extracts from 19 Ethiopian plant species and four pure pyrrolizidine alkaloids on bloodstream forms of T. brucei brucei. The dichloromethane extract of Solanaceo angulatus flowers was the most active extract against T. brucei brucei, with an IC50 value of 12.17 μg/ml. The other active extracts were the crude dichloromethane extracts of Crotalaria philippiae twigs (IC50 = 12.67 mg/ml) and Solanecio manni leaves (IC50 = 24.89 mg/ml). The other natural products were screened for their anti-trypanosomal activities, and the results have shown moderate activities, which are considered as promising candidates for the treatment of trypanosomiasis (Nibret et al., 2009) [99].

A report on volatile components of four Ethiopian Artemisia spp. extract and their in vitro anti-trypanosomal and cytotoxic activities, is a published in phytochemistry by Nibret and Wink (2010a) [61]. According to the study, Artemisia species are one
of the many traditional medicinal plants of Ethiopia used for the treatment of infectious and non-infectious health problems. Eight extracts prepared from leaves and aerial parts of four Artemisia species (Artemisia absinthium, Artemisia abyssinica, Artemisia afra, and Artemisia annua) growing in Ethiopia were tested and confirmed to have in vitro anti-trypanosomal activity against bloodstream forms of T. brucei brucei (Nibret and Wink 2010a) [61]. Artemisinin, the best known antimalarial compound from Artemisia annua showed antitrypanosomal activity with an IC50 value of 35.91 μg/ml (Nibret and Wink 2010a) [61].

Essential oils from three Ethiopian medicinal plants; Hagenia abyssinica (Rosaceae), Leonotis ocymifolia (Lamiaceae), and Moringa stenopetala (Moringaceae) were investigated for their in vitro trypanocidal (T. brucei brucei) by Nibret and Wink (2010b) [62]. The oil of M. stenopetala seeds and its main compound, benzyl isothiocyanate showed the most potent trypanocidal activities with IC50 values of 5.03 μg/ml and 1.20 μg/ml, respectively. The oils of H. abyssinica and L. ocymifolia exhibited trypanocidal activities with IC50 values of 42.30 μg/ml and 15.41 μg/ml, respectively. According to their findings, both plant extracts showed appreciable anti-trypanosomal activity of crude DCM and methanol aerial part extracts of A. abyssinica. According to their findings, both plant extracts showed appreciable in vitro and in vivo antitrypanosomal property against field isolate of T. congoense in mice. With the dichloromethane extract exhibiting the higher activity. It was reported that after incubation with the dichloromethane extract, trypanosome motility was eliminated by either completely immobilizing or killing the parasites within 18 and 40 min, respectively, at 4 mg/ml and 2 mg/ml concentration levels. This finding in part confirms an earlier in vitro work by Nibret and Wink (2010a) [61] involving the plant, and using the same solvent of extraction but against a drug sensitive T. brucei brucei.

Very recently, Among the 30 medicinal plants tested for their anti-trypanosomal activity against T. brucei brucei by Nibret and Wink (2011) [66, 63, 65], the one with higher anti-trypanosomal activity (D. abyssinica) in vitro has been investigated for its in vivo activity against T. congolense by Tadesse et al (2015) [85]. According to Tadesse et al (2015) [85], Administration of higher curative doses (250 and 200 mg/kg) of DCM and methanol extracts of the plant considerably displayed in vivo activity as evidenced by reduction in parasitemia level despite the failure to completely clear bloodstream form of the parasite. The study confirmed for the presence of spermidine alkaloids in D. abyssinica that may in part account for the observed anti-trypanosomal activity of this plant. Other Ethiopian plants with proven anti-trypanosomal activity are listed in table 1.

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<td>Tinospora bakyis</td>
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<td>Abdelrahman, 2011</td>
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<tr>
<td>Artemisia myrrhaeae</td>
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<tr>
<td>Heanastophis barteri</td>
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<tr>
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<tr>
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<td>Onotu et al., 2014a</td>
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<tr>
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<td>Antia et al 2009</td>
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<tr>
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<td>Inabo and Fathuddin, 2011</td>
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<tr>
<td>Senna occidentalis</td>
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<td>Mustapha et al., 2013</td>
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<td>T. brucei brucei</td>
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<td>Wurochekke and Nok, 2004</td>
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<td>Onotu et al 2014b</td>
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Conclusion
It is clear that medicinal plants play a prominent role against various human and animal diseases. A variety of medicinal plants and plants extracts have been reported for their significant anti-trypanosomal activity. This review represents an overview of the potentials of these plants in combating the disease. Different plants traditionally used for the disease. Different plants traditionally used for the management of African animal trypanosomiasis were evaluated in \textit{in vitro} and \textit{in vivo} study. Mode of action of the plants or their active ingredient is almost not studied in detail. The review concluded that flora is a potential suitable initial point to discover new and efficacious trypanocidal drug.

References


Shaba P, Pandey NN, Sharma OP, Rao JR, Singh RK. In vitro trypanocidal activity of methanolic extracts of...


