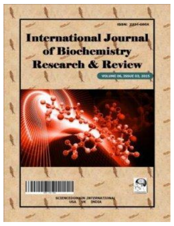


International Journal of Biochemistry Research & Review
7(2): 45-79, 2015, Article no.IJBcRR.2015.056
ISSN: 2231-086X

SCIENCEDOMAIN ***international***
www.sciencedomain.org

SCIENCEDOMAIN

African Natural Products with Potential Anti-trypanosomal Properties: A Review

L. Bashir[1*], O. K. Shittu[1], S. Sani[2], M. B. Busari[3] and K. A. Adeniyi[4]

[1]*Tropical Disease Research Unit, Department of Biochemistry, Federal University of Technology, P.M.B.65, Minna, Nigeria.*
[2]*Department of Biochemistry, Federal University Ndufu-Alike Ikowo Abakaliki, Ebonyi State, Nigeria.*
[3]*Center for Genetic Enginnerring and Biotechnology, Global Institute for Bioexploration Unit, Federal University of Technology, P.M.B.65, Minna, Nigeria*
[4]*Applied Parsiitology and Entomology Unit Department of Biological Science, Federal University of Technology, P.M.B.65, Minna, Nigeria.*

Authors' contributions

This work was carried out in collaboration between all authors. Authors LB and author OKS designed the study, wrote the protocol and final editing of the manuscript. Author LB did the literature search and wrote the first draft of the manuscript. Author OKS supervised the work. Author SS, MBB and KAA took part in the literature search, undertook the initial editing and took part in final editing of the paper. All authors read and approved thefinal manuscript.

Article Information

DOI: 10.9734/IJBcRR/2015/16039
Editor(s):
(1) Chunying Li, Department of Biochemistry and Molecular Biology, Wayne State University, School of Medicine, Detroit, USA.
Reviewers:
(1) Anonymous, Brazil.
(2) Anonymous, Brazil.
(3) Anonymous, Nigeria.
Complete Peer review History: http://www.sciencedomain.org/review-history.php?iid=1037&id=3&aid=8778

Review Article

Received 1st January 2015
Accepted 14th March 2015
Published 13th April 2015

ABSTRACT

Ethnopharmacological Relevance: Africa is considered to be the cradle of mankind with a rich biological and cultural diversity marked regional difference in healing practices. Natural product of Africa represents a constant interest as sources of health remedies, nutrition and cosmetic formulations. African trypanosomiasis is one of the neglected tropical diseases caused by fly-borne protozoa known as trypanosomes that affect both human and livestock with devastating consequences. Chemotherapy of African trypanosomiasis is unsatisfactory for various reasons including unacceptable toxicity, poor efficacy, undesirable route of administration and drug

**Corresponding author: E-mail: bashirlawal12@gmail.com;*

resistance. In this regards, the last few decades have witnessed a surfeit of investigations which have been geared to investigate the effect of common traditionally-used medicinal plants/insect in alleviating the cellular changes produced during trypanosome infection.

Major Objective: This review presents the profiles of African natural product (plants and insect) with anti-trypanosomal properties, reported in the literature.

Methodology: Literature was collected from published articles (through electronic search), thesis, Proceedings as well as book of abstract that report on the in vitro or in vivo anti-trypanosomal activity of plants, insects and their products.

Results: A total of 215 plants pecies from 82 families were found. While two herbal formulation and three insect/there product were reviewed for invivo anti-trypanosomal activity Furthermore, some of the plants were investigated for possible ameliorative effects on the trypanosome-induced pathological changes. Phyto- chemistry studies of the anti-trypanosomal plants led to the isolation of 96 specific bioactive anti-trypanosomal compounds from different parts of the plants

Conclusion: It is clear that these reviews provide strong evidence of the potential beneficial effects of phytotherapy in the traditional management of trypanosomiasis, which could be subsequently developed into a cost effective alternative medicine to complement treatment of trypanosomiasis.

Keywords: Africa; trypanosomiasis; natural product; plants; insect.

1. INTRODUCTION

Human African trypanosomiasis (HAT) also known as sleeping sickness is a fatal, fly-borne neuro-inflammatory disease caused by two agents (protozoa), *T. brucei gambiense* which is responsible for chronic form of HAT in West and Central Africa, and *T. brucei rhodesiense*, the etiological factor for the acute form of the disease in East Africa (Fig. 1). The parasites are transmitted by the bite of infected tsetse flies (*Glossina* spp.) [1]. Over 60 million people living in 36 countries are threatened with sleeping sickness and the estimated number of cases is thought to be between 300,000 and 500,000 [2]. In Latin America, infection with *T. cruzi* is responsible for Chagas' disease, which is the leading cause of heart disease [3]. Nearly 90 million people in 19 endemic countries are at risk of contracting Chagas' disease and 16 million people are already infected [4].

Animal trypanosomiasis is caused by *T. brucei*, *T. evansi*, *T. congolense* and *T. vivax* [5]. The disease distributed over approximately 25 million 2 km in Africa. It is a major factor retarding the growth of the livestock industry in Africa [2], and it has constituted a major obstacle to the economic development and thus an important priority for biomedical and public agencies, agricultural sector and the scientific community [6].

Although, the increasing trend of HAT cases has been reversed and not more than 50 cases of HAT are diagnosed yearly outside Africa [7], effective and satisfactory chemotherapy has not been found against the causative agents; *T. brucei rhodesiense* and *T. brucei* gambiense therefore new epidemics of this disease could appear [8].

Nature has presented to humanity the gift of biological and cultural diversity of natural product for healing practices. African traditional healing practices are holistic involving both the body and the mind. The traditional healer typically diagnoses and treats the psychological basis of an illness before prescribing medicines to treat the symptoms [9]. The vast majority of people (80% of the world‘s population) still rely chiefly on their traditional materia medica (medicinal plants and other materials) for their primary health care needs [9]. In sub-Saharan Africa, the ratio of traditional healers to the population is 1/500, while that for medical doctors to the population is 1/40 000 ([10]. This is as a result of the high cost of Western pharmaceuticals and health care, or because the traditional medicines are more acceptable from a cultural and spiritual perspective [11]. It is also a fact that one quarter of all medical prescriptions are formulations based on substances derived from natural origin. Natural products also benefit from containing many specific molecular principles in their natural state, which possess a variety of influences on human physiological and biochemical systems, as opposed to purified synthetic drugs which are based on a single molecular substance derived from the natural product [12].

In this regards, the last few decades have witnessed a surfeit of investigations which have been geared to investigate the effect of common traditionally-used medicinal plants in alleviating the cellular changes in vivo produced during the T.b. brucei infections of animals. In Africa, a number of medicinal plants used in the traditional management of trypanosomiasis have been screened and showed both siginificant in vitro /in vivo anti-trypanosomal activity. In addition to herbal plant, researchers (Ekanem and Yusuf, [13;14]: Shittu and Elekwechi, [15], Shittu and Bashir, [16] targeted finding new anti-trypanosomal agents to combat the trypanosomomiasis by screening extracts from insect and their products.

At present, the available review on anti-trypanosomal agents focus only on medicinal plants [17], synthectic chemicals [18], chemistry aspect with little or no information on the plants [19]. This review article has been presented to enumerate some indigenous plants/insect with potential in *vivo or/and in vitro* anti-trypanosomal properties. This could be used as an updated source for recent progress in the identification of promising agents with selective, trypanocidal activity that can serve as novel lead compounds for effective anti-trypanosomal chemotherapy. Furthermore, this review may serve as a motivator and reference point for researchers who are working day and night to find a divine solution to this disease.

2. METHODS

A systematic study was carried out through a computer search of data on PubMed, Sciencedirect, Sciencedomain, Medline and Google Scholar from published articles using key words (trypanosomiasis; Africa; ethnobotany; anti-trypanosomal activity; medicinal insects and their products; medicinal plants; plant extracts; active compounds; and mode of action). Data was also obtained from thesis, proceedings as well as book of abstract that report on the in vitro or in vivo anti-trypanosomal activity of plants/insect and there product that were collected from different parts of Africa. Data presented including the scientific name, family, methodology used, the degree of activity of the plant and insect. However anti-trypanosomal plants whose levels of activity were not indicated by the authors were excluded.

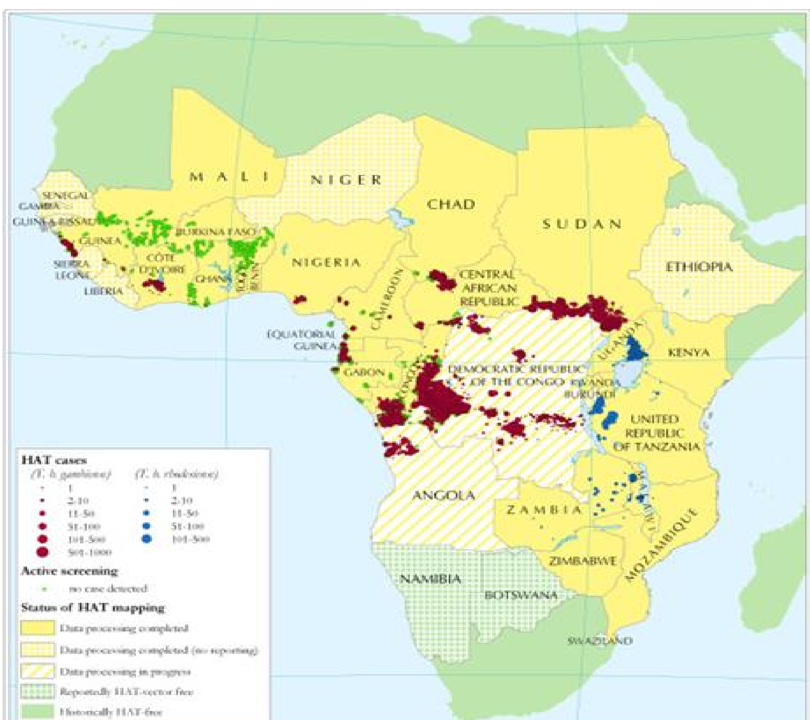


Fig. 1. The distribution and burden of trypanosomiasis in Africa; the map follows the expected lines of demarcation for the occurrence of *T. brucei* gambiensis and *T. brucei rhodesiense*, and also suggest a high occurrence of disease. However the case in this map only includes those that were reported or captured and so comprise a minority of the total case

3. RESULTS

Tables 1-6 show the review datas on scientific name, Family, Part (s) used Extract/fraction, Model, Parasite IC_{50} or MIC (µg/mL), Country, References of African natural products with anti-trypanosomal property. A total of 215 plants species from 82 families were found. Plants from Asteraceae (13.0%), Leguminosae (6.19%), Anacadaceae (4.28%), Maliaceae (4.28%), Fabaceae (3.80%), Rubiaceas (3.33%) and Euphoraceae (3.33%) families have received more scientific attention than others. A total of 104 plants from 55 family (in vitro) and 36 plants from 16 family (in vivo) were found in west Africa, a total 68 plant from 14 family (in vitro) and 7 plants from 5 family (In vivo) were found in east African, a total 42 plant from 21 family (Invivo) were found in southern African, a total 5 plant from 5 family (Invivo) were found in central African, 1 plant from 1 family (in vitro) and 3 plants from 3 family (in vivo) were found in north Africa While two herbal formulation and three insect/their product were reviewed for invivo anti-trypanosomal activity. Phyto-chemistry studies of the anti-trypanosomal plants led to the isolation of 96 specific anti-trypanosomal compounds from different parts of the plants (Table 7).

4. DISCUSSION

Different techniques used in assessment of anti-trypanosomal activities present problems associated with comparing the trypanocidal potency of the plants reviewed in this study. Some aurthors presented there results minimum inhibitory concentration (MIC), mean lethal dose 50 (IC_{50}) and % inhibition of parasite motility in vitro. However, IC_{50} values of 20µg/mL are considered good activity while IC_{50} values of 21–60 and 61–100 µg/mL are considered moderate and low activities respectively. Any IC50>100µg/mL are considered ineffective [20]. Furthermore, Atawodi et al. [21] and Maikai et al. [22], corroborated the report of Kaminsky et al. [23], showing that parasite motility is a reliable index for determining anti-trypanosomal activity of crude plant extracts.

4.1 Anti-trypanosomal Activity of West African Plant

A total of 35 West Africa plant shows good anti-trypanosomal activity IC_{50} (<20 µg/mL). The most interesting results were those of *Alcornea cordifolia, Maytenus laevis, Lantana ukambensis, Crataeva religiosa and Ocimum gratissimum* with IC_{50} (µg/mL) 0.2, 0.62, 1.5, 1.6 and 1.66 respectively. The high activity values obtained for these plants render them candidates for the isolation of anti-trypanosomal compounds which could be developed into new lead structures for drug development. 19 West Africa plant shows moderate anti-trypanosomal activity IC_{50} (21-60 µg/mL), while 4 plants shows low anti-trypanosomal activity IC_{50} (61-100 µg/mL). Furthermore, 18 of the plants were reported to inhibit the parasite motililty in less than 30 minute at 4mg/ml. The most interesting result is *Securidaca longepedunculata* (5 minute) while extracts from 23 West African plants inhibit the parasite motililty within 31-60 minute at 4mg/ml. However, methanol extracts of *T. globiferus, G. latifolium* at 10 mg/ml ceases the parasite motility in less than 10 min [24], while other were reported not to be active. According to Atawodi et al. [21], statement on trypanocidal activity of a plant extract should be made in the context of the method and solvent of extraction. Different extracts from some of the plant reviewed demonstrated different degree of trypanocidal property for instance DCM extracts of *Acanthospermum hispidum, Byrsocarpus coccineus, Byrsocarpus coccineus, Carpolobia lutea* and *Keetia leucantha* shows good trypanocidal activity while the methanol and aqueous extracts shows moderate or low trypanocidal activity. In contrast, methanol and aqueous extracts of *Dialium guineense* shows a moderate activity while DCM extract was inactive [20]. The variation in the trypanocidal activities of these plants may be attributed to the variation in the availability and amounts of phytoconstituents in the extracts. Phytoconstituents such as flavonoids, alkaloids, terpenes, quinones, polyphenols, Triterpenoids and sterols are the most fre-quently implicated phytochemicals in the plants extracts. A total of abaut 47 specific anti-trypanosomal compounds were isolated from different parts of the West African plants (Fig. 2). The most active compounds were Citronellal (IC_{50} 2.76 µg/mL), myrcene (IC_{50} 2.24 µg/mL), limonene (IC_{50} 4.24 µg/mL), isolated from *Ocimum gratissimum* seed oil [25], erythrodiol, (IC_{50} 5.30 µg/mL), betulin (IC_{50} 4.0 µg/mL), 24 hydroperoxy-24-vinylcholesterol (IC_{50} 3.20 µg/mL), from *Strychnos spinosa* [26]. The DNA intercalation in com-bination with portion biosynthesis inhibition is reported to be the mechanism of action responsible for the observed antitry-panosomal effect of most of these compounds [27]. Extract from different part of plants also exhibit different degree of trypanocidal activity for instance methanol and aqueous extracts of *Keetia leucantha* twig show a low activity [20], while the oil extracted from the leaf show a good activity [28], this observation might be due to variations in geographical location, time or period of collection and chemical constituents [19].

4.2 Anti-trypanosomal Activity of Southern African Plants

Appreciable numbers of plant, as well as bioactive compounds were found to have been investigated for in vitro anti-trypanosomal activity in south African. Among the south Africa medicinal plants screened for trypanocidal activity against *T.b. rhodesiense*, dichloroethane leaves extract of *Abrus precatorius* was found to be the most potent with an IC_{50} value 0.01 µg/mL. Similarly, DCM extracts of *Hypericum aethiopicum* was found to be active with an IC_{50} value 4.47 µg/mL followed by *Vernonia oligocephala* with an IC_{50} value 4.67 µg/mL while *Alepidea amatymbica* was the least effective with an IC_{50} value 73.1 µg/mL [29]. Further more among 10 South African plants rescently evaluated against *T. brucei rhodesiense*, DCM extractof *Psoralea pinnata l*eaves was found to be the most potent with an IC_{50} value 0.15 µg/mL [30].

Different parts of the same plants, same plants of different origin as well as different solvents extracts show different anti-trypanosomal activity. For instance, *Abrus precatorius* from West Africa showtrypanocidal activity with IC_{50} value of 17.9 ug/ml [31], against *T. brucei rhodesiense* while the same plant from southern Africa had IC_{50} value of 0.01 ug/ml [32]. Fruit extract of *Ekebergia capensis* had IC_{50} value of 11.5 ug/ml against *T. cruzi* while the root extract of the same plants had IC_{50} value of 1.36 ug/ml against *T.b. rhodesiense* [29], As said earlier, the variation in the trypanocidal activities of these plants may be attributed to the variation in the availability and amounts of phytoconstituents in the extracts. Among the specific bioactive compounds isolated from south Africa plant were Abruquinone A, B, D, G, H, I, J, K, L and 7, 8, 3′, 5′-tetramethoxyisoflavan-1′,4′-quinone from whole plant of *Abrus precatorius* [32,33], schkuhrin I and II from *Schkuhria pinnata*, cynaropicrin from the leaves of *Vernonia mespilifolia* [30], and putranoside A from stem of *Drypetes gerrardii* [33]. All the bioactive compounds isolated show a potent trypaocidal activity with an IC_{50} less than 1 ug/ml against *T. b. rhodesiense,* except schkuhrin II, Abruquinones J and putranoside A with IC_{50} of 1.5, 11.2 and 8.0 ug/ml respectively. The compounds were also found to be more effective against *T. b. rhodesiense* than T. cruzi, for instance schkuhrin I had IC_{50} of 0.18 ug/ml against *T. b. rhodesiense* and 16.4 ug/ml against *T. cruzi* while schkuhrin II had IC_{50} of 1.50 ug/ml against *T. b. rhodesiense* and 26.9 ug/ml against *T.cruzi* [30]. Although, a considerable numbers of medicinal plants from this region have been investigated and were found active against trypanosome parasite, there exit a very few researchers on the subject matter, researchers in this region of Africa are therefore encourage to intensify studies on the trypanocidal potency of their natural flora.

4.3 Anti-trypanosomal Activity of Central African Plants

A very little imformation on trypanocidal potency of medicinal plant from central Africa were obtained from literature. Five medicinal plants from central africa have been reported to exhibit activities in vitro include *Garcinia lucida*, [34] *Aframomum letestuanum* [35], *Vernonia guineensis* with IC_{50} ranged of 3–5 mg/ml [36], *Enanatia chlorantha* (1.87 µg/ml), *Isolona hexaloba* (1.95 µg/ml) and *Quassia Africana* (1.88 µg/ml) [37]. The bioactive agents isolated from these region include Letestuianin A (IC_{50} >100 µg/ml), Letestuianin B (IC_{50} 67 µg/ml), Letestuianin C (IC_{50} 2.6 µg/ml) and 5-hydroxy-1,7-bis (4- hydroxyphenyl) hepta-4,6- dien-3-one (IC_{50} 2.6 µg/ml) isolated from DCM seed extract of *Aframomum letestuanum* they demonstrate activity against *T. brucei brucei* [35]. Furthermore 4 bioactive agents including, 6-acetonyldihydrochelerythrine (IC_{50} 3.9 µg/ml), Dihydrochelerythrine (IC_{50} 0.8 µg/ml), Lucidamine A (IC_{50} 14.1 µg/ml), Lucidamine B (IC_{50} 4. [34,36] isolated vernoguinoside and vernoguinosterol from stem bark of *Vernonia guineensis* both compound demonstrated significant trypanocidal activity against *T. brucei rhodesiense* with an IC_{50} range of 3–5 mg/ml.

Table 1. ***In vitro*** **anti-trypanosomal activity of West African plant**

Scientific name	Family	Part (s) used	Extract/fraction	Parasite	IC50 MIC (µg/mL)	Motility of the parasite	Country	Authors
Abrus precatorius	papillionaceae	Leaf	Chloroform fraction	T. b. r	17.9 ug/ml	-	Nigeria	Saganuwan et al. [31]
Acacia artaxacantha	Leguminosae	Stem bark/ root	n-Hexane/ethanol	T. b. b/ T. co	Btw 13 and 69 ug/ml	-	Nigeria	Adewunmi et al. [38]
Acanthospermum hispidum	Asteraceae	Aerial part	DCM/ Methanol / Aqueous	T. b. b	14.5/47.5/54.8	-	Benin	Bero et al. [20]
Adansonia digitata	Bombacaceae	Leaf	Aqueous	T. b. b	-	4mg/ml@ 40mint	Nigeria	Atawodi, [39]
Adenium obesum	Apocynaceae	Root	Pet. Ether	T. b. b	-	4mg/ml@ 35mint	Nigeria	Atawodi, [39]
Afrormosialaxiflora	Leguminosae	Leaf	Pet. Ether	T. b. b	-	4mg/ml@ 20mint	Nigeria	Atawodi, [39]
Afzelia africana	Leguminosae	Leaf/ Stem bark	Pet. Ether	T. b. b	-	4mg/ml@ 30mint	Nigeria	Atawodi, [39]
Albuca spp	Asparagaceae	Bulb	Aqueous	T. b. b	-	4mg/ml@ 55mint	Nigeria	Atawodi, [39]
Alcornea cordifolia	Euphorbiaceae	Bark/Leaf	Methanol	T. b. b	<0.2	-	Nigeria	/Adewunmi e t al. [38]
Ampelocissus grantii	Vitaceae	Aerial part	DCM	T. b. b	500	-	BurkinaF aso	Aderbauer et al. [40]
Anchomanes difformis	Araceae	Rhizome	Methanol	T. b. b/ T. co	13.87 ug/ml	45 min at 4 mg/ml	Nigeria/B enin	Atawodi et al. [41] Bero et al. [20]
Anchomanes difformis	Araceae	Root	DCM/ Methanol / Aqueous	T. b. b	50.7/14.7/13.8		Benin	Bero et al. [20]
Annona senegalensis	Annonaceae	Root	Pet. Ether	T. b. b	-	4mg/ml@ 35mimt	Nigeria	Atawodi [39]
Anthocleista vogelii	Loganiaceae	Root bark	Aqueous/ Ethanolic	T. b. b	-	100% activity@ 20mg/ml	Nigeria	Abu et al. [42]
Baillonella toxisperma		Barks	Ethanol	T. r	9.6 µg/ml	-	Bénin	Lagnika et al. [43]
Balanites aegyptiaca	Balanitaceae	Stem bark/ Shoot	Aqueous/ DCM	T. b. b	500/50	-	Nigeria/ BurkinaF aso	Wurochekke and Nok [44]/Aderbauer et al. [40]
Blighia unijugata	Sapindaceae	leaf	Aqueous/ethanolic	T. b. b	-	No acivity @40mg/ml	Nigeria	Abu et al. [42].
Boswellia dalzielii	Burseraceae	leaves	Ethanol/Methanol	T. r	9.6 µg/ml	-	Bénin/ Nigeria	Lagnika et al. [43]
Brassicaoleracea	Brassicaceae	Leaf	Methanol	T. e	-	1000 µg/ml	Nigeria	Shaba et al. [45]
Bridelia ferruginea	Euphorbiaceae	Stem bark	methano	T. b. b	-	4mg/ml@ 35mimt	Nigeria	Atawodi, [39]
Byrsocarpus coccineus	Connaraceae	Aerial part	DCM/ Methanol / Aqueous	T. b. b	14.7/21.1/49.5		Benin	Bero et al. [20]
Canarium schweinfurthii	Burseraceae	Stem bark	Pet. Ether/Chloroform	T. b. b	-	4mg/ml@ 30/35mimt	Nigeria	Atawodi, [39]
Carpolobia lutea	polygalaceae	Aerial part	DCM/ Methanol / Aqueous	T. b. b	18.3/>100/>100	-	Benin	Bero et al. [20]
Cassia siamae	Leguminosae	Leaf/ Stem bark/ Root	Aqueous/hexane/ ethylacetate	T. b. b	25.8/ 10.19/ 46.50	-	Nigeria	Abiodun et al. [46]

Scientific name	Family	Part (s) used	Extract/fraction	Parasite	IC50 MIC (µg/mL)	Motility of the parasite	Country	Authors
Cassia sieberiana	Caesalpiniaceae	leaf	DCM	T.b. b	> 19	-	Nigerian	Hoet et al. [47]
Cassytha filiformis	Lauraceae	Leaf	Pet. Ether	T. b. b	-	4mg/ml@ 20mimt	Nigeria	Atawodi, [39]
Cassytha sp.	Lauraceae	Leaves	Methanol	T. b. b	-	25min at 4mg/ml	Nigeria	Atawodi et al. [41]
Ceiba pentandra	Bombacaceae		DCM	T. b. b	200	-	BurkinaF aso	Aderbauer et al. [40]
Clerodendrom capitatum	Stem bark	Root	n-Hexane/ethanol	T. b. b/ T. co	Btw 13 and 69 ug/ml	--	Nigeria	Adewunmi et al. [38]
Cochlospermum planchonii	Cochlospermaceae	Root/leaf	Pet. Ether	T. b. b	-	4mg/ml@ 20/40mint	Nigeria	Atawodi, [41]
Crataevareligiosa	Capparaceae	Leaves	cyclohexane	T. r	1.6 µg/ml		Bénin	Lagnika et al. [43]
Crateva adansonii	Capparaceae	Leaves	crude hexane	T.b. b	12.5 µg/ml		Nigeria	John et al. [48]
Cussonia arborea	Araliaceae	Root /stem	Aqueous/ Ethanolic	T.b. b	-	No activity @ 40mg/ml	Nigeria	Abu et al. [42]
Cymbopogon nardus	Poaceae		Methanol	T. b. b	0.31 µg/mL		Nigeria	John *et al.,* [52]
Dialium guineense	Leguminosae	Aerial part	Dcm/ Methanol / Aqueous	T. b. b	>100/42.3/52.0	-	Benin	Bero et al. [20]
Diospyros mespiliformis	Ebenaceae	Leaf	chloroform	T. b. b	-	4mg/ml@ mint45	Nigeria	Atawodi, [41]
Dissotis rotundifolia	Melastomataceae	Leaf	Ethanol	T. b. b	-	100% activity@ 800mg/kg	Nigeria	Mann et al. [49]
Erythrophleum suaveolens	Leguminosae	Stem bark	Pet. Ether	T. b. b	-	4mg/ml @40mimt	Nigeria	Atawodi, [41].
Eucalyptus citriodora	Myrtaceae	Leaf	aqueous	T. b. b	-	0.4 g/mL@2mimt	Nigeria	Habila et al. [50]
Eugenia uniflora	Myrtaceae	Leaf	n-Hexane/ethanol	T. b. b/ T.co	-	Btw 13 and 69 ug/ml	Nigeria	Adewunmi et al. [38]
Euphorbia hirta	Euphorbiaceae	Leaf	ethylacetate	T. b. r	8.70	-	Nigeria	Abiodun et al. [46]
Ficus platyphylla	Moraceae		Methanol	T. b. b	25	-	Burkina Faso	Sawadogo et al. [51]
Ficus sycomorus		Stem	Methanol	T. b. b	-	4mg/ml @60mimt	Nigeria	Atawodi, [41]
Gardenia erubescens	Rubiaceae	Leef/stem bback	Aqueous/ Ethanolic	T. b. b	-	100% activity@ 20mg/ml	Nigeria	Abu et al. [42]
Gongronema latifolium	Asclepiadaceae.	Stem bark	Methanol	T. b. b	-	15 min at 10 mg/ml	Nigeria	Josephine et al. [24]
Haematostaphis barteri	Anacardiaceae.	Leaves	aqueous	T.co	-	40 minutes @ 0.25 mg	Nigeria	Wurochekke et al. [53]
Heliotropium indicum	Boraginaceae	Aerial part	Dcm/ Methanol / Aqueous	T. b. b	58.3/80.2/>100	-	Benin	Bero et al. [20]
Hymenocardia acida	Hymenocardiaceae	Root bark /stem bback	Aqueous/ Ethanolic	T. b. b	-	100% activity@ 2.5mg/ml	Nigeria	Abu et al. [42]
Hymenocardia acida	Hymenocardiaceae	Twig and leaf	DCM	T.b. b	≤19 µg/ml	-	Nigerian	Hoet et al. [47]
Keetia leucantha	Rubiaceae	Leaf	essential oil	Bloodstrea m/procyclic	20.90/>100 ug/ml	-	Nigerian	Bero et al. [28]

Scientific name	Family	Part (s) used	Extract/fraction	Parasite	IC50 MIC (µg/mL)	Motility of the parasite	Country	Authors
				forms of *T. brucei*				
Keetia leucantha	Rubiaceae	Twig	DCM/ METHANOL / AQUEOUS	T. b. b	5.8/53.1/86.9	-	Nigerian	Bero et al. [20]
Khaya senegalensis	Meliaceae	Stem bark/leaves	Ethanolic/Methanol / Ethanol	T. r	300 µg/ml/9.6 µg/ml	35 min at 4 mg/ml	Nigeria/ Bénin	Bulus and Addau, [54], Atawodi et al. [21], Lagnika et al. [43]
Lannea kerstingii	Anacardiaceae	Leaf	Methanol	T. b. b		4mg/ml@40min	Nigeria	Atawodi, [41]
Lannea welwistchii	Anacardiaceae	Leaf	Aqueous	T. b. b	6.3 mg/ml(mic)	-	Nigeria	Antia et al. [55]
Lantana ukambensis	Verbenaceae		Methanol	T. b. b	1.5	-	Burkina Faso	Sawadogo et al. [51]
Lawsonia inermis		Root	Methanol	T. b. b	-	4mg/ml@45min	Nigeria	Atawodi, [41]
Lonchocarpus laxiflorus		Stem	Methanol	T. b. b	-	4mg/ml@30min	Nigeria	Atawodi, [41]
Lophira lanceolata	Ochnaceae	Leef/stem bback	Aqueous/ Ethanolic	T. b. b	-	100% activity@ 20mg/ml	Nigeria	Abu et al. [42]
Magnifera indica	Anacardiaceae	Root	Pet. Ether	T. b. b	-	4mg/ml@30min	Nigeria	Atawodi, [41]
Maytenus laevis	C elastraceae	Root	hexane + ethyl acetate	T. b. b	0.625		Nigeria	John et al. [52]
Momordica balsamina	Cucurbitaceae	Whole plant	Pet. Ether	T. b. b	-	4mg/ml@35min	Nigeria	Atawodi, [41]
Monodora myristica	Annonaceae	Seed	Ethyl acetate		3.12	-	Nigeria	John et al. [52]
Morinda lucida	Rubiaceae		Methanol fractio	T. b. b	6.25-12.5 µg/m	-	Nigeria	Nwakaego, [56]
Moringa oleifera	Moringaceae	Leaf	chloroform	T. b. b	-	4mg/ml@35min	Nigeria	Atawodi, [41]
Nauclea latifolia	Rubiaceae	Leaf	Methanol	T. b. b	-	4mg/ml@30min	Nigeria	Atawodi, [41]
Nauclea pobeguinii	Rubiaceae	Bark	ethyl acetate	T. b. b	6.25	-	Nigeria	John et al. [52]
Ocimum gratissimum	Lamiilaceae	Leaves	ethanol	T. b. b	1.66/1.29 µg/mL	-	bennin	Bénédicta et al. [25]
Ozoroa insignis	Anacardiaceae		Methanol	T. b. b	6.2	-	Burkina Faso	Sawadogo et al. [51]
Parinari curatellifollia	Chrysobalanaceae		Methanol	T. b. b	25	-	Burkina Faso	Sawadogo et al. [51]
Parkia clappertoniana	Leguminosae	Stem bark	Pet.ether	T. b. b	-	50 min at 4 mg/ml	Nigeria	Atawodi, [41]
Pericopsis laxiflora	Loganiaceae	Leaf	DCM	T. b. b	>19 µg/ml		Nigeria	Hoet et al. [47]
Peristrophe bicalyculata	Acanthaceae	Whole plant	aqueous	T. b. b	-	immobilized 90% of the parasites,@ 100mg/kg	Nigeria	Abdulazeez et al. [57]
Picralima nitida	Apocynaceae	Root	Methanol	T. b. b	-	10 min at 4 mg/ml	Nigeria	Ene et al. [58]

Scientific name	Family	Part (s) used	Extract/fraction	Parasite	IC50 MIC (μg/mL)	Motility of the parasite	Country	Authors
Piliostigma reticulatum	Leguminosae	Leaves	aqueous	T. b. b	-	25 min at 4 mg/ml	Nigeria	Atawodi et al. [59]
Prosopis africana	Leguminosae	Leaf	Pet.ether	T. b. b	-	35 min at 4 mg/ml	Nigeria	Atawodi, [41]
Prosopis Africana	leguminaceae	Bark	Methanol	T. b. b	12.5		Nigeria	John et al. [52]
Psidium guajava	Myrtaceae		ethanolic	T. b. b	6.3 μg/mL	-	Nigeria	Oluyomi et al. [60]
Pupalia lappacea	Amaranthaceae	Aerial part	Dcm/ Methanol / Aqueous	T. b. b	52.0/>100/>100	-	Benin	Bero et al. [20]
Saba florida	Apocynceae	Whole plant	Pet.Ether	T. b. b	-	25 min at 4 mg/ml	Nigeria	Atawodi, [41]
Sansevieria liberica	Dracaenaceae	Aerial part	Dcm/ Methanol / Aqueous	T. b. b	60.1/>100/>100	-	Benin	Bero et al. [20]
Schrankia leptocarpa	Leguminosae	Leaf	Dcm/ Methanol / Aqueous	T. b. b	49.2/>100/>100	-	Benin	Bero et al. [20]
Securidaca longepedunculata	Polygalaceae	Root	Methanol	T. b. b	-	5 min at 4 mg/ml	Nigeria	Atawodi et al. [21]
Spondias mombim	Anacardiace	Root	hexane + ethyl acetate	T. b. b	25	-	Nigeria	John et al. [52]
Sterculia setigera	Sterculiaceae	Root bark	Pet.ether	T. b. b	-	25 min at 4 mg/ml	Nigeria	Atawodi, [41]
Stereospermum kunthianum	Bignonianceae	Leef/stem bback	Aqueous/ Ethanolic	T. b. b	-	No activity @ 40mg/ml	Nigeria	Abu et al. [42]
Striga spp.	Orobanchaceae	Leaves	Methanol	T. b. b	-	40 min at 4 mg/ml	Nigeria	Atawodi et al. [21]
Strychnos spinosa	Loganiaceae	Leaf	DCM	T.b. b	≤19 μg/ml	-	Nigerian	Hoet et al. [47]
Syzygium guinense	Myrtaceae	Stem bark	Pet.ether	T. b. b	-	25 min at 4 mg/ml	Nigeria	Atawodi, [41]
Tapinanthus globiferus	mistletoe	Leavea	Methanol	T. b. b	-	10 min at 10 mg/ml	Nigeria	Josephine et al. [24]
Terminalia avicennioides	Combretaceae	Stem bark	hexane + ethyl acetate/ Methanol	T. b. b	2.5	40 min at 4 mg/ml	Nigeria	John et al. [52] Atawodi et al. [211]
Terminalia catapa	Combretaceae	Leaf	hexane + ethyl acetate/ Methanol	T. b. b	17.24/ 7.80/ 1321.	-	Nigeria	Abiodun et al.[46]
Terminalia ivorensis	Combretaceae		n-Hexane/ethanol	T. b. b/ T. co	Btw 13 and 69 ug/ml	-	Nigeria	Adewunmi et al. [38]
Terminalia superba	Combretaceae	Stem	Aqueous	T.b. b	0.8 mg/ml(mic)	-	Nigerian	Antia et al. [55]
Trichilia emetica	Meliaceae	Leaf	DCM	T.b. b	≤19 μg/ml	-	Nigerian	Hoet et al. [47]
Uapaca togoensis	Euphorbiaceae	Root bark /stem bback	Aqueous/ Ethanolic	T.b. b	-	No activity @ 40mg/ml	Nigeria	Abu et al. [42]
Verbascum sinaiticum	Scrophulariaceae	Leaf	Aqueous	T.co	-	60 min at 4 mg/ml	Nigeria	Mergia et al. [61]
Vitex doniana	Lamiaceae	Stem bark	Pet.ether	T. b. b	-	45 min at 4 mg/ml	Nigeria	Atawodi, [41]
Waltheria indica	Sterculiaceae	stem bark	aqueous	. T. b. b	-	1mg/ml @ 25minute	Nigeria	Bala et al. [62]
Withania somnifera	Solanaceae	Whole plant	Ethyl acetate	T. b. b	50.0 ug/ml	-	Nigeria	John et al. [52]
Xeoderris sthulmannii	Fabaceae	Stems, leaves	Methanol	T. b. b	25		Burkina	Sawadogo et al. [51]

Scientific name	Family	Part (s) used	Extract/fraction	Parasite	IC50 MIC (µg/mL)	Motility of the parasite	Country	Authors
							Faso	
Ximenia americana	Olacaceae	Stem bark	aqueous	. T. b. b	-	2mg/ml @ 55minute	Nigeria	Bala et al. [62]

T.b. b =Trypanosoma brucei brucei, T.e =Trypanosomaevansi, T.co =Trypanosomacongolense

Table 2. *In vitro* anti-trypanosomal activity of Southern African plants

Scientific name	Family	Part (s) used	Extract/fraction	Parasite	IC_{50} MIC (µg/mL)	Country	References
Abrus precatorius	Leguminosae	Leaves	CH2Cl2/MeOH (1 : 1)	T. b. r	0.01-17	South Africa	Hata et al. [32]/ Matthias et al. [33]
Acacia erioloba	Fabaceae	Roots	DCM/MeOH (1 : 1)	T. b. r	18.50	South Africa	Mokoka et al. [30]
Agathosma apiculata	Rutaceae	Whole plant	DCM/MeOH (1 : 1)	T. b. r /T. c	11.1/41.5	South Africa	Mokoka et al. [29]
Alepidea amatymbica	Apiaceae	Whole plant	DCM/MeOH (1 : 1)	T. cruzi	20.3/73.1	South Africa	Mokoka et al. [29]
Artabotrys monteiroae	Annonaceae	Leaves	DCM/MeOH (1 : 1)	T. b. r /T. c	10.3/41.3	South Africa	Mokoka et al. [29]
Artemisia afra	Asteraceae	Leaves	DCM	T. b. r /T. c	9.6/27.6	South Africa	Mokoka et al. [29]
Asystasia gangetica	acanthaceae	Leaves	DCM/MeOH (1 : 1)	T. b. r /T. c	13.2/74.7	South Africa	Mokoka et al. [29]
Catha edulis	Celastraceae	Root	DCM	T. b. r /T. c	14.2/19.1	South Africa	Mokoka et al. [29]
Clausena anisata	Rutaceae	Roots	DCM/MeOH (1 : 1)	T. b. r	7.19	South Africa	Mokoka et al. [30]
Conyza albida	Asteraceae	Whole plant	DCM/MeOH (1 : 1)	T. b. r /T. c	18.8/38.3	South Africa	Mokoka et al. [29]
Conyza podocephala	Asteraceae	Whole plant	DCM/MeOH (1 : 1)	T. b. r /T. c	13.9/47.2	South Africa	Mokoka et al. [29]
Conyza scabrida	Asteraceae	Leaves	DCM/MeOH (1 : 1)	T. b. r /T. c	30.0/49.4	South Africa	Mokoka et al. [29]
Croton menyhartii	Euphorbiaceae	Leaves	DCM/MeOH (1 : 1)	T. b. r /T. c	11.7/33.3	South Africa	Mokoka et al. [29]
Cymbopogon validus	Poaceae	Leave	DCM/MeOH (1 : 1)	T. b. r /T. c	11.9/47.1	South Africa	Mokoka et al. [29]
Drypetes gerrardii	Meliaceae	Stems/leaves	DCM/MeOH(1 : 1)	T. b. r	7.31/12.1	South Africa	Mokoka et al. [30]
Ekebergia capensis	Meliaceae	Fruit/root	DCM/MeOH (1 : 1)	T. b. r /T. c	11.5/24.4/1.36	South Africa	Mokoka et al. [29], Mokoka et al. [30]
Euclea natalensis	Ebenaceae	Roots	DCM/MeOH (1 : 1)	T. b. r /T. c	28.1/43.7	South Africa	Mokoka et al. [29]
Eucomis autumnalis	Asparagaceae	Flowers/buds	DCM	T. b. r /T. c	37.1/29.7	South Africa	Mokoka et al. [29]
Helichrysum nudifolium	Asteraceae	Whole plant	DCM/MeOH (1 : 1)	T. b. r /T. c	33.1/43.9	South Africa	Mokoka et al. [29]
Hypericum aethiopicum	Hypericaceae	Leaves	DCM/MeOH (1 : 1)	T. b. r /T. c	4.47/18.1	South Africa	Mokoka et al. [29]
Leonotis leonurus	Lamiaceae	Leaves	DCM/MeOH (1 : 1)	T. b. r /T. c	14.7/50.1	South Africa	Mokoka et al. [29]
Leonotis ocymifolia	Lamiaceae	Leaves	DCM	T. b. r /T. c	9.1/63.5	South Africa	Mokoka et al. [29]
Maytenus undata	Celastraceae	Roots	DCM	T. b. r /T. c	35.2/28.4	South Africa	Mokoka et al. [29]
Oedera genistifolia	Asteraceae	Whole plant	DCM/MeOH(1 : 1)	T. b. r	4.38	South Africa	Mokoka et al. [30]
Ozoroa sphaerocarpa	Anacardiaceae	Whole plant	DCM	T. b. r /T. c	10.90	South Africa	Mokoka et al. [30]
Pappea capensis	Sapindaceae	Roots / leaves	DCM/ DCM/MeOH (1 : 1)	T. b. r /T. c	15.4/14.10	South Africa	Mokoka et al. [30]
Pentzia globosa	Asteraceae	Roots	DCM	T. b. r /T. c	5.76/31.3	South Africa	Mokoka et al. [29]
Plumbago zeylanica	Plumbaginaceae	Leaves	DCM/MeOH (1 : 1)	T. b. r /T. c	13.0/54.5	South Africa	Mokoka et al. [29]
Psoralea pinnata	Fabaceae	Leaves	DCM/MeOH(1 : 1)/DCM	T. b. r	0.15/0.31	South Africa	Mokoka et al. [30]
Ptaeroxylon obliquum	Rutacea e	Leaves	DCM	T. b. r /T. c	11.3/41.5	South Africa	Mokoka et al. [29]

Scientific name	Family	Part (s) used	Extract/fraction	Parasite	IC_{50} MIC (µg/mL)	Country	References
Rauvolfia caffra	Apocynaceae	Roots	DCM	T. b. r /T. c	17.9 /41.1	South Africa	Mokoka et al. [29]
Salvia repens	Lamiaceae	Whole plant	DCM/MeOH (1 : 1)	T. b. r /T. c	10.8/ 36.2	South Africa	Mokoka et al. [29]
Schefflera umbellifera	Araliaceae	Roots	DCM/MeOH (1 : 1)	T. b. r /T. c	20.9 /57.6	South Africa	Mokoka et al. [29]
Schkuhria pinnata	Asteraceae	Whole plant	DCM/MeOH (1 : 1)	T. b. r /T. c	2.04	South Africa	Mokoka et al. [30]
Setaria megaphylla	Poaceae	Whole plant	DCM/MeOH (1 : 1)	T. b. r /T. c	16.8 /43.9	South Africa	Mokoka et al. [30]
Tarchonanthus camphorates	Asteraceae	Whole plant	DCM/MeOH (1 : 1)	T. b. r /T. c	3.93 /18.6	South Africa	Mokoka et al. [30]
Turraea floribunda	Meliaceae	Bark/leave	DCM/MeOH (1 : 1)	T. b. r /T. c	24.4/ 17.10	South Africa	Mokoka et al. [30]
Vernonia hirsuta	Asteraceae	Whole plant	DCM/MeOH (1 : 1)	T. b. r /T. c	18.1 /43.0	South Africa	Mokoka et al. [29]
Vernonia mespilifolia	Asteraceae	Leaves	DCM/MeOH (1 : 1)	T. b. r /T. c	1.01	South Africa	Mokoka et al. [30]
Vernonia natalensis	Asteraceae	Whole plant	DCM/MeOH (1 : 1)	T. b. r /T. c	12.6/ 39.3	South Africa	Mokoka et al. [29]
Vernonia oligocephala	Asteraceae	Leaves	DCM	T. b. r /T. c /	4.67 /14.3	South Africa	Mokoka et al. [29]

T.b. b =Trypanosoma brucei brucei; T.e =Trypanosomaevansi; T.co =Trypanosomacongolense

Table 3. *In vitro* anti-trypanosomal activity of central African plants

Scientific name	Family	Part (s) used	Extract/fraction	Parasite	IC_{50} MIC (µg/mL)	Country	References
Vernonia guineensis	Asteraceae	Stem bark	Ethanol	*T. b.r*	3–5 mg/ml	Cameroon	Joseph et al. [36]
Aframomum letestuanum	Zingiberaceae	Seed	DCM	T.b.b./T.b.r	2.6	Cameroon	Kamnaing et al. [35]
Enanatia chlorantha	Annonaceae	Stem bark	Methanol	*T. c*	1.87	Republic of Congo	Musuyu et al. [37]
Isolona hexaloba	Annonaceae	Stem bark	Methanol	T.b.b.	1.95 µg /ml,	Republic of Congo	Musuyu et al. [37]
Quassia africana	simaroubaceae	Root bark	Methanol	*T.c*	1.88µg/ml	Republic of Congo	Musuyu et al. [37]

T.b.b =Trypanosoma brucei brucei; T.e =Trypanosomaevansi; T.co =Trypanosomacongolense

Table 4. *In vitro* anti-trypanosomal activity of North African plants

Scientific name	Family	Part (s)	Extract/fraction	Parasite	IC_{50} MIC (µg/mL)	Country	References
Ageratum conyzoides	Asteraceae	Leaves	n-Hexane/ CH2Cl2	T. b. r	2.4/0.78	sudan	Nour et al. [63]

T.b. b =Trypanosoma brucei brucei; T.e =Trypanosomaevansi; T.co =Trypanosomacongolense

Table 5. *In vitro* anti-trypanosomal activity of east African plant

Scientific name	Family	Part (s) used	Extract/fraction	Parasite	IC50 MIC(µg/mL)	Country	References
Albizia anthelmintica	Fabaceae	Root	Methanol / DCM	T.b.b	49.42/51.09	Tanzania	Nibret et al. [64]
Albizia harveyi	Fabaceae	Root	Methanol / DCM	T.b.b	33.16/85.07	Tanzania	Nibret et al. [64]
Artemisia absinthium	Asteraceae	Aerialpart	Methanol/DCM	T.b.b	27.90/27.05	Ethiopian	Nibret, [65]
Artemisia abyssinica	Asteraceae	Aerialpart	Methanol/DCM	T.b.b	41.76/19.13	Ethiopian	Nibret, [65]
Artemisia afra	Asteraceae	Leah	Methanol/DCM	T.b.b	77.54/25.27	Ethiopian	Nibret, [65]
Artemisia annua	Asteraceae	Leaf	Methanol/DCM	T.b.b	99.44/41.05	Ethiopian	Nibret, [65]
Balanites aegyptiaca	Balantiaceae	Bark	Methanol / DCM	T.b.b	22.11/39.40	Tanzania	Nibret et al. [64]
Cassia abbreviata	Fabaceae	Leaf	Methanol / DCM	T.b.b	54.07/22.14	Tanzania	Nibret et al. [64]
Combretum zeyheri	Combretaceae	Bark	Methanol / DCM	T.b.b	87.45/38.97	Tanzania	Nibret et al. [64]
Entada abyssinica	Fabaceae	Bark	Methanol / DCM	T.b.b	46.39/56.21	Tanzania	Nibret et al. [64]
Entandrophragma bussei	Malaceae	Bark	Methanol / DCM	T.b.b	52.92/14.48	Tanzania	Nibret et al. [64]
Harrisonia abyssinica	Simaroubaceae	Leaf	Methanol / DCM	T.b.b	28.92/22.93	Tanzania	Nibret et al. [64]
Khaya anthotheca	Meliaceae	Seed	Pet. ether	T.b.r	5.72	Uganda	Obbo et al. [67]
Kigelia africana	Bignoniaceae	Leaf	Methanol / DCM	T.b.b	53.24/23.65	Tanzania	Nibret et al. [64]
Lannea humilis	Anacardiaceae	Bark	Methanol / DCM	T.b.b	56.16/75.41	Tanzania	Nibret et al. [64]
Lannea stuhlmannii	Anacardiaceae	Root	Methanol / DCM	T.b.b	44.23/22.24	Tanzania	Nibret et al. [64]
Lonchocarpus capassa	Fabaceae	Leaf	Methanol / DCM	T.b.b	73.80/21.68	Tanzania	Nibret et al. [64]
Securidaca longepedunculata	polygalaceae	Leaf	Methanol / DCM	T.b.b	55.56/11.02	Tanzania	Nibret et al. [64],
Senna singueana	Fabaceae	Leaf	Methanol / DCM	T.b.b	49.09/49.37	Tanzania	Nibret et al. [64]
Solanecio mannii	Asteraceae	Leaf	Methanolic/ dichloromethane extracts	T.b. b	50.58/24.89	Ethiopia	Nibret et al. [64]
Strychnos panganiensis	Loganiaceae	Leaf/stem	ethanol	T.b.r	56/56	Tanznia	Freiburghaus et al.[68]
Strychnos spinosa	Strychnaceae	Leaf	aqueous	T.b.r	2500	Tanzania	Freiburghaus et al. [69]
Teclea trichocarpa	Rutaceae	Leaves	methanol	T.b.r/ Cruzi	>90 /30	Kenya	Mwangi et al. [70]
Terminalia sericea	Combretaceae	Leaf	Methanol / DCM	T.b.b	36.23/21.71	Tanzania	Nibret et al. [64]
Toona ciliata	Meliaceae	Roots	Methanol/chloroformextract	T.b.r	6.95/3.2 µg/ml	kenya	Mercy et al. [71]
Turraea fischeri	Malaceae	Bark	Methanol / DCM	T.b.b	66.14/37.76	Tanzania	Nibret et al. [64]
Vernonia auriculifera	Asteraceae	Root	DCM	T.b.r	9.4	Uganda	Freiburghaus et al. [72]
Vernonia subuligera	Asteraceae	Leaf/root bark	Dichlorometh/petroleum ether	T.b.r	0.6/0.8	Tanzania	Freiburghaus et al. [69]
Warburgia salutaris	Canellaceae	Leaf	Methanol / DCM	T.b.b	45.13/10.68	Tanzania	Nibret et al. [64]
Ximenia americana	Canellaceae	Stem	DCM/methanol	T.b. b	86.64/49.18	Tanzania	Nibret et al. [66]
Ximenia americana	Olaceae	Leaf	Methanol / DCM	T.b.b	86.64/49.18	Tanzania	Nibret et al. [64]
Zanha africana	Sapindaceae	Root	Methanol / DCM	T.b.b	33.53/12.63	Tanzania	Nibret et al. [64]
Zanthoxylum chalybeum	Rutaceae	Leaf	Methanol / DCM	T.b.b	36.00/11.02	Tanzania	Nibret et al. [64]
Zanthoxylum xanthoxyloides	Rutaceae	Leaf/stem	DCM/methanol	T.b.b	36.00/11.02	Tanzania	Nibret et al. [66]

T.b.b =Trypanosoma brucei brucei; T.e =Trypanosomaevansi; T.co =Trypanosomacongolense

Table 6. *In vivo* anti-trypanosomal activity of African plant

Scientific name	Family	Part (s) used	Parasite	Extract	Dose	Model	%inhibition/survival days	Country	References
Thymus vulgaris	Lamiaceae	Leaf	T. b. b	methanol	500 mg/kg	Curative/ suppresive	8 days	Nigeria	Shittu et al. [73]
Acacia nilotica	Mimosaceae	Stem bark	T. b. b	Methanol	200	curative	30 days	Nigeria	Mann et al. [74]
Acalypha wilkesiana	Euphorbiaceae	Leaves	T.bb	aqueous	400 Mg/Kg	curative	2.03/11.00±0.0	Nigeria.	Olukunle et al. [75]
Adamsonia digitata	Malvaceae	Seed	T. b. b	methanol	300 mg/kg	curative	38	Nigeria	Hassan et al. [76]
Allium sativum	Alliaceae	Bulb/Pulp	T. b. b	Methanol/Aceticacid	20 mg/kg	curative	14	Nigeria	Yusuf, [77]/ Peni et al. [78]
Annona senegalensis	Annonaceae	Leaf	T. b. b	methanol	200 mg/kg	curative	20 days	Nigeria	Kabiru et al. [79]
Annona senegalensis+Eucalyptus camaldulensi		Leaf	T. b. b	methanol	200 mg/kg	Combined therapy(1:1)	>90 days	Nigeria	Kabiru et al. [80]
Argemone mexicana	Papaveraceae	Whole plant	T. e	Chloroform/ methanolic	500 mg/kg	curative	15 and 16 days	Sudan	Samia, [81]
Aristolochia bracteolata	Aristolochiaceae	Whole plant	T. e	Chloroform/ methanolic	500 mg/kg	curative	25 and 19 days	Sudan	Samia, [81]
Artemesia annua	Asteraceae		T.b. r	Methanol	5000 mg/kg	curative	15.6	Kenya	Esther et al. [82]
Artemisia abyssinica	Asteraceae	Aerial parts	T.co	dichloromethane	400 mg/kg	curative	40.67 days	Ethiopia	Teka et al. [83]
Artemisia maciverae	Asteraceae	Whole plant	T.b. b	chloroform	100 mg/kg	curative	74.15%	Nigeria	Ene et al. [84]
Artemisia maritima	Asteraceae	Whole plant	T.b. b	chloroform	100 mg/kg	curative	26%	Nigeria	Ene et al. [85]
Azadirachta indica	Meliaceae		T.b. r	dichloromethane	5000 mg/kg	curative	27days	Kenya	Esther et al. [82]
Bombax buonopozense	Bombacaceae	Stem bark	T. b. b	Methanol	300	curative	30 days	Nigeria	Mann et al. [74]
Buchholzia coriacea	Capparaceae	Seed	T.co	Methanol/aeous	500/ 1000 mg/kg	curative	29days/100%	Nigeria	Nweze et al. [86]/ Okere et al. [87]
Citrullus lanatus	Cucurbitaeceae,	Leaf	T.b	aqueous extract	200	curative	97.18%	Nigeria	BIU et al. [88]
Cannabis sativa	Cannabinaceae	Whole plant	T. e	methanol	125/250 mg/kg	curative	> 45days	sudan	Samia et al. [89]
Cucumis metuliferus	Cucurbitaceae	Pulp	T. b. b	methanol	500 mg/kg	currative	47days	Nigeria	Abubakar et al. [90]
Calotropis procera	Asclepiadaceae	Leaf	T. e	Methanol	200 mg/kg	curative		Nigeria	Ibrahim et al. [91]
Dissotis rotundifolia	Melastomataceae	Leaf	T. b. b	ethanol	800 mg/kg	curative	78.4%	Nigeria	Mann et al. [92]

Scientific name	Family	Part (s) used	Parasite	Extract	Dose	Model	%inhibition/survival days	Country	References
Eucalyptus camaldulensis	Myrtaceae	Leaf	T. b. b	methanol	200 mg/kg	Curative	20 days	Nigeria	Kabiru et al. [80]
Garcinia kola	Clusiaceae	Nut	T. b. b	Methanol		Curative		Nigeria	Ogbadoyi et al. 93]
Gongrenema latifolium	Asclepiadaceae	Stem bark	T. co	methanolic	400 mg/kg	Curative	9 days	Nigeria	Abedo et al. [94]
Guiera senegalensis	Combretaceae	Leaf	T. b.	methanol	150	Curative	42%	BurkinaFaso	Aderbauer et al. [40]
Securidaca longepedunculata	Polygalaceae	Root	T. b.	methanol	150	Curative	48%	BurkinaFaso	Aderbauer et al. [40]
Heterotis rotundifolia	Melastomataceae	Whole plant	T. b.	methanol	800	Curative	30	Nigerian	Mann and Obgbadoyi, [95]
Hymenocardia acida	Euphorbiaceae	Root bark	T. b. b	DCM	300 mg/kg	Curative	9days	Nigeria	
Khaya senegalensis	Meliaceae	Stem	T. b. b	DCM	200 mg/kg	Curative	11days	Nigeria	Bulus and Addau, [54]
Kigelia africana	Bignoniaceae	Fruits	T.b. r	DCM	1000 mg/kg	Curative	41.8	Kenya	Esther et al. [82]
Lippia multiflora	Verbenaceae	Leaves	T. b. b	Aqueous	400 Mg/Kg	Curative	3.45%/11.00days	Nigeria.	Olukunle et al. [75]
Morinda morindiodes	Rubiaceae	Root bark	T. b. b	Aqueous	400 Mg/Kg	Curative	6.66 %	Nigeria.	Olukunle et al. [75]
Moringa oleifera	Moringaceae	Stems	T. b. b	Aqueous	200 mg/kg	Curative	30 days	Nigeria	Bulus and Addau, [82]
Ocimum grattissimum	Lamiaceae	Leaves	T.b b	Aqueous	50 Mg/Kg	Curative	11.11/22.44+3.5	Nigeria	Adamu et al. [96]
Prosopis africana	Leguminoceae)	Leaves	T. b. b	methanol	200 mg/kg	Curative	14days	Nigerian	Atawodi and Funmi [97]
Psidium guajava	Myrtaceae	Leaf	T. b. b	ethanolic		Prophylactic	32 days	Nigeria	Adeyemi et al. [98]
Pterocarpuserinaceus,	Leguminosae	Leaf	T. b.	Methanol	40	Curative	≥14days	Nigerian	Mann and Obgbadoyi, [95]
Zanthoxylum zanthoxyloides	Rutaceae	Stem bark	T. b.	Methanol	100	Curative	No activity	Nigerian	Mann and Obgbadoyi, [95]
Tapinanthus globiferus	Loranthaceae	Leaf	T. co	methanolic	400 mg/kg	Curative	24 days	Nigeria	Abedo et al. [94]
Terminalia avicennioides	Combretaceae	Fruit	T. b. b	Methanol	300	Curative	12 days	Nigeria	Mann et al. [74]
Tinospora bakis	melastomataceae	Leaf	T. e	Chloroform/ methanolic	500 mg/kg	Curative	20 days	Sudan	Samia, [81]
Tithonia diversifolia	Asteraceae	Leaves	T. b. b	Aqueous	400 Mg/Kg	Curative	2.03/11.6±0.40	Nigeria.	Olukunle et al. [75]
Tridax procumbens	Asteraceae	Leaves	T. b. b	Methanol	300 mg/kg	Curative	28	Nigeria.	Abubakar et al. [99]
Vernonia amygdalina	Asteraceae	Leaf	T. b. b	Methanol	300 mg/kg	Curative	24 days	Nigeria	Yusuf et al. [100]

Scientific name	Family	Part (s) used	Parasite	Extract	Dose	Model	%inhibition/survival days	Country	References
Zanthoxylumzantho xyloides	Rutaceae	Stem bark	T. b.			Curative		Nigerian	Mann and Obgbadoyi, [95]

T.b. b =Trypanosoma brucei brucei, T.e =Trypanosomaevansi, T.co =Trypanosomacongolense

Table 7. Anti-trypanosomal compounds isolated from African plant

Compound	Plant species	Family	Part used	Trypanosome species	IC_{50}	Solvent	Author
16-acetoxy-11-hydroxy octadeca-17-ene-12,14-diynyl acetate	*Cussonia zimmermannii*	Araliaceae	Root bark	T.b.r	0.42	Pet.ether	Senn et al. [101]
8-hydroxyheptadeca-4,6-diyn-3ylacetate	*Cussonia zimmermannii*	Araliaceae	Root bark	T.b.r	5.4	Pet.ether	Senn et al. [101]
8-hydroxyheptadeca-1-ene-4,6-diyn-2ylacetate	*Cussonia zimmermannii*	Araliaceae	Root bark	T.b.r	0.41	Pet.ether	Senn et al. [101]
24-hydroperoxy-24- vinylcholesterol	*Strychnos spinosa*	Loganiaceae	Leaves	T.b. b	3.2	lipophilic	Hoet et al. [26]
2-oxo-3-deacetyl salannin	*Azadirachta indica*	Meliaceae	Leaf	*T.b. r*	6.9	Chloroform	Githua et al. [102]
4,7-Dimethoxy-5-methyl-2H-Chromen-2-one	*Toona ciliata*	Meliaceae	Root	*T.b. r*	31.25 μg/ml	Methanol	Mercy et al. [71]
4’-hydroxy-5,6,7,3’,5’-pentamethoxyflavone (ageconyflavone C).	*Ageratum conyzoides*	Asteraceae	Leaves	T.b. r	3.01	Methanol	Nour et al. [63]
41 (4Z,6E)-5-hydroxy-1,7-bis (4- hydroxyphenyl) hepta-4,6-dien-3-one	*Aframomum letestuanum*	Zingiberaceae	Seed	*T.b. b*	2.6	DCM	Kamnaing et al. [35]
5,6,7,3’,4’,5’-hexamethoxyflavone	*Ageratum conyzoides*	Asteraceae	Leaves	T.b. r	8.58	Methanol	Nour et al. [63]
5,6,7,5’-tetramethoxy-3’,4_-methylenedioxyflavone	*Ageratum conyzoides*	Asteraceae	Leaves	T.b. r	7.29	Methanol	Nour et al. [63]
5,6,7,8,3’,4’,5’-heptamethoxyflavone (5_-methoxynobiletine	*Ageratum conyzoides*	Asteraceae	Leaves	T.b. r	4.76	Methanol	Nour et al. [63]
5,6,7,8,5’-pentamethoxy-3’ , 4_-methylenedioxyflavone (eupalestin,)	*Ageratum conyzoides*	Asteraceae	Leaves	T.b. r	6.67	Methanol	Nour et al. [63]
6- acetonyldihydrochelerythrine	*Garcinia lucida*	Clusiacea	Stem	*T.b. b*	3.9	DCM	Fotie et al. [34]
7- deacetylkhivorin	*Khaya anthotheca*	Meliaceae	Seeds	*T.b. r/T.cr*	16.88 / 31.82	Pet. Ether	Obbo et al. [67]
7,15-dihydroxy-7,15-deoxo nimbin	*Azadirachta indica*	Meliaceae	Leaf	*T.b. r*	15.6	Chloroform	Githua et al. [102]
7,8,3′,5′-tetramethoxyisoflavan-1′,4′-quinone	*Abrus precatorius*	Leguminosae	Whole plant	T.b. r	0.3	DCM/ Methanol (1 : 1)	Hata et al. [32]
7-acetyl-15-methoxy-29- methylene-7,15-deoxo nimbolide	*Azadirachta indica*	Meliaceae	Leaf	*T.b. r*	7.8	Chloroform	Githua et al. [102]
7-methoxyflavone	*Conchocarpus heterophyllus*	Rutaceae	Branches	*T.cr*	787 μg/mL	Hexane	Ambrozin et al. [103]
8-hydroxyheptadeca-1-ene- 4,6-diyn-2yl acetate	*Cussonia zimmermannii*	Araliaceae	Root	*T.b. r*	0.14	Pet.ether	Senn et al. [101]
8-hydroxyheptadeca-4,6-diyn- 3yl acetate	*Cussonia zimmermannii*	Araliaceae	Root	*T.b. r*	5.4	Pet.ether	Senn et al. [101]
Abruquinone B	*Abrus precatorius*	Leguminosae	Whole plant	T.b. r	0.2	DCM/	Hata et al. [32]

Compound	Plant species	Family	Part used	Trypanosome species	IC_{50}	Solvent	Author
						Methanol (1 : 1)	
abruquinone G	*Abrus precatorius*	Leguminosae	Whole plant	T.b. r	17.0	DCM/ Methanol (1 : 1)	Hata et al. [32]
Abruquinone H	*Abrus precatorius*	Leguminosae	Whole plant	T.b. r	12.0	DCM/ Methanol (1 : 1)	Hata et al. [32]
abruquinone I	*Abrus precatorius*	Leguminosae	Whole plant	T.b. r	0.3	DCM/ Methanol (1 : 1)	Hata et al. [32]
Abruquinones A	*Abrus precatorius*	Leguminosae	Whole plant	T.b. r	0.02	DCM/ Methanol (1:1)	Matthias et al. [33]
Abruquinones D	*Abrus precatorius*	Leguminosae	Whole plant	T.b. r	0.01	DCM/ Methanol (1:1)	Matthias et al. [33]
Abruquinones J	*Abrus precatorius*	Leguminosae	Whole plant	T.b. r	11.2	DCM/ Methanol (1:1)	Matthias et al. [33]
Abruquinones K	*Abrus precatorius*	Leguminosae	Whole plant	T.b. r	0.11	DCM/ Methanol (1:1)	Matthias et al. [33]
Abruquinones L	*Abrus precatorius*	Leguminosae	Whole plant	T.b. r	0.02	DCM/ Methanol (1:1)	Matthias et al. [33]
Arborinine	*Teclea trichocarpa*	Rutaceae	Leaves	T.b. r	23.52	Methanol	Mwangi et al. [70]
Artemisinin	*Artemisia annua*	Asteraceae	Leaf	T.b.b	35.91	DCM/ Methanol (1:1)	Nibret, 2009
Azaanthraquinone	*Mitracarpus scaber*	Rubiaceae	Leaf	T.co	50	Methanol	Nok [124]
Beta-sitosterol	*Buchholziacoriacea*	Capparaceae	Seeds	*T.b. b*	12.5 µg/ml	methanol	Nweze et al. [86]
betulin	*Strychnos spinosa*	Loganiaceae	Leaves	T.b. b	54.0	lipophilic	Hoet et al. [26]
Betulinic acid	*Keetia leucantha*	Rubiaceae	Leaf	Bloodstream/procyclic forms of T.b	11.2/40. 90 µg /ml	Oil	Bero et al. [28]
Caryophyllene	*Keetia leucantha*	Rubiaceae	Leaf	Bloodstream/procyclic forms of T.b	41.2/>10 0 µg /ml	Oil	Bero et al. [28]

Compound	Plant species	Family	Part used	Trypanosome species	IC_{50}	Solvent	Author
cedrelone	*Toona ciliata*	Meliaceae	Root	*T.b. r*	7.85 µg/ml	Methanol	Mercy et al. [71]
Cedrelone	*Toona ciliata*	Meliaceae	Root	*T.b. r*	31.25	Chloroform	Githua et al. [102]
cinerin II	*Chrysanthemum cinerariifolium*	Asteraceae	Flowers	T.b. r	12.2	n-hexane	Michael et al. [104]
cipadesin	*Cipadessa fruticosa*	Meliaceae	Fruits	*T.cr.*	189.0 µmol/L	DCM	Ana et al. [105]
cipadesin A	*Cipadessa fruticosa*	Meliaceae	Fruits	*T.cr.*	136.1 µmol/L	DCM	Ana et al. [105]
citronellal	*Ocimum gratissimum*	lamilaceae	Seed oil	*T.b. b*	2.76±1.55 µg/mL	Oil	Bénédicta et al. [25]
clerosterol	*Strychnos spinosa*	Loganiaceae	Leaves	T.b. b	53.6	lipophilic	Hoet et al. [26]
cynaropicrin	*Vernonia mespilifolia*	Asteraceae	Leaf	T.b. r/ T.cr	0.23/5.14	DCM/ Methanol	Mokoka et al. [30]
Dihydrochelerythrine	*Garcinia lucida*	Clusiacea	Stem	*T.b. b*	0.8	DCM	Fotie et al. [34]
drypetenone D	*Drypetes gerrardii*	Putranjivaceae	Stem	T.b. r	6.0	DCM/ Methanol (1:1)	Matthias et al. [33]
drypetenone E	*Drypetes gerrardii*	Putranjivaceae	Stem	T.b. r	-	DCM/Methanol (1:1)	Matthias et al. [33]
encecalol methyl ether 6	*Ageratum conyzoides*	Asteraceae	Leaves	T.b. r	78.4	Methanol	Nour et al. [63]
erythrodiol	*Strychnos spinosa*	Loganiaceae	Leaves	T.b. b	5.3	lipophilic	Hoet et al. [26]
Espintanol	*Oxandra espintana*	Anonaceae	Leaf	T.cr	25 µg/ml	methanol	Hocquemiller, [106]
febrifugin	*Cipadessa fruticosa*	Meliaceae	Fruits	*T.cr.*	168.0 µmol/L	DCM	Ana et al., [105]
flavone	*Conchocarpus heterophyllus*	Rutaceae	Branches	*T.cr*	2116 µg/mL	Hexane	Ambrozin et al.[103]
Geranylacetone	*Keetia leucantha*	Rubiaceae	Leaf	Bloodstream/procyclic forms of T.b	16.2/>100 µg g/ml	Oil	Bero et al. [28]
Grandifolione	*Khaya anthotheca*	Meliaceae	Seeds	*T.b.r/T.cr*	10.66/20.9	Pet. Ether	Obbo et al. [67]
jasmolin I	*Chrysanthemum cinerariifolium*	Asteraceae	Flowers	T.b. r	30.9	n-hexane	Michael et al. [104]
jasmolin II	*Chrysanthemum cinerariifolium*	Asteraceae	Flowers	T.b. r	12.0	n-hexane	Michael et al., [104]
Kolavenol	*Entada abyssinica*	Leguminosae	Stem	*T.b. r*	2.5	Ethamol	Freiburghaus et al. [107]

Compound	Plant species	Family	Part used	Trypanosome species	IC_{50}	Solvent	Author
Letestuianin A	*Aframomum letestuanum*	Zingiberaceae	Seed	*T.b. b*	>100	DCM	Kamnaing et al.[35]
Letestuianin B	*Aframomum letestuanum*	Zingiberaceae	Seed	*T.b. b*	67	DCM	Kamnaing et al.[35]
Letestuianin C	*Aframomum letestuanum*	Zingiberaceae	Seed	*T.b. b*	2.6	DCM	Kamnaing et al. [35]
limonene	*Ocimum gratissimum*	lamilaceae	Seed oil	*T.b. b*	4.24±2.27 μg/mL	Oil	Bénédicta et al.[25]
Lucidamine A	*Garcinia lucida*	Clusiacea	Stem	*T.b. b*	14.1	DCM	Fotie et al. [34]
Lucidamine b	*Garcinia lucida*	Clusiacea	Stem	*T.b. b*	4.1	DCM	Fotie et al. [34]
lupeol	*Strychnos spinosa*	Loganiaceae	Leaves	T.b. b	19,3	lipophilic	Hoet et al. [26]
Melicopicine	*Teclea trichocarpa*	Rutaceae	Leaves	T.b. r	15.56	Methanol	Mwangi et al. [70]
mexicanolide	*Cipadessa fruticosa*	Meliaceae	Fruits	*T.cr.*	326.3 μmol/L	DCM	Ana et al. [105]
myrcene	*Ocimum gratissimum*	Lamiaceae	Seed oil	*T.b. b*	2.24±0.2 7 μg/mL	Oil	Bénédicta et al.[25]
n-Hexadecanoic acid	*Keetia leucantha*	Rubiaceae	Leaf	Bloodstream/procyclic forms of T. b	>100/>1 00 g g/ml	Oil	Bero et al. [28]
Normelicopicine	*Teclea trichocarpa*	Rutaceae	Leaves	T.b. r	5.24	methanol	Mwangi et al. [70]
Oleanolic acid	*Keetia leucantha*	Rubiaceae	Leaf	Bloodstream/procyclic forms of T. b	7.3/86.4 μg g/ml	Oil	Bero et al. [28]
Oleic acid	*Keetia leucantha*	Rubiaceae	Leaf	Bloodstream/procyclic forms of T. b	64.30/>1 00 μg g/ml	Oil	Bero et al. [28]
phytol	*Keetia leucantha*	Rubiaceae	Leaf	Bloodstream/procyclicforms of *T.b. b*	19.1/>100	Oil	Bero et al. [28]
putranoside A	*Drypetes gerrardii*	Putranjivaceae	Stem	T.b. r	18.0	DCM/ Methanol (1:1)	Matthias et al. [33]
pyrethrin I	*Chrysanthemum cinerariifolium*	Asteraceae	Flowers	T.b. r	6.9	n-hexane	Michael et al. [104]
pyrethrin II	*Chrysanthemum cinerariifolium*	Asteraceae	Flowers	. T.b. r	10.6	n-hexane	Michael et al. [104]
quercetin	*Rapanea lancifolia*	Myrsinaceae	Branches	*T.b.b*	13.2 μmol/L	methanol	Camacho et al. [108]
Saringosterol	*Strychnos spinosa*	Loganiaceae	Leaves	T.b. b	7.8	Ipophilic	Hoet et al. [26]
schkuhrin I	*Schkuhria pinnata*	Asteraceae	Whole plant	T.b. r/ T.cr	0.86/16.4	DCM/ Methanol	Mokoka et al. [30]
schkuhrin II	*Schkuhria pinnata*	Asteraceae	Whole plant	T.b. r/ T.cr	1.50/26.9	DCM/ Methanol	Mokoka et al. [30]
Siderin	*Toona ciliata*	Meliaceae	Leaf	*T.b. r*	7.18	Chloroform	Githua et al. [102]

Compound	Plant species	Family	Part used	Trypanosome species	IC_{50}	Solvent	Author
Skimmianine	*Teclea trichocarpa*	Rutaceae	Leaves	T.b. r	15.78	Methanol	Mwangi et al. [70]
stigmastanol	*Strychnos spinosa*	Loganiaceae	Leaves	T.b. b	>100	Ipophilic	Hoet et al. [26]
stigmasterol	*Strychnos spinosa*	Loganiaceae	Leaves	T.b. b	55.5	Ipophilic	Hoet et al. [26]
Terchebulin	*Terminalia avicenioides*	Combretaceae	Leaf	T.b. b	27.5	Aqueous	Shuaibu et al. [109].
punicalagin, ,	*Terminalia avicenioides*	Combretaceae	Leaf	T.b. b	15	Aqueous	Shuaibu et al. [109]
ellagic acid	*Terminalia avicenioides*	Combretaceae	Leaf	T.b. b	25	Aqueous	Shuaibu et al. [109].
flavogallonicacid	*Terminalia avicenioides*	Combretaceae	Leaf	T.b. b	7.5	Aqueous	Shuaibu et al. [109]
ursolic acid	*Keetia leucantha*	Rubiaceae	Leaf	Bloodstream/procyclic forms of T. b	2.5/6.5 µg g/ml	Oil	Bero et al. [28]
uvaol	*Strychnos spinosa*	Loganiaceae	Leaves	T.b. b	12.3	Ipophilic	Hoet et al. [26]
vernoguinoside	*Vernonia guineensis*	Asteraceae	Stem bark	*T.b. r*	3–5 mg/ml	Ethamol	Joseph et al. [36]
vernoguinosterol	*Vernonia guineensis*	Asteraceae	Stem bark	*T.b. r*	3–5 mg/ml	Ethamol	Joseph et al. [36]
α-Amyrin	*Teclea trichocarp*	Rutaceae	Leaves	T.b. r	11.21	Methanol	Mwangi et al. [70]
α-amyrin	*Strychnos spinosa*	Loganiaceae	Leaves	T.b. b	48.9	Lipophilic	Hoet et al. [26]
α-Ionone	*Keetia leucantha*	Rubiaceae	Leaf	Bloodstream/procyclic forms of T. b	13.1/81.4 µg /ml	Oil	Bero et al. [28]
α–sulphur	*Buchholziacoriacea*	Capparaceae	Seeds	*T.b. b*	25 µg/ml	Methanol	Nweze et al. [86]
β-amyrin	*Strychnos spinosa*	Loganiaceae	Leaves	T.b. b	54.3	Lipophilic	Hoet et al. [26]
β-Ionone	*Keetia leucantha*		Leaf	Bloodstream/procyclic forms of T. b	10.5/55. 8 µg /ml	Oil	Bero et al. [28]
β-sitosterol	*Morinda lucida*	Rubiaceae	Leaves	*T.b. b*	12.5 µg/ml	Methanol	Nwakaeg, [56]
β-sitosterol	*Strychnos spinosa*	Loganiaceae	Leaves	T.b. b	>100	lipophilic	Hoet et al. [26]
β–Sitosterol	*Teclea trichocarp*	Rutaceae	Leaves	T.b. r	>90	Methanol	Mwangi et al. [70]

T.b. b =Trypanosoma brucei brucei; T.e =Trypanosomaevansi; T.co =Trypanosomacongolense

4.4 Anti-trypanosomal Activity of North African Plants

A very little imformation on trypanocidal potency of medicinal plant from North Africa were obtained from literature. Only one and three medicinal plant was found to have been investigated for invitro and invivo activity. N-Hexane and DCM extract of *Ageratum conyzoides* show a significant activity against *T. b. rhodesiense* with IC_{50} values of 2.4 and 0.78 ug/ml respectively [63]. The whole plant of *Argemone Mexicana, Aristolochia bracteolate* and *Tinospora bakis* when administered to Trypanosoma evansi infected rats at dose of 500 mg/kg significantly reduced the parasitaemia count and extend the survival time compare to untreated group, with chloroform extract of *Aristolochia* been the most active (25 survival days) [81]. However, methanol extract of *Cannabis sativa* at dose of125/250 mg/kg prolonge the survival days of Trypanosoma *evansi* infected mice beyond 45 day (Samia *et al.,* 2012).The anti-trypanosomal compounds isolated from North african plant (Fig. 2) include 4'-hydroxy-5,6,7,3',5'-pentamethoxyflavone (IC_{50} 3.01 ug/ml), 5,6,7,3',4',5'-hexamethoxyflavone, (IC_{50} 8.58 ug/ml), 5,6,7,5'-tetramethoxy-3',4-methylenedioxyflavone (IC_{50} 7.29 ug/ml), 5,6,7,8,3',4',5'-heptamethoxyflavone (IC_{50} 4.76 ug/ml), and 5,6,7,8,5'-pentamethoxy-3' , 4'methylenedioxyflavone (IC_{50} 0 6.67 ug/ml) from *Ageratum conyzoides* [63].

4.5 Anti-trypanosomal Activity of East African Plants

An appreciable data on trypanocidal potency of medicinal plant from east African plant were obtained from literature. The most intresting in vitro trypanocidal activity from east African plant were those of seed extract of *K. anthotheca* (IC_{50} 5.72 ug/ml), and root extract of *T. ciliate* (IC_{50} 3.2-6.9 µg/ml). However, out of the medicinal plant from this area with invivo trypanocidal activity only *Artemisia abyssinica* [83] and *Kigelia Africana* [82], show appreciable activity by prolonging the survival days of the rat to 40.67 and 41.8 at 400 and 100 mg/kg respectively Detailed phytochemical study of east African plant led to the isolation of 17 compounds (Fig. 2) with varied degree of trypanocidal activity (Table 7), the most notable one were those of 8-hydroxyheptadeca-1-ene- 4,6-diyn-2yl acetate (IC_{50} 0.14 ug/ml) and 8-hydroxyheptadeca-4,6-diyn- 3yl acetate (IC_{50} 5.4 ug/ml) isolated from *Cussonia zimmermannii* [101].

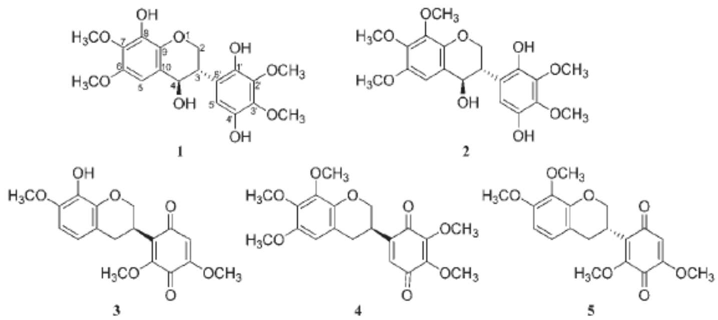
4.6 African Plants with Ameliorative Effects on the Trypanosome-induced Pathological Changes

4.6.1 African herbal formula (AFH)

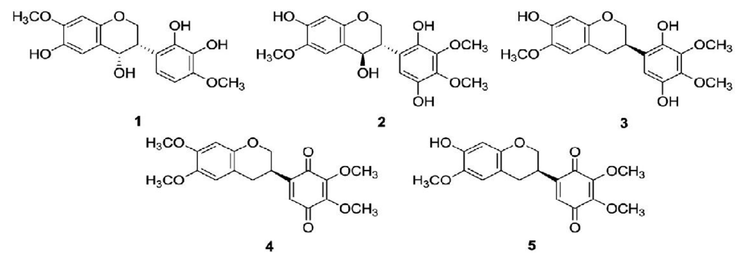
A herbal mixture of herbs code named African Herbal Formula (AFH) has been applied by members of the family and close-associates for all kinds of health problems and it is very popular among the low socio-economic class. The influe-nce of these Herbal Formula on the haematological parameters of trypanosome infected rats were investicated. Observations showed that the formula has an effect on the haemopoietic system manifested by a positive increase in the levels of haemoglobin, packed cell volume and red blood cell while the white blood cell and lymphocyte levels were decreased. AHF also delayed the proliferation of the parasites and improved the level of the characteristic weight loss associated with trypanosomiasis [110]. This suggests that the Herbal Formula must have possibly combated the parasite directly without demanding further production of the effectors cells of the immune system.

4.6.2 Jobelyn®,(herbal preparation)

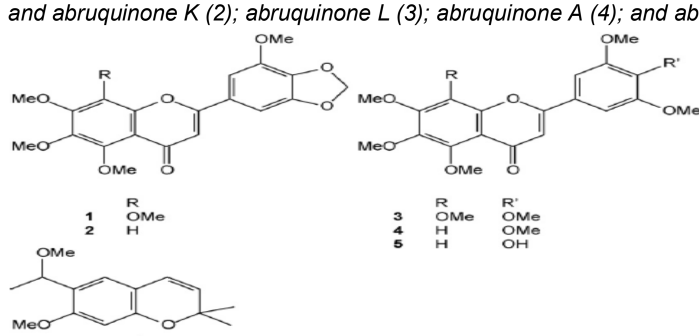
Jobelyn®, manufactured by Health Forever Products Ltd, Lagos, Nigeria, is a commercial herbal preparation that recently made its way into the herbal medicine market in Nigeria. It is available as a powdered preparation formulated into capsules and suspension and contains iron, protein, fat, carbohydrates, tannins, saponins, Sorghum b/color or Sorghum (family: Gramineae). A study was carried out to determine the effectof this herbal preparationon packed cell volume (PCV) and haemoglobin (Hb) concentrations in anaemic rabbits. The PCV and Hb concentrations of healthy rabbits infected with *T. brucei brucei* were monitored for 49 days. T. b. brucei produced a significant reduction in PCV and Hb concentrations in all infected rabbits when compared with the controls ($p<0.05$). These hematological parameters were restored to normal levels in the anaemic rabbits by the herbal preparation. The anaemic rabbits not treated with the herbal preparation presented with a progressive decline in their PCV and Hb concentrations and majority of them died before the end of the study [111].



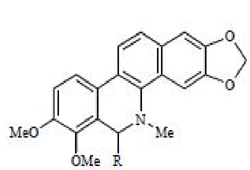
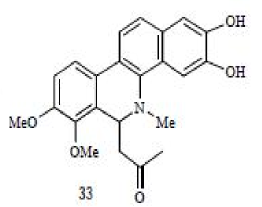
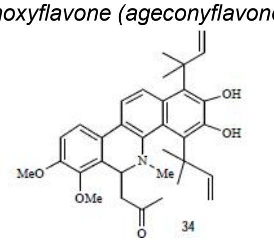
Abruquinone H (1) and abruquinone G (2); abruquinone I (3); abruquinone B (4); and 7,8,3',5'-tetramethoxyisoflavan-1',4'-quinone(5).



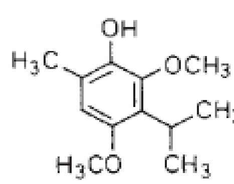
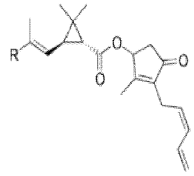
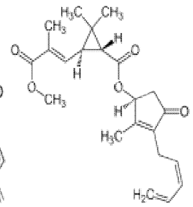
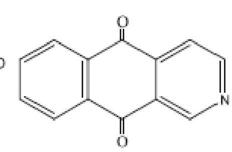
Abruquinone J (1) and abruquinone K (2); abruquinone L (3); abruquinone A (4); and abruquinone D (5).



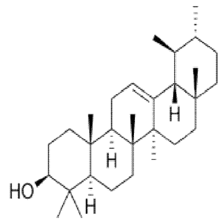
5,6,7,8,5'-pentamethoxy-3'; 4'-methylenedioxyflavone (eupalestin,1); 5,6,7,5' tetramethoxy- 3',4'-methylenedioxyflavone (2); 5,6,7,8,3_,4_,5_-heptamethoxyflavone (5'-methoxynobiletine, 3), 5,6,7,3',4',5'-hexamethoxyflavone (4) and 4'-hydroxy-5,6,7,3',5'-pentamethoxyflavone (ageconyflavone C, 5).

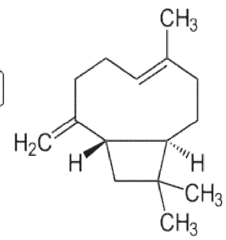




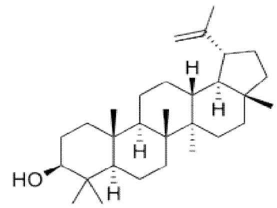
6-acetonyldihydrochelerythrine lucidamine A lucidamine B

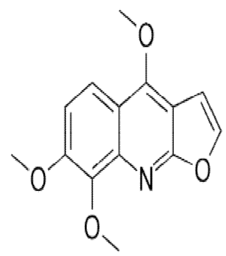





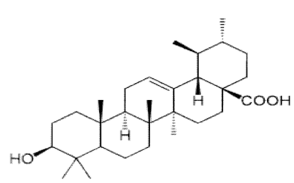
Espintanol pyrethrin I pyrethrin II Azanthraquinone

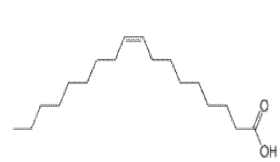

Alpha –amyrine

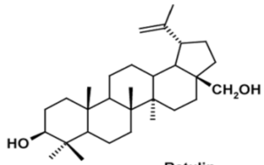

Caryophyllene

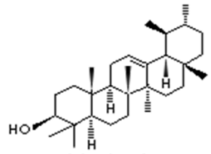

Lupeol

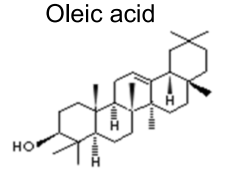

Skimmianine

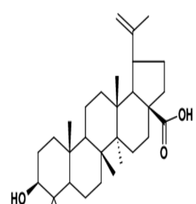

Ursolic acid

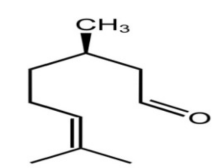

Oleic acid

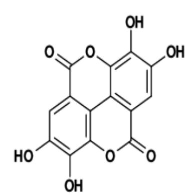

Betulin

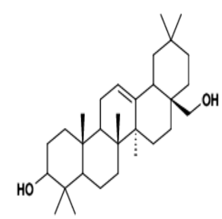

alpha-Amyrin

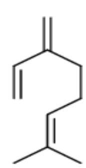

beta-Amyrin

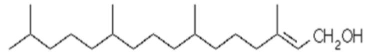

Betulinic Acid

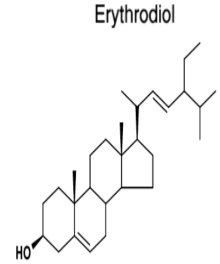

Citronellal

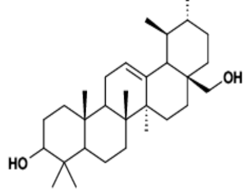

Ellagic Acid

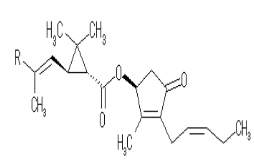

Erythrodiol

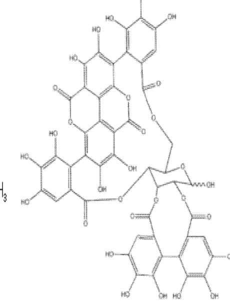

Myrcene

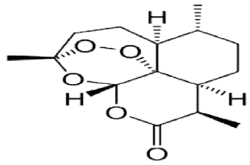

Phytol

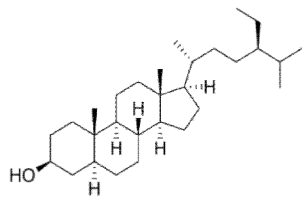

Stigmasterol

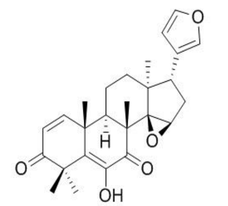

Uvaol

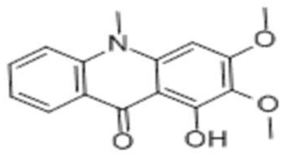

Jasmolin I (R = CH_3)
Jasmolin II (R = $COOCH_3$)

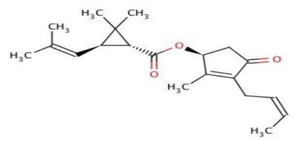

punicalagin

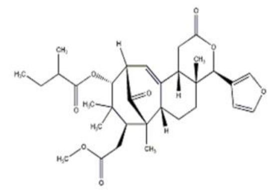

Artemisinin

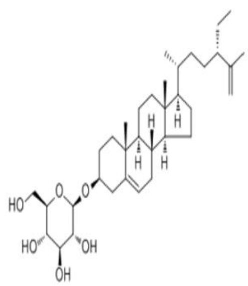

Stigmastanol

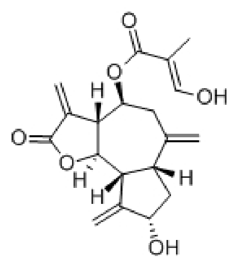

Cedrelone

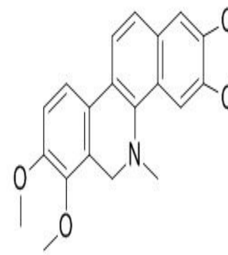

Arborinine

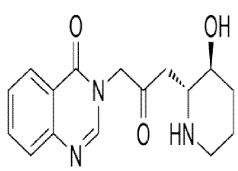

cinerin

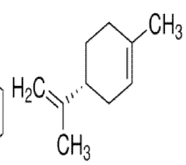

cipadesin

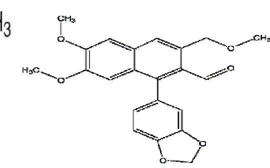

Clerosterol

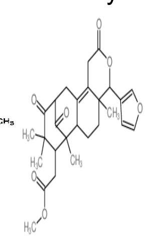

cynaropicrin

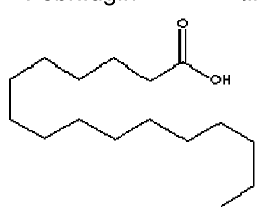

Dihydrochelerythrine

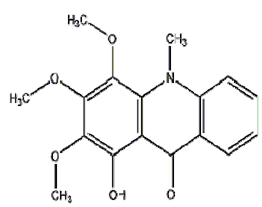

Febrifugin

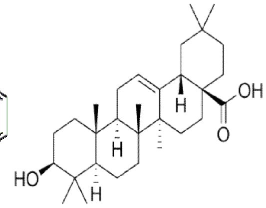

limonene

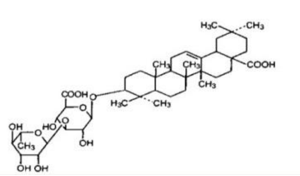

Lucidamine

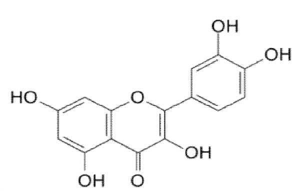

Amexicanolide

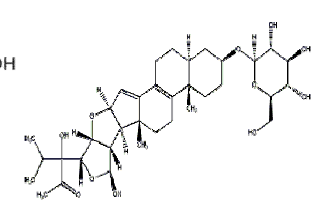

n-Hexadecanoic acid

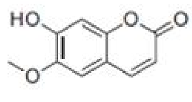

Normelicopicine


Oleanolic acid

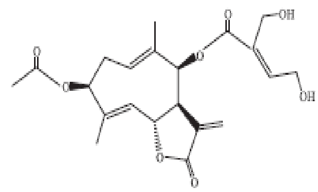

Putranoside


Aquercetin

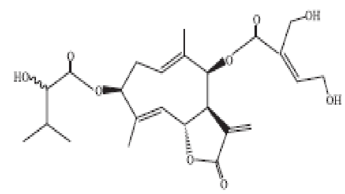

vernoguinoside



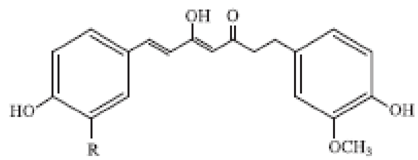
β–ionone

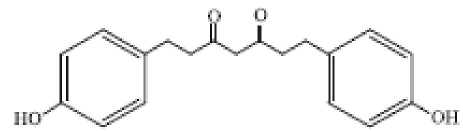


Schkuhrin I

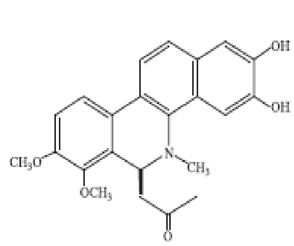


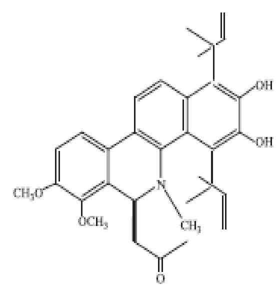
schkuhrin II

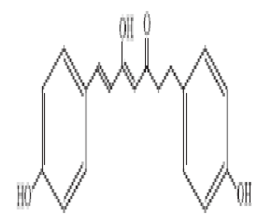




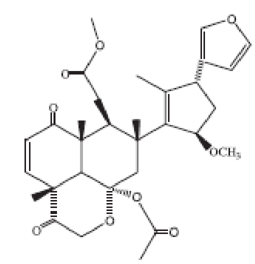
Letestuianin A (R= H) Letestuianin B (R= OCH_3) Letestuianin C

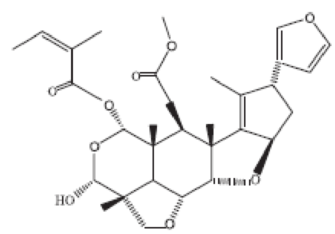


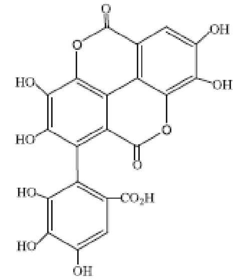




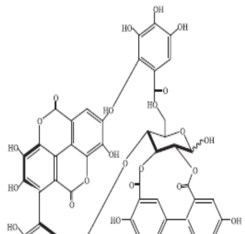
Lucidamine A,LucidamineB &(4Z,6E)-5-hydroxy-1,7-bis (4- hydroxyphenyl) hepta-4,6- dien-3-one

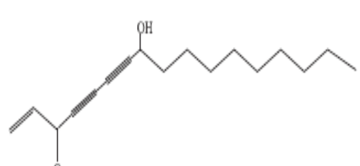


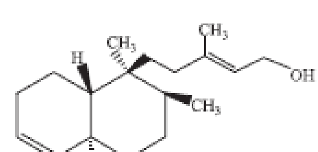




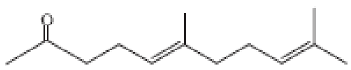
7-acetyl-15-methoxy-29-methylene-7,15-deoxonimbolide. 2-oxo-3-deacetyl salannin.
Flavogallonicacid



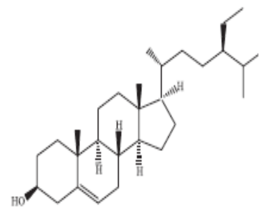




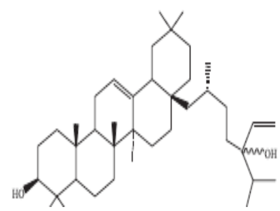
Terchebulin 8-hydroxyheptadeca-4,6-diyn-3ylacetate Kolavenol



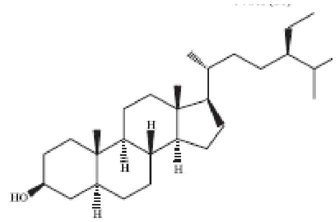
Geranylacetone



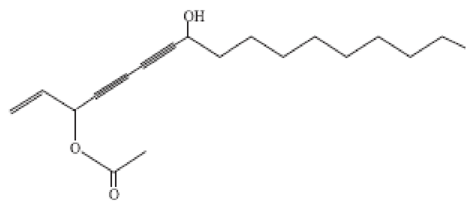
Beta sitosterol



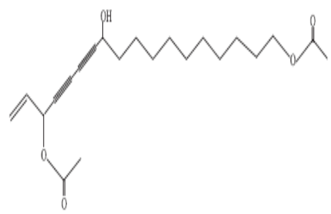
Saringosterol



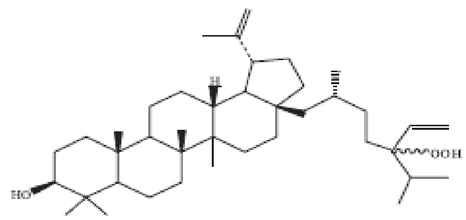
Stigmastero



8-hydroxyheptadeca-1-ene-4,6-diyn-2ylacetate



16-acetoxy-11-hydroxy octadeca-17-ene-12,14-diynyl acetate.



24-hydroperoxy-24- vinylcholesterol

Fig. 2. Structures of isolated bioactive anti-trypanosomal compounds from African natural products

4.6.3 *Artemisia herba-alba*

Artemisia herba-alba commonly known as white wormwood or desert wormwood chloroform extracts of *Artemisia herba-alba* when administered to Trypanosoma evans iinfected rabbits causes significant reduction in parasitaemia count and significantly ameliorated the parasite induced alteration in haematological (PCV, Hb, RBCs and WBC) and biochemical values (ALT, ALP and AST) comparable to normal (uninfected) rabbits thereby confirming their antiparasitic properties [112].

Fathy et al. [113], evaluated the anti-trypanosomal efficacy of crude ethanolic extracts (CEE) of the aerial parts of *Artemisia herba alba* against *Trypanosoma evansi* infection. The results indicated significant difference ($p<0.05$) in the context of reduction in the extent of clinical signs, low levels of parasitaemia and mortality pattern in animals received crude ethanolic extracts (CEE) of *Artemisia herba alba* compared to those served as negative group. The extract also increases the PCV of infected animals compare to untreated control. There was no significant difference in almost all investigated parameters between standard group (positive control) and treatment group. It is concluded that CEE of *A. herba-alba* and Berenil® showed relatively aparasitaemia and normal heamatologic values in the infected rabbits, thereby confirming their antiparasitic properties.

4.6.4 Black seed oil (*Nigella sativa* oil)

The effect of black seed oil (*Nigella sativa*) on parasitaemia, haematological and biochemical parameters in Trypanosoma brucei-infected rats was investigated. The seed oil results in low parasitaemia load and also prolong life span of the infected rats from 12 days of the infected untreated (control) rats to 22 days for the infected black seed oil-treated rats. The seed oil also causes significant increases in haematological (Hb, PCV, RBC, WBC and platelet counts) and some serum biomarker enzyme (Serum ALP, AST and ALP) with decreases in the liver enzyme activities. Protein concentrations show significant decreases in the serum and increases in the liver when compared with the infected untreated [114]. The black seed oil has probably stimulate the host immune system to control parasite proliferation thereby making it a possible agent for managing African sleeping sickness despite possible gradual damage to host organs as shown by increases in some serum enzymes.

4.6.5 *Camellia sinensis*

Green tea, the dried leaf of *Camellia sinensis*, contains a variety of biologically active compounds such as polyphenols, methylxanthines, essential oils, proteins, vitamins, and amino acids [115]. The purified compounds from ethyl acetate fraction of *Camellia sinensis* green tea leaves lysed more than 50% of the parasites present in the blood of infected BALB/c mice at concentrations as low as 0.12 to 85 pM. The most active compounds were gallocatechin gallate and epigallocatechin gallate, the number of amastigotes in infected Vero cells decreasedby 50% in the presence of each of these compounds at 100nm. The activity of recombinant arginine kinase, a key enzyme in the energy metabolism of the parasite was inhibited by about 50% by nanomolar concentrations of catechin gallate or gallocatechingallate [116].

4.6.6 *Cissus multistriata*

Cissus multistriata belongs to the family of plant known as Vitaceae.methanolic leaf extracts, of Saba florida (Benth) when administered to T.brucei infected rat at a dose of 200 and 400mg/kg b.w produce significant Improvements of packed cell volume (PCV), red blood cell count s (RBC) and increase in total serum protein when compared to untreated group [117]. The nutritional composition of this leaf extract may be responsible for this observation as it has been reported to be usedin the management of protein deficiency disease in children.

4.6.7 *Piper nigrum* (black pepper)

P. nigrum is a famous spice King. Traditionally, *P. nigrum* fruits have been used in the treatment and prevention of diarrhoea, large intestine toxins, asthma, respiratory disorder, different gastric problems, cancer, fever, common cold and stomach disorder [118]. Methanol extract (250-1000 µg mL-1) of dried fruits of *Piper nigrum* (Black pepper) were wer evaluated for it trypanocidal activities against Trypanosoma evansi using Vero cells grown in Dulbecco's Modified Eagle Medium (DMEM) and supplemented with foetal calf serum (FCS) 20-40% at appropriate conditions. In vitro cytotoxicity test of *P, nigrum* fruits extract at concentrations (1.56-100 µg ml-1) was done on Vero cells but without FCS. In vitro trypanocidal activity varied from immobilization, reduction and to the killing of trypanosomes in corresponding ELISA plate wells. At 750 µg mL-1of MPE, there was reduction of average mean trypanosomes count in extract. At 1000 µg ml-1 of the test extract of *P. nigrum*, there was complete killing of trypanosomes at 7 h of incubation. Trypanosomes counts decreased in concentration and time–dependent manner with. MPE of P, nigrum and diminazine aceturate, standard drug, were cytotoxic to Vero cells except at concentrations of 1.56-3.13 and 1.56-6. 25 µg ml-1 [119].

4.6.8 *Triticum aestivum* (wheat)

Wheat and its products are part of the regular western diet. Administration of ethyl acetate extract of wheat (*Triticum aestivum*) to *T. brucei* infected rat shows reduced parasitaemia and extension of life span from 8 days in the infected untreated (control) group to 14 days. The extract of wheat (*Triticum aestivum*) also show significant increases (p<0.05) in the haemoglobin (Hb) concentration, packed cell volume (PCV) and red blood cell (RBC) counts in infected treated groups when compared with infected untreated (control). The extract also show significant decrease in the activities of serum aspartate transaminase (AST), liver alanine transaminase (ALT) and serum alkaline phosphatase (ALP) when compared with infected untreated group. The author suggested that the crude extracts of fermented wheat could be potential agents in the management of African sleeping sickness [77]. According to Shittu and Tanimu [120], Prophylactic treatment of *T. brucei* infected rats with wheat supplemented diet extended the lifespan of infected rats by 4 extra days from the Control (infected untreated), while early stage treatments also extended the lifespan by 4 days.

4.6.9 *Zingiber officinale* (ginger)

Zingiber officinale (ginger) has been widely used around the world as food and as a spice. It is considered a safe herbal medicine with only a few and insignificant adverse/side-effects.it has been reported that ginger is endowed with strong in vitro and in vivo anti-oxidant properties [121], in vivo antitrypanosomal effect of methanolic extract of *Zingiber officinale* (ginger) in Trypanosoma brucei brucei-infected mice were evaluated at dose of at 200, 400 and 800 mg/kg body weightThe extract of *Zingiber officinale* produce a dose dependent significant decrase in level of parasitaemia compare to untreated group.

4.7 Anti-trypanosomal Activity of Insect and There Products

4.7.1 Honey

Honey is the sweet, viscous natural fluid produced by honeybees (*Apis melliflera*). Honey administered to *T. brucei* infected rat at dose of 3 mg/Kg body weight produce an extension in the life span of infected rat from 12 days for control to 19 days for infected honey-treated rats. Parasitaemia was also effectively lowered. However the honey causes significant increase in serum ALP, AST, ALT activity but decrease in Liver ALT activities. The authors suggested that, honey could be a potential agent in the management of African trypanosomosis. However, the Increase in serum biochemical parameters suggest possible damage to organs where these maybe abundant [13].

In another study, Ekanem et al. [122], Trypanosoma brucei-infected rats were treated with natural honey and honey supplemented diet at three days before infection (prophylaxis), early and late stages of infection. Prophylactic treatment with natural honey extended the lifespan of infected rats by 13 extra days from the control of 12 days post infection while early and late stage treatments extended the lifespan by 10 and 5 days, respectively. Prophylactic feeding with honey-supplemented diet extended the lifespan by 6 extra days while early and late stage feeding extended it for 5 and 3 days, respectively.

Still on the trypanocidal activities of honey Ekanem and Yusuf, [14], investigated whether honey has protective effect on some liver functions and blood parameters affected by trypanosome infection. The serum albumin concentration in infected untreated rats increased significantly ($p<0.05$) compared with control whereas treatment with honey returned this effect to normal values. Anaemia which became severe by day 11 of post infection as measured by significant changes ($p<0.05$) in the haemoglobin, packed cell volume, red blood cell, white blood cell and platelets counts was ameliorated when compared with the control ($p<0.05$). There was a significant decrease ($p<0.05$) in liver gamma glutamyl transferase in infected untreated, prophylactic and late stage treated group compared with the control groups. The authors suggested that honey has ameliorative effects on symptoms and some biochemical effects of *T. brucei* infections in rats.

4.7.2 Honey bee (*Apis mellifera)*

The trypanocidal potentials of honey bee (*Apis mellifera*) extract was investigated against Trypanosome brucei brucei infected rat. The of honey bee extract significantly reduced the parasitaemia count and extend the life span from 5 days of untreated to 10 and 15 days for prophylactic and early treated group. The extract also significantly increase ($p<0.05$) (HB, PCV, RBC and WBC) counts of infected treated groups when compared with infected not treated group [15].

4.7.3 House flies (*Musca domestica)*

Shittu and Bashir, [16], evaluated the invivo anti-trypanosomal potential of crude methanolic extract of Musca domestica against *T. brucei* brucei infected rats. Results showed that the methanolic extract of Musca domestica reduced the level of parasite replication by 26% and 49% and extend the lifespan from day 5 of the infected untreated to 7 and 11 days prophylactic and early treated respectively. The extract also results in significant decrease in antioxidant enzyme (Serum superoxide dismutase) compared to infected not treated group.

4.8 Possible Mechanism of Natural Product against Trypanosomiasis

In many investigations conducted so far, it was found that the plant parts differ significantly in their activity. The differences observed in the anti-trypanosomal evaluation suggest the susceptibility of the test parasite to various secondary metabolites present in these medicinal plants. The possible mechanisms by which these plants extracts and phytochemicals therein carry out this role remain a subject of great speculations and debate in the scientific community [123]. The suggested mechanisms of action for for the isolated anti-trypanosomal compounds from medicinal plants are (i) The DNA intercalation in com-bination with portion biosynthesis inhibition [27]. (ii) Interference with the redox balance of the parasites acting either on the respiratory chain or on the cellular defenses against oxidative stress [124]. For instance, the observed trypanocidal activity of *K. africana* extract was justified due to the increase of oxygen consumption and stimulation of hydrogen peroxide production in the protozoan cell. (iii) Covalent bonds with amino groups of proteins and affect a vast number of cellular activities in parasite as in the case of drimane sesquiterpenoids (warburganal, polygodial). Isolated from *Warburgia salutaris* [64], (iv) They have also proposed that iron chelation is an effective way of killing trypanosomes and the prime target is the enzyme ribonucleotide reductase whose activity is central to DNA synthesis prior to cell division as depicted in trypanosomiasis infection.

5. CONCLUSION AND FUTURE PERSPECTIVES

This review has presented a list of natural product (plants/insect) with anti-Trypanosoma properties. Many new bioactive agents isolated from plants having anti-Trypanosoma effects showed anti-trypanosoma activity equal and sometimes even more potent than known anti-trypanosomalagents such as diminazene aceturate and homidium chloride. However, many other active agents obtained from plants have not been well characterized. However, it is of paramount importance for African scientist to embark and devise new automated bioassays with special emphasis on high through-put procedures that can screen and process data from a panoply of phytochemicals within shorter time lapse. These procedures should also attempt to rule out false positive hits and dereplication methods to remove nuisance compounds. Furthermore, despite continuous comprehensive and mechanism-orientated evaluation of medicinal plants in Africa, there is still limited information regarding procedures to be adopted for quality assurance, authentication and standardization of crude plant products. Finally, above and beyond simple in vitro and in vivo assays, randomized controlled trials using standardized products or products containing pure plant extracts must be carried out and reported for each claim.

CONSENT

It is not applicable.

ACKNOWLEDGEMENTS

We would like to express our gratitude to John Omaku, Attah Idris of Federal University of Technology minna, Nigeria and Rex Ntue of University of calabar Nigeria for help rendered during the preparation of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Dietmar S, Kevin MT. Novel anti-trypanosomal agents. Expert Opin. Investig. Drugs. 2005;14(8):939-955.
2. WHO: African trypanosomiasis or sleeping sickness. World Health Org. Fact Sheet. 2001;259. Available:http://www.who.int/mediacentre/factsheets/fs259/en/
3. Williams-Blangero S, Vandeberg JI, Blangero J, Corrêa-Oliveira R. Genetic epidemiology of *Trypanosoma cruzi* infection and Chagas' disease. Front. Biosci. 2003;8:337-345.
4. Molyneux DH. Current public health status of the trypanosomiases and leishmaniases. In: Trypanosomiasis and Leishmaniasis: Biology and Control. Hide G, Mottram JC, Coombs GH, Holmes PH (Eds), CAB International, Wallingford, Oxon, UK. 1997;39-50.
5. Mbaya A, Aliyu M, Ibrahim U. The clinico-pathology and mechanisms of trypanosomosis incaptive and free-living wild animals: A review.Veterinary Research Communications. 2009;337: 793–809.
6. Aksoy S. Control of tsetse flies and trypanosome using molecular genetics. Vet. Parasitol . 2003;115 (2):125-145
7. Lejon V, Boclaert M, Jannin J, Moore A, Buscher P. The challenge of Trypaosoma brucei gambiense sleeping sickness diagnosis outside Africa Lancet infectious disease. 2003;3:804-808.
8. Seke Etet PF, Mahomoodally MF. New insights in staging and chemotherapy of African Trypanosomiasis and possible contribution of medicinal plants. The Scientific World Journal. 2012;1-16.
9. Gurib-Fakim A. Medicinal plants: Traditions of yesterday and drugs of tomorrow. Molecular Aspects of Medicine. 2006;27:1–93.
10. Abdool Karim SS, Ziqubu-Page TT, Arendse R. Bridging the gap: Potential for a health care partnership between African traditional healers and biomedical

personnel in South Africa. South African Medical Journal. 1994;84:1–16.

11. Cunningham I. New culture medium for maintenance of tsetse tissues and growth of trypanosomatids. J. Protozool. 1977;24: 325-329.

12. Taylor JLS, Rabe T. McGaw LJ, Jäger AK, van Staden J. Towards the scientific validation of traditional medicinal plants. Plant Growth Regulation. 2001;34:23–37.

13. Ekanem JT, Yusuf OK. Activities of alkaline phosphatase, glutamate oxaloacetate transaminase and glutamate pyruvate transaminase in liver and serum of *Trypanosoma brucei*-infected rats treated with honey Biokemistri. 2005;17(2): 185-191.

14. Ekanem JT, Yusuf OK. Some liver function indices and blood parameters in *T. brucei*-infected rats treated with honey. BIOKEMISTRI. 2007;19(2):81-86.

15. Shittu OK, Elekwechi U. Therapeutic potentials of methanol extracts of honey bee (*Apis mellifera*) against trypanosome brucei brucei infection. Nigerian society of biochemistry and molecular biology (NSBMB); 2014. Ilorin.

16. Shittu OK, Bashir L. Activity of methanolic extract of *Musca domestica* against *Trypanosoma brucei brucei* infected rats. Nigerian society of biochemistry and molecular biology (NSBMB); 2014. Ilorin.

17. Mohammed A, Ibrahim AN, Aminu M, Murtala B, Isah B, Abubakar BA. Anti-trypanosomal activity of African medicinal plants: A review update. J of Ethnopha. 2014;154:26–54.

18. Dietmar S.The development of drugs for treatment of sleeping sickness: A historical review. Parasites & Vectors. 2010;3(15):1-9

19. Hoet S, Opperdoes F, Brun R, Quetin-Leclercq J. Natural products active against African trypanosomes: A step towards new drugs. Nat. Product Reports. 2004a;21: 353-364.

20. Bero J, Hannaert V, Chataigné G, Hérent MF, Quetin-Leclercq J. In vitro antitrypanosomal and antileishmanial activity of plants used in Beninin traditional medicine and bio-guided fractionation of the most active extract. J. of Ethnopharm. 2011;1372:998–1002.

21. Atawodi SE, Bulus T, Ibrahim S, Ameh DA, Nok AJ, Mamman M, Galadima M. *In vitro* trypanocidal effect of methanolic extract of some Nigerian savannah plants African Journal of Biotechnology. 2003;2(9):317-321.

22. Maikai V, Nok J, Adaudi A, Alawa C. in vitro antitrypanosomal activity of aqueous and methanolic crude extracts of stem bark of *Ximenia americana* on Trypanosoma congolense. J. Med. Plants Res. 2008;23: 55–58.

23. Kaminsky R, Schmid C, Brun R. An In vitro selectivity index for evaluation of cytotoxicity of antitrypanosomal compounds. *In vitro* Toxicol. 1996;9:315–324.

24. Josephine AA, Alice J, Rakiya A, Melemi M, Hamza I, Hafsatu M, Fatima S, Sunday Mercy D, Jabiru G, Umaru A, Bashir K, Comparative Studies of *In vitro, In vivo* Trypanocidal Activity and Phytochemical Screening of *Tapinanthus globiferus* and Gongronema latifolium, International Journal of Animal and Veterinary Advances. 2013;5(3):120-124.

25. Bénédicta GH, KpadonouK, Salomé DS, Kpoviessi AC, Eléonore Y, Ladekan B, Fernand GB, Michel FD, Mansourou MB, Joëlle QC, Georges C, Accrombessi A, Joanne B. *In vitro* anti-trypanosomal and antiplasmodial activities of crude extracts and essential oils of *Ocimum gratissimum* Linn from Benin and influence of vegetative stage. J. ofEthnopharm. 2014; 155:1417–1423.

26. Hoet S, Pieters L, Muccioli GG, Habib-Jiwan JL, Opperdoes FR, Quetin- Leclercq J. Antitrypanosomal activity of triterpenoids and sterols from the leaves of Strychnos spinosa and related compounds. J. Nat. Prod. 2007;70:1360–1363.

27. Sülsen VP, Cazorla SI, Frank FM, Redko FC, Anesini CA, Coussio JD, Malchiodi, EL, Martino VS, Muschietti LV. Trypanocidal and Leishmanicidal Activities of Flavonoids from Argentine Medicinal Plants. Am. J. Trop. Med. Hyg. 2007; 77(4):654–659.

28. Bero J, Beaufaya C, Hannaert V, Hérenta MF, Michelsb PA Quetin-LeclercqaJ. Anti-trypanosomal compounds from the essential oil and extracts of Keetia leucantha leaves with inhibitor activity on *T. brucei* glyceraldehyde-3-phosphate dehydrogenase. Phytomedicine. 2013;20: 270–274.

29. Mokoka TA, Zimmermann S, Julianti T, Hata Y, Moodley N, Cal M, Adams M, Kaiser M, Brun R, Koorbanally N, Hamburger M. *In vitro* screening of traditional South African Malaria remedies against *Trypanosoma brucei rhodesiense, Trypanosoma cruzi, Leishmania donovani,* and *Plasmodium falciparum.* Planta Med. 2011;77:1663–1667.
30. Mokoka TA, Xolani PK, Zimmermann S, Hata Y, Adams M, Kaiser M, Moodley N, Maharaj V, Koorbanally NA, Hamburger M, Brun R, Fouche G. Anti-protozoal screening of 60 South African plants, and the identification of the antitrypanosomal germacranolides Schkuhrin I and II. Planta Medica. 2013;79:1380–1384.
31. Saganuwan AS, Patrick AO, Igoche GA, Ngozi JN, Reto B. *In vitro* Antiplasmodial, Anti-trypanosomal, antileishmanial and cytotoxic activities of various fractions of *Abrus precatorius* leaf. International Journal of Tropical Disease and Health. 2015;5(3):221-229.
32. Hata Y, Raith M, Nejad SE, e Zimmermann S, Mokoka T, Naidoo D, Fouche G, Maharaj V, Kaiser M, Brun R, Hamburger M. Antiprotozoal Isoflavan Quinones from *Abrus precatorius* ssp. Africanus. Planta Med. 2013;79:492–498.
33. Matthias H, Hata Y, Nejad SE, De Mieri M, Zimmermann S, Mokoka T, D Naidoo D, Fouche G, Maharaj V, Kaiser M, Brun R, Potterat O. Antitrypanosomal isoflavan quinones from Abrus precatorius. Fitoterapia. 2014;93:81–87.
34. Fotie J, Bohle DS, Olivier M, Adelaida GM, Nzimiro S. Trypanocidal and antileishmanial dihydrochelerythrine derivatives from *Garcinia lucida*. J. Nat. Prod. 2007;7010:1650–1653.
35. Kamnaing P, Tsopmo A, Tanifum EA, Tchuendem MH, Tane P, Ayafor J.F, Sterner O. Rattendi D, Iwu MM, Schuster B, Bacchi C. Trypanocidal diarylheptanoids from Aframomumletestuianum. Journal of Natural Products. 2003;66:364–367
36. Joseph DC, Alembert TT, Apollinaire T, Pierre T, Johnson FA, Olov S. Vernoguinosterol and vernoguinoside, trypanocidal stigmastane derivatives from *Vernonia guineensis* (Asteraceae). Phytochemistry. 2002;59:371–374.
37. Musuyu DM, Fruth BI, Nzunzu LJ, Mesia GK, Kambu OK, Tona GL, Cimanga RK, Cos P, Maes L, Apers S, Pieters L. *In vitro* antiprotozoal and cytotoxic activity of 33 ethonopharmacologically selected medicinal plants from Democratic Republic of Congo. J. Ethnophar. 2012;141:301–308.
38. Adewunmi CO, Agbedahunsi JM, Adebajo AC, Aladesanmi AJ, Murphy N, Wando J. Ethno-veterinary medicine: Screening of Nigerian medicinal plants for trypanocidal properties. J Ethnopharmacol. 2001;77:19-24.
39. Atawodi SE. Comparative *In vitro* trypanocidal activities of petroleum mther, chloroform, methanol and aqueous extracts of some Nigerian savannah plants. African J. Biotech. 2005;42:177–182.
40. Aderbauer B, Clausen PH, Kershaw O, Melzig MF. *In vitro* and *In vivo* trypanocidal effect of lipophilic extracts of medicinal plants from Mali and Burkina Faso. J Ethnopharmacol. 2008;119(2):225–231.
41. Atawodi SE, Funmi O. Evaluation of anti-trypanosomal properties of four extracts of leaves, stem and root barks of prosopis africana in Laboratory Animals. Biokemistri. 2009;21(2):101-108.
42. Abu AH, Uchendu CN, Ofukwu RA. *In vitro* anti trypanosomal activity of crude extracts of some Nigerian medicinal plants. J. Applied Bioscie. 2009;21:1277–1282.
43. Lagnika L, Attioua B, Vonthron-Senecheau C, Kaiser M, Lobstein A, Sanni A, Weniger B. *In vitro* preliminary study of antiprotozoal effect of four medicinal plants from Benin. J. Medicinal Plants Res. 2013; 7(10): 556-560,
44. Wurochekke AU, Nok AJ. *In vitro* anti Trypanosomal activity of some medicinal plants used in the treatment of trypanosomosis in Northern Nigeria. Afr. J. Biotechnol. 2004;3(9):481-483.
45. Shaba P, Pandey NN, Sharma OP, Rao JR. and Singh RK. Anti-trypanosomal effects of *Brassica oleracea* (Cabbage) fruits and leaves. J. Vet. Adv. 2012; 2(7):304-401.
46. Abiodun OO, Gbotosho GO, Ajaiyeoba EO, Brun R, Oduola AM. Antitrypanosomal activity of some medicinal plants from Nigerian ethnome- dicine. Parasitology Research. 2012;1102,521–526.
47. Hoet S, Opperdoes F, Brun R, Adjakidjé V, Quetin-Leclercq J. *In vitro*

antitrypanosomal activity of ethnopharmacologically selected Beninese plants. J. Ethnophar. 2004b; 911:37–42.

48. John OI, Ngozichukwuka PI, Alexander IG, Carol JC, Nzekwe U, Rajeev KS. Scientific investigation of anti-trypanosomal activity of crateva adansonii DC leaves extracts. Indo Global Journal of Pharmaceutical Sciences. 2012;2(3):226-229.

49. Mann A, Egwim EC, Barnabas B, Nda-Umar A, Mohammed G, Ekanem JT. Efficacy of Dissotis rotundifolia on *T. brucei brucei* infection in rats. African Journal of Biochemistry Research. 2009;3(1):005-008.

50. Habila N, Abel SA, Zakari L, Isaac A.,Bello EH, Monday AD, Taofiq OA .Evaluation of *In vitro* activity of essential oils against. *T. brucei brucei* and *Trypanosoma evansi*. Journal of Parasitology Research. 2010;1-5

51. Sawadogo WR, Douaron GL, Maciuk A, Bories C, Loiseau PM, Figadère B, Guissou IP, Nacoulma OG. In vitro antileishmanial and antitrypanosomal activities of five medicinal plants from Burkina Faso, Parasitol Res. 2011;1-5.

52. John OI, Alexander IG, Carol JC, Hazar AM. Anti-trypanosomal activity and cytotoxicity of some compounds and extracts from Nigerian Medicinal Plants, Phytochemicals - Bioactivities and Impact on Health, Prof. Iraj Rasooli (Ed.), ISBN: 978-953-307-424-5; 2011 In Tech, Available:http://www.intechopen.com/books/phytochemicals-bioactivities-and-impact-on-health/anti-trypanosomalactivity-and-cytotoxicity-of-some-compounds-and-extracts-from-nigerian-medicinal-p

53. Wurochekke AU, Bello H, Yusuf HB, Mahmoud SJ. *In-vitro* trypanocidal activity of aqueous stem bark of *Haematostaphis barteri* against *Trypanosoma congolense* and *Trypanosoma brucei brucei.* Sch. Acad. J. Pharm. 2014;3(1):38-42.

54. Bulus T, Addau FT. Comparative Anti-trypanosomal Screening of Methanolic Extracts of Khaya Senegalensis and *Moringa oleifera*. Science World Journal. 2013;8(2).1-6

55. Antia RE, Olayemi JO, Aina OO, Ajaiyeoba EO. *In vitro* and *In vivo* animal model antitrypanosomal Evaluation of ten medicinal plant extracts from south west Nigeria. African Journal of Biotechnology. 2009;8(7):1437-1440.

56. Nwakaego EN, *In vitro* anti-trypanosomal activity of *Morinda lucida* leaves. African Journal of Biotechnology. 2012;(7):1812-1817

57. Abdulazeez AM, Baba IA, Yenusa EZ, Omanibe SJ, Oladimeji IH. Anti-trypanosomal effect of Peristrophe bicalyculata extract on *Trypanosoma brucei brucei*-infected rats. Asian Pacific Journal of Tropical Medicine. 2013;37: 523–531.

58. Ene AC, Edeh NG, Bonny-Okoli C, Ojiako OA, Ujowundu CO, Igwe CU. *In vitro* and *In vivo* anti-trypanosomal effects of methanol and aqueous extracts of *Picralima nitida*. British Journal of Pharmaceutical Research. 2014;4(5):644-653.

59. Atawodi SE, Funmi O. Evaluation of Anti-trypanosomal Properties of four extracts of leaves, stem and root barks of *Prosopis africana* in Laboratory Animals. Biokemistri. 2009;21 (2):101-108.

60. Oluyomi SA, Melissa LS, Musbau AK, Avery VM. antitrypanosomal activity of ethanolic extracts of *Psidium guajava* leaves in Alamar Blue based assay. VETERINARSKI ARHIV. 2011;81(5):623-633.

61. Mergia E, Workineh S, Getachew T, Tilahun T. Phytochemical screening and *In vitro* antitrypanosomal activity of aqueous and methanol leaf extract of *Verbascum sinaiticum* (Scrophulariaceae) against *Trypanosoma congolense* Field Isolate. J Clin Exp Pathol. 2014;4(4):1-8.

62. Bala AY, Adamu T, Abubakar U, Ladan MJ, Abubakar MG. Studies on the *In vitro* trypanocidal effect of the extracts of some selected medicinal plants in Sokoto State, Nigeria. Nigerian Journal of Basic and Applied Science. 2009;17(2):257-264.

63. Nour AMM, Sami AK, Marcel K, Reto B, Wai'l EA, Thomas JS. The antiprotozoal activity of methylated flavonoids from *Ageratum conyzoides* L. J. Ethnopharm, 2010;129:127–130.

64. Nibret E, Sporer F, Asres K, Wink M. Antitrypanosomal and cytotoxic activities of pyrrolizidine alkaloid-producing plants of Ethiopia. Journal of Pharmacy and Pharmacology. 2009;616:801–808.

65. Nibret EWM. Volatile components off our Ethiopian Artemisia species extractsandtheir *In vitro*. Phytomedicine; 2009. DOI:10.1016/j.phymed.2009.07.016.
66. Nibret E, Ashour ML, Rubanza CD, Wink M. Screening of some Tanzanian medicinal plants for their trypanocidal and cytotoxic activities. Phytotherapy Res. 2010;246:945–947.
67. Oboh A, Lawal M, Malann YD. Anti-trypanosoma activity of the ethanolic leaf extract of *Senna occidentalis* (Fabaceae) on *T. brucei* brucei Infected Mice. I. 2. No. 1. 2013;32-37.
68. Freiburghaus F, Jonker S, Nkunya M, Mwasumbi L, Brun R. *In vitro* trypanocidal activity of some rare Tanzanian medicinal plants. Acta Tropica. 1997;673:181–185.
69. Freiburghaus, F, Kaminsky R, Nkunya M, Brun R. Evaluation of African medicinal plants fortheir *In vitro* trypanocidal activity. J. Ethnophar. 1996;551:1–11.
70. Mwangi ESK, Keriko JM, Machocho AK, Wanyonyi AW, Malebo HM, Chhabra SC, Tarus PK. Antiprotozoal activity and cytotoxicity of metabolites from leaves of *Teclea trichocarpa*. Journal of Medicinal Plants Res. 2010;4(9):726-731.
71. Mercy G, Ahmed H, Joseph K, Patrick K, Grace M, Mary N, Gathu N. Anti-trypanosomal Tetranotriterpenoids from *Toona ciliata* roots. Agric. Biol. J. N. Am. 2011;2(7):1042-1047.
72. Freiburghaus F, Ogwal EN, Nkunya MH, Kaminsky R, Brun R. *In vitro* antitrypanosomal activity of African plants used in traditional medicine in Uganda to treat sleeping sickness.Tropical Med. Inter. Health. 1996b;16:765–771.
73. Shittu OK, Habibat U, Usman YU. Effect of methanolic leaf extract of Thymus vulgaris on some biomarker enzymes in *T. brucei* infected rats. Int J Pharm Biomed Res. 2013b;4(2):83-87.
74. Mann M, Oluwaseyi RI, Abdulfatai TA, Chidiebere U, Ekpenyong EU, Isaac IO, Mohammed SS, Dauda RI, Yusuf AY, Kabir AY, Ogbadoyi, EO. *In vivo* Anti-trypanosomal effects of some ethnomedicinal plants from Nupeland of North Central Nigeria. J Tradit Complement Altern Med. 2011;8(1):15-21.
75. Olukunle JO, Abatan MO, Soniran OT, Takeet MI, Idowu OA, Akande FA, Biobaku, KT, Jacobs EB. *In-vivo* Anti-trypanosomal evaluation of some medicinal plants extracts from Ogun State, Nigeria. Science World Journal. 2010; 1(5):17-19.
76. Hassan MI, Emmanuel OO, Kabiru YA, Maimuna UB, Ilumi JY. Evaluation of anti-trypanosomal activity of ethyl acetate extract of adansonia digitata seed extract In *T. B. brucei* Infected Albino MiceInt. J. Drug Res. Tech. 2012;2(7):454-460.
77. Yusuf OK. Evaluation of Anti-trypanosomal Activities of Fermented Wheat germ and Garlic bulb Extracts in *T. brucei*-infected rats. A Phd Thesis Submitted To the Department Of Biochemistry, University Of Ilorin, Ilorin, Nigeria; 2010.
78. Peni IJ, Ajagbonna OP, Elinge CM, Agaie BM, Elsa AT, Yusuf H, Ribah IM. Effects of *Allium sativum* Bulb extract, diminazene aceturate and their combination on parasitaemia, and biochemical indices in rats experimentally Infected with *Trypanosoma Brucei Brucei.* Journal of Applied Pharmaceutical Science. 2012;02 (06): 112-115.
79. Kabiru YA, Ogbadoyi EO, Okogun JI, Gbodi TA, Makun HA. Anti-trypanosomal potential of eucalyptus camaldulensis. British Journal of Pharmacology and Toxicology. 2013;4(2):25-32.
80. Kabiru YA, Okogun JI, Gbodi TA, Makun HA, Ogbadoyi EO. Evaluation of the efficacy of combination therapy in *T. b. brucei*–infected mice using extracts of annona senegalensis and eucalyptus camaldulensi. IOSR Journal of Pharmacy. 2012;24;32-37
81. Samia AH. Trypanocidal activity of some Sudanese medicinal plants against experimental *Trypanosoma evansi* infection. Research Journal of Medicinal Plant. 2011;5:756–763.
82. Esther M, Ogoti P, Joanna A, Gabriel M, Mabel I, Grace M. Evaluation of *In vivo* antitrypanosomal activity of selected medicinal plant extracts. Journal of Medicinal Plants Research. 2008;3(11): 849-854.
83. Teka F, Getachew T, Workineh S. Evaluation of *In vivo* anti-trypanosomal activity of crude extracts of Artemisia abyssinica against a *Trypanosoma congolense* isolate. BMC Complementary and Alternative Medicine. 2014;14:117.

84. Ene AC, Atawodi SE, Ameh DA, Nnamani CN, Apeh YEO. Anti-trypanosomal effects of petroleum ether, chloroform and methanol extracts of *Artemisia maciverae* Linn. Indian Journal of Experimental Biology. 2009;47:981-986.
85. Ene AC, Edeh NG, Bonny-Okoli C, Ojiako OA, Ujowundu CO, Igwe, CU. *In vitro* and *In vivo* antitrypanosomal effects of methanol and aqueous extracts of *Picralima nitida.* British J. Pharm Res. 2014;4(5):644-653.
86. Nweze NE, Anene BM, Asuzul U. *In vitro* anti-trypanosomal activities of crude extracts, β-sitosterol and α-sulphur from *Buchholzia coriacea* seed, African J. Biotec. 2011;10(69):15626-15632.
87. Okere OS, Iliemene UD, Tese T, Mubarak L, Olowoniyi OD. Proximate analysis, phytochemical screening and antitrypanocidal potentials of *Bucholzia coriacea* in *Trypanosoma brucei brucei*-Infected MiceI OSR-JPBS. 2014;9(4):69-77.
88. Biu AA, Buratai LB, Onwuatogwu J, Mohammed A, Agada NO, konto M. *In vivo* efficacy of aqueous extract of *Citrullus lanatus* Leaf on *T. brucei* Infected Albino Rats. Journal of Agriculture and Veterinary Sciences. 2013;5(2):57–63.
89. Samia HA, Israa MM, Salwa MEK, Ismail AA.Trypanocidal effect of Cannabis sativa on experimental camel trypanosomosis. Research Journal of Medicinal Plant. 2012;1-5.
90. Abubakar A, Iliyasu B, Ojiegbu FN, Igweh AC, Shamaki BU, Dung EC, Domtur LL, Okogun JI, Gbodi TA, Ogbadoyi EO. Evaluation of the anti-trypanosomal activity of *Cucumis* metuliferus pulp in rabbits. Journal of Medicinal Plants Research. 2011;5(11):2136-2142.
91. Ibrahim MA, Aliyu AB, Meduteni K, Yunusa I. Saponins-rich fraction of *Calotropis procera* leaves elicit no antitrypanosomal activity in a rat model. Asian Pacific Journal of Tropical Biomedicine. 2013; 37:569–572.
92. Mann A, Egwim EC, Barnabas B, Nda-Umar A, Mohammed G, Ekanem JT. Efficacy of *Dissotis rotundifolia* on *Trypanosoma brucei brucei* infection in rats. African Journal of Biochemistry Research. 2009;3(1):005-008.
93. Ogbadoyi EO, Kabiru AY, Omotosho RF. Preliminary studies of the antitrypanosomal activity of *Garcinia kola* nut extract in mice infected with *Trypanosoma brucei brucei*. Journal of Medicine and Medical Sciences. 2011;21:628–631.
94. Abedo JA, Jonah OA, Abdullahi RS, Mazadu MR, Idris HY, Muhammed H, Shettima FT, Ombugadu S, Daudu M, Garba J, Abdulmalik Kugu BA, Usman AO. Evaluation of Trypanosomal activity of *Tapinanthus globiferus* and Gongronema latifolium on *Trypanosoma congolense* Bioscience Res. 2013;10(1):20-28.
95. Mann A, Ogbadoyi EO. Evaluation of medicinal plants from Nupeland for their *In vivo* Antitrypanosomal Activity. American Journal of Biochemistry. 2012;2(1):1-6.
96. Adamu M, Nwosu CO, Agbede RIS. Anti-trypanosomal effects Of aqueous extract of *Ocimum gratissimum* (Lamiaceae) leaf In rats infected With *Trypanosoma brucei brucei.* Afr. J. Trad. CAM. 2009;6(3):262–267.
97. Atawodi SE, Funmi O. Evaluation of anti-trypanosomal properties of four extracts of leaves, stem and root barks of *Prosopis africana* in Laboratory Animals. Biokemistri. 2009;21(2):101-108.
98. Adeyemi OS, Akanji MA, Oguntoye SA. Ethanolic leaf extract of *Psidium guajava*: Phytochemical and trypanocidal activity in rats infected with *T. brucei brucei*. Journal of Medicinal Plants Research. 2009;3(5): 420-423.
99. Abubakar A, Okogun JI, Ogbadoyi EO. Screening for anti-trypanosomal potential of *Tridax procumbens* in infected mice. Programme Book. 3rd Stakeholders Meeting of the African Network for Drugs and Diagnostics Innovation 11-13 October United Nations Office in Nairobi UNON, Kenya; 2010.
100. Yusuf AB, Umar IA, Nok AJ. Effects of methanol extract of *Vernonia amygdalina* leaf on survival and some biochemical parameters in acute *T. brucei brucei* infection African Journal of Biochemistry Research. 2012;6(12):150-158.
101. Senn M, Gunzenhauser S, Brun R, Séquin U. Antiprotozoal polyacetylenes from the Tanzanian medicinal plant *Cussonia zimmermannii*. Journal of Natural Products. 2007;7010:1565–1569.

102. Githua M, Hassanali A, Keriko J, Murilla G, Ndungu M, Nyagah G. New antitrypanosomal tetranotriterpenoids from *Azadirachta indica*. African Journal of Traditional, Complementary and Alternative Medicines. 2010;7(3):207–213.
103. Ambrozin ARP, Vieira PC, Fernandes JB, da Silva MFGF, de Albuquerque S. Trypanocidal activity of Meliaceae and Rutaceae plant extracts. Mem Inst Oswaldo Cruz. 2004;99: 227-231
104. Michael A, Hata Y, Stefanie Z, Melanie Q, Marcel K, Matthias H. Antiplasmodial and antitrypanosomal activity of pyrethrins and pyrethroids. J. Agric. Food Chem. 2011; 59:9172–9176.
105. Ana CL, Artur PN, Alessandra RP, Ambrozin JB, Fernandes IPC, Vieira MF, das G F. da S. Sérgio de A. Trypanocidal activity of flavonoids and limonoids isolated from Myrsinaceae and Meliaceae active plant extracts. Revista Brasileira de Farmacognosia Brazilian Journal of Pharmacognosy. 2010;20(1):1-6.
106. Hocquemiller, T, Cortes D, Arango GJ, Myint SH, Cave, A, Angelo A, Mufioz V, Fournet A. J. Nat. Prod.1991;54:450—452.
107. Freiburghaus F, Steck A, Pfander H, Brun R. Bioassay-guided isolation of a diastereo isomer of kolavenol from Entada abyssinica active on *Trypanosoma brucei rhodesiense*. J. Ethnopharm. 1998;613: 179–183.
108. Camacho MD, Phillipson JD, Croft SL, Marley D, Kirby GC, Warhurst DC. Assessment of the antiprotozoal activity of *Galphimia glauca* and the isolation of new nor-secofriedelanes and nor-friedelanes. J Nat Prod. 2002;65:1457-1461.
109. Shuaibu MN, Wuyep PT, Yanagi T, Hirayama K, Ichinose A, Tanaka T, Kouno I, Trypanocidal activity of extracts and compounds from the stembark of *Anogeissus leiocarpus* and *Terminalia avicennoides*. Parasitology Research. 2008;1024:697–703.
110. Okpuzor J, Okochi VI, Okubena MO, Awoyemi AK. The influence of African Herbal Formula on the haematological parameters of trypanosome infected rats. African Journal of Biotechnology. 2003; 2(9):312-316.
111. Patrick OE, Canice CA, Augustine OO. Response of *T. brucei brucei*–induced anaemia to a commercial herbal preparation. African Journal of Biotechnology. 2003;2(9):307-311.
112. Fathy MAA, Zainal ABH, Abdinasir YO, Nazlina I. Antitrypanosomal effects of crude ethanolic extract of *Artemisia herba alba* follwing experimental infection of rabbits. IOSR Journal of Pharmacy and Biological Sciences. 2013;7(5):60-68.
113. Fathy MAA, Zainal ABH, Abdinasir YO, Nazlina I. Antitrypanosomal effects of crude ethanolic extract of *Artemisia herba alba* follwing experimental infection of rabbits. AIP Conference Proceedings 2013;1571:177. DOI: 10.1063/1.4858650.
114. Ekanem JT, Yusuf OK .Some Biochemical and Haematological effects of Black seed (*Nigella sativa*) oil on *T. brucei* infected rats. Afr. J. Biotech. 2008;7(2):153 –157.
115. Yamamoto T. Chemistry and application of green tea. CRC Press, Inc., Boca Raton, Yineger H, Kelbessa E, Bekele T, Lulekal E. Ethnoveterinary medicinal plants at Bale Mountains National Park, Ethiopia. J Ethnopharmacol. 2007;112:55-70.
116. Cristina P, María CG, Mo´nica IE, Virginia M, Jorge C, Mirtha MF, Hector NT. Anti-*Trypanosoma cruzi* activity of green tea (*Camellia sinensis*) Catechins. Antimicrobial Agents and Chemotherapy. 2004;48(1):69–74.
117. Omale J, Joseph JE. Comparative evaluationof trypanocidal activities of Cissus multistriata and Saba florida (benth) leaf extracts J Biosci Tech. 2011;2(1):197-204.
118. Scott IM, Jensen HR, Philogene BJR, Arnason JT. A review of *Piper* spp. (Piperaceae). Phytochemistry, insecticidal activity and mode of action. Phytochem. Rev. 2008;7:65-75.
119. Shaba P, Pandey NN, Sharma OP, Rao JR, Singh RK. Anti-trypanosomal activity of *Piper nigrum* L (Black pepper) against *Trypanosoma Evansi.* J Vet Adv. 2012; 2(4):161-167.
120. Shittu OK, Tanimu M. Proximate analysis of wheat supplemented diet and its anti-trypanosomal effect on infected rat. International Journal of Applied Biological Research. 2012;4(1-2):109-103.
121. Sepide M, Alireza O, Majid M, Vahide EA. Laleh P. Anti-inflammatory effects of *Zingiber officinale* in type 2 diabetic

patients. Adv. Pharm. Bull. 2013;3(2):273-276.

122. Ekanem JT, Majolagbe OR, Sulaiman FA, Muhammad NO. Effects of honey-supplemented diet on the parasitaemia and some enzymes of *Trypanosoma brucei*-infected rats. African Journal of Biotechnology. 2006;5(17):1557-1561.

123. Orhue N, Nwanze E, Okafor A. Scoparia dulcis protects against *T. brucei* induced immunosuppression in experimentally infected rabbits. Afri. J. Food Sci. 2009; 3:172-175.

124. Nok AJ. Azaanthraquinone inhibits respiration and *In vitro* growth of long slender blood stream forms of *Trypanosoma congolense*. Cell Biochemistry and Function. 2002;203:205–212.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=1037&id=3&aid=8778