



# Ethno-Botanical Survey: Exploring Indigenous Remedies for African Animal Trypanosomosis in Nigeria

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## Authors' contributions

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

## Article Information

DOI: 10.9734/IJBCRR/2023/v32i10846

## Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/109816>

**Original Research Article**

**Received: 10/10/2023**

**Accepted: 14/12/2023**

**Published: 29/12/2023**

## ABSTRACT

The Fulani pastoralist of Nigeria and other indigenous livestock farmers have used medicinal plants to treat various animal diseases for centuries, amongst which include the African animal trypanosomosis (AAT). It is a severe debilitating parasitic disease of livestock and some wild animal species. It is caused by pathogenic Trypanosomes and transmitted by Tsetse flies. It causes severe economic losses to livestock farmers in Africa. In this study, an ethno-botanical survey was conducted in the Tsetse-endemic areas of Bauchi, Plateau and Kaduna States of Nigeria to identify medicinal plants used traditionally to treat AAT. During the study, eighty questionnaires were administered to the respondents who were predominantly Fulani pastoralists, and other indigenous livestock farmers. seventy-eight questioners were fully completed and retrieved. The study revealed that that most of the respondents have retained the tradition knowledge system of medicinal plants passed down to them for generations. The study revealed various herbal preparation methods

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employed by indigenous Nigerian livestock farmers, including decoctions, infusions, and incorporating plant material into feed. Fifteen medicinal plants species belonging to 13 families were identified to be used by Nigerian pastoralist for the treatment AAT. These included *Khaya senegalensis* (28.2%), *Azadirachta indica* (25.6%), *Boswellia dalzielii* (23%), *Prosopis africana* (23%), *Anogeisus leocarpus* and *Terminalia avicennioides* (21.8%), *Adansonia digitata* and *Annona senegalensis* (19.2%), *Pilostigma thoningii* (16.7%), *Nauclea latifolia* (15.0%). *Balanites aegyptiaca* (12.5%). *Eucalyptus torelliana* (11.5%), *Tamarindus indica* (10.3%), *Ximenia americana* (9%) and *Guiera senegalensis* 7.7%).

**Conclusions:** The information obtained from this study and the medicinal plants identified can be harnessed for the development of plant-based medicaments for the treatment of AAT.

**Keywords:** Trypanosomosis; tsetse flies; ethnobotanical; survey; medicinal plants.

## 1. INTRODUCTION

Before the advent of orthodox drugs, many livestock farmers in Nigeria and in many other African countries used herbal preparations and other traditional medicines for the treatment of both human and animal diseases [1]. These traditional medicine systems are still being used especially among the Fulani and other indigenous livestock farmers in northern Nigeria. This traditional medicine knowledge system has been passed through generations and is still being employed in the management of different human and animal medical conditions, especially in African rural areas where modern medical and veterinary services are either unavailable or scarcely available [2]. The use of herbal medicaments is preferred by most rural farmers because they are a cheaper alternative to orthodox medicines [3]. The therapeutic effects of most medicinal plants have been associated with the presence of high contents of phytochemical compounds like flavonoids, alkaloids, glycosides, terpenes, tannins etc. The presence of these compounds in medicinal plants has also been associated with their antioxidant activities, which plays a role in the prevention of age-related diseases which are particularly induced by oxidative stress [4]. Most of these plant compounds are also known to possess therapeutic potentials against most infectious and non-infectious diseases including cancer prevention [5].

The quest for medicinal plants with potent antitrypanosomal effects stems from the fact that AAT causes severe debilitation in both livestock and some wild animal species, and the eradication of the diseases using chemotherapy and vaccination has been hindered by the antigenic variation and resistance to

conventional drugs developed by the trypanosome parasites. Therefore, this study sought to carry out an ethno-botanical survey in order to obtain valuable information on the medicinal plants used by the Fulani pastoralists and other indigenous livestock keepers to treat AAT in Nigeria and the various preparation methods.

## 2. MATERIALS AND METHODS

### 2.1 Instrument of Study

A well-structured open-ended questionnaire was utilized as the study's instrument in conjunction with facilitated conversation, as described by [3]. The respondents were chosen based on their location in the Tsetse fly endemic areas of the country, asked to provide information on their understanding of AAT, the medicinal plants used to treat the disease, the methods of processing the plants, the methods of administering the prepared medications, the dosages and outcomes of treatment with such plant preparations.

Prior to the commencement of the study in the selected areas, Permission was sought from the chieftains and traditional leaders of the communities. The purpose and significance of the study was explained to them, after which they willingly allowed the research study to be carried out in the areas. The respondents that participated in the study also willingly consented to be part of the study. The respondents were requested to share their experiences and knowledge of medicinal plants especially those used for the treatment of African Animal Trypanosomosis. They were also to give information on the part or parts of the plants used for the treatments, the methods of

preparation, the routes of administration, the dosages or quantities administered and the frequency of administration. The respondents were also requested to give information on the effectiveness of the treatments and the time taken for recovery to take place

## 2.2 Area of Study

The study was carried out in four Tsetse fly endemic areas of the country, which included Toro Local government area of Bauchi State, Jos East and Jos South Local Government Areas of Plateau State and Kaura Local Government Area of Kaduna State. These areas all within the savannah or grass land areas of the country where cattle grazing activities are high.

## 2.3 Bauchi State

**Bauchi state is located in the North:** East region of Nigeria. The geographical coordinates of Bauchi state are a latitude 10°30'N and Longitude 10°0'E. It covers a land area of about 45,83 square km. Jigawa and Kano states form borders with Bauchi state on the northwest, Kaduna state on the west, and Plateau and Taraba states on the southern part, while Yobe state is on the eastern part. The ethnic groups of Bauchi state include: Tangale, Waja (Wajawa), Fulani, and Hausa. The headquarters of the local government is in Toro town. it has total land area of about 6932 square kilometers, Toro LGA has average annual temperatures of 32 degrees Celsius. There are currently about 449,819 people living in Toro LGA, according to estimates. The major tribes found in Toto include the Panawa, Jarawa, Izere, and Hausa/Fulani. They make up the main ethnic groups in the local government. The languages spoken in area include Zeem, Hausa, and Ffulde . Both Islam and Christianity are extensively practiced winin the communities. The GPS coordinates for Toro Local Government Area are Latitude 10°26'47.26" N and Longitude 9°13'14.02" E.

## 2.4 Plateau State

According to Offiah (2012)b, Plateau State is the twelfth-largest state in Nigeria. Geographically, it belongs to the nation's North Central region. Jos serves as the capital of Plateau State. The Jos Plateau is where the State gets its name [3].

Plateau state has a land area of 26,899 square kilometers. It is situated between longitudes 80°32' and 100°38' East and latitudes 80°24' and 80°24' North. The Shere Hills' elevation varies from 1,200 meters to 1,829 meters above sea level.

Plateau State is situated in the tropical zone, but has a near temperate climate with an average temperature of between 18 and 22°C. The mean annual rainfall varies from 131.75 cm (52 in) in the southern part to 146 cm (57 in) on the Plateau. The average lower temperatures have led to a reduced incidence of some tropical diseases such as malaria. The Jos Plateau is the source of many rivers in northern Nigeria, including the Kaduna, Gongola, Hadejia and Yobe rivers [6].

Jos East local government area has its headquarters in Angware town, which also serves as the local government's administrative center. The Afizere, also known as the Jarawa, are the main tribe in Jos East, which has a population of 85,602 and a land area of roughly 1,020 km<sup>2</sup>. The neighborhood's postal code is 930. The Asharwa International dancing company is a significant Afizere dancing company that has represented Nigeria in nations like the United Kingdom, the United States, South Africa, Kenya, Ukraine, etc.

Jos South Local Government Area (LGA) is situated between latitudes 9°48'00"N and 8°52'00"E. It has a land area of around 510 km<sup>2</sup> and is 1,250 meters above sea level. Its northern and eastern boundaries are formed by Jos North LGA, while its eastern and southern boundaries are formed by Jos East LGA, Bassa, Riyom, and Barkin Ladi.

## 2.5 Kaduna State

Kaduna State geographically falls between latitude 10°20'N and longitude 7°45'E. the state is classified under the North-western zone of the country, however, only the northern part of the state truly is in the north-west. Kaduna State consists of twenty-three (23) Local government Areas.

Kaura LGA has a mean annual temperature of 35 °C, with the highest and lowest temperatures occurring in April and January, respectively, and is situated in the Middle Belt region of the nation.

It is 485 square kilometers in size and experiences average temperatures of 32 degrees centigrade. The region experiences two distinct seasons: dry and rainy, with an annual rainfall of 1,000 mm and an average wind speed of 11 km/h. The economy of Kaura is basically agrarian with a variety of crops grown in the area. The inhabitants also practice animal husbandry where domestic animals such as cows and goats are reared and sold as a source of income. Other important economic enterprises engaged in by the people of Kaura LGA include hunting, blacksmithing, and leather works. Kaura LGA is made up of the towns and villages of Garaji, Fadan Takad, Bondong, Biniki, Fada, Fadan Attakar, Fada Ciki Gari, and Zumuruk.

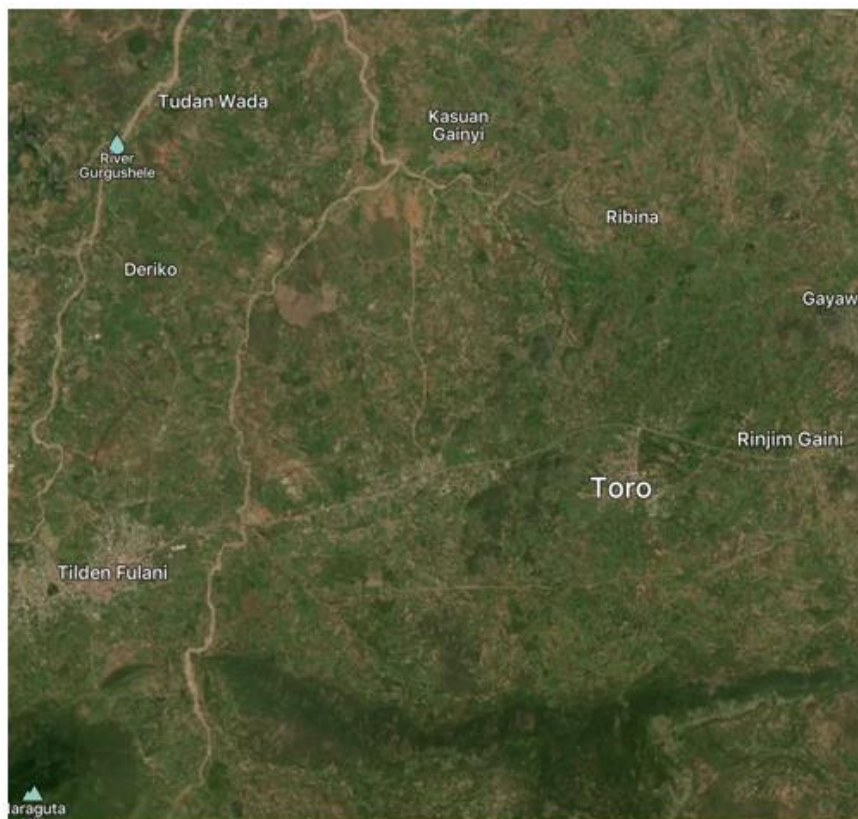
## 2.6 Instrument of Study

A well-structured open-ended questionnaire with a guided dialogue technique was used as the primary data collection tool. A total of 80 questionnaires were distributed to the

respondents, and 78 were fully completed and retrieved (97.5%). The questionnaires were administered to selected members of the communities who kept cattle and other farm animals. The data collection was accompanied by a guided dialogue technique described by based on the information required concerning medicinal plants used to treat AAT [3].

## 2.7 Sampling Techniques

The purposeful sampling technique was used in this study; because the technique requires the researcher to identify the segment of the population that can provide the required information and he collects such information from the respondents using the necessary tools. In this study, the target population was the Fulani pastoralist who are known to be verse in the area of herbal medicines used for treating different animal disease conditions. Other respondents included the non-Fulani indigenous livestock keepers within the studied areas.



**Fig. 1. Google earth geographical positioning of Toro Local Government**  
Latitude: 10° 2' 50"N, Longitude: 9° 4' 55" E, Elevation: 962 m (3,156 feet) above sea level. Source: (<https://mapcarta.com/>)

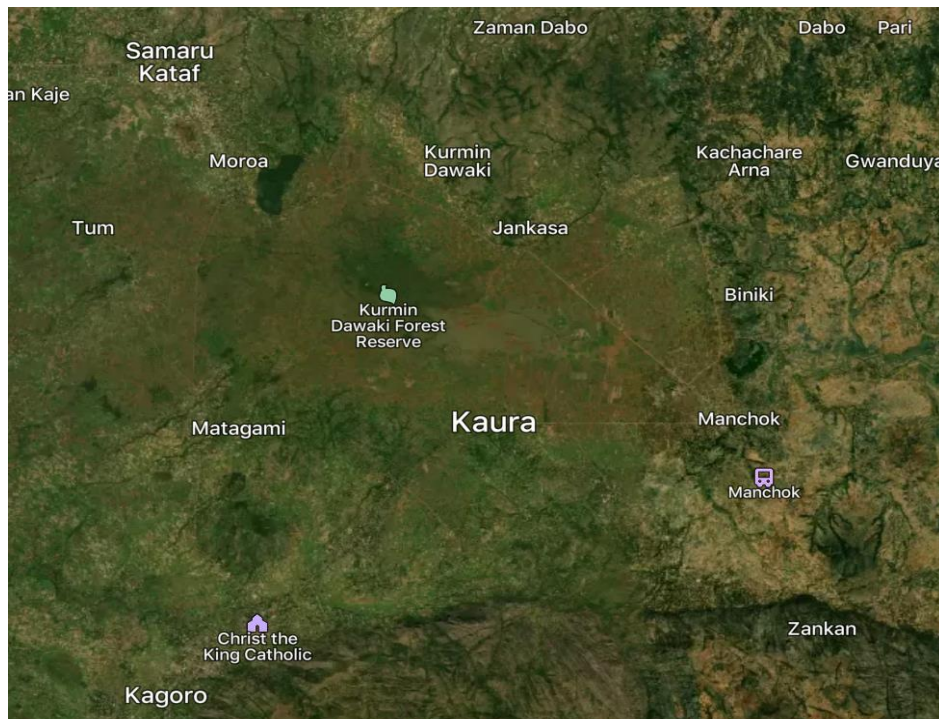




**Fig. 2. Google earth geographical positioning of Jos East**  
Latitude: 9° 53' 28"N, Longitude: 9° 7' 5" E, Elevation: 1,095 m (3,593 feet) above sea level. Source: (<https://mapcarta.com/>)



**Fig. 3. Google earth geographical positioning of Jos South**  
Latitude: 9° 45' 17"N, Longitude: 8° 50' 34"E, Elevation: 1,217m (3,993ft) above sea level. Source: (<https://mapcarta.com/>)



**Fig. 4. Google earth geographical positioning of Kaura Local Government area of Kaduna State**

Latitude: 9° 45' 17"N , Longitude: 8° 27' 30"E, Elevation: 968m (3,176 feet) above sea level. Source: (<https://mapcarta.com/>)

**Table 1. Questionnaire distribution and retrieval**

LGA	Number of Questionnaires administered	No. Returned	Ethnic Group	Gender/marital status	Age group
Toro	20	20	Fulani	Male/Married	15-25 = 2 25-50= 15 >50 = 3
Jos East	20	20	Fulani / Izere	Male/Married	15-25 = 0 25-50= 15 >50 = 5
Jos South	20	18	Fulani/Berom	Male/Married	15-25 = 0 25-50= 12 >50 = 8
Kaura	20	20	Fulani	Male/Married	15-25 = 5 25-50= 10 >50 = 5

### 3. RESULTS

#### 3.1 Medicinal Plants with Folkloric Evidence

Some of the medicinal plants mentioned by respondents to have folkloric evidence of use for the treatment of African animal

trypanosomosis included *Khaya senegalensis*, *Azadirachta indica*, *Boswellia dalzielii*, *Prosopis Africana*, *Anogeissus leiocarpus*, *Terminalia avicennioides*, *Adansonia digitata*, *Annona senegalensis*, *Piliostigma thoningii*, *Corymbia torelliana*, *Balanites aegyptiaca*, *Nauclea latifolia*, *Tamarindus indica*, *Ximenia americana*, *Guiera senegalensis*.

Most of the respondents admitted having knowledge of medicinal plants used for the treatment of African animal trypanosomosis. Out of the 78 respondents, 22 (28.2%) indicated that they used *Khaya senegalensis* for the treatment of African Animal trypanosomosis, either alone or in combination with other preparations. 20 respondents (25.6%) indicated that they have the folkloric evidence of the use of *Azadirachta indica*, which made it the second highest in occurrence and percentage distribution. *Boswellia dalzielii* and *Prosopis africana* were each mentioned by 18 respondents (23%) as medicinal plants used to treat AAT. In like manner, *Anogeissus leocarpus* and *Terminalia avicennioides* were each mentioned by 17 respondents (21.8%) indicated their use for the treatment of AAT. *Adansonia digitata* and *Annona senegalensis* were each mentioned also by 15 respondents Others also mentioned during the survey included *Piliostigma thoningii* by 13 respondents (16.7%). *Nauclea latifolia* was mentioned by 12 respondents (15.4). *Balanites aegyptica* was mentioned by 10 respondents (12.8). *Corymbia torelliana* was mentioned by 9 respondents (11.5) *Tamarindus indica* was mentioned by (7.7%). respondents (10.3%) and *Ximenea americana* was mentioned by 7 respondents (9%) and *Guiera senegalensis* was mentioned by 6 respondents (7.7%)

The Table 2 shows the frequency and percentage distribution of the medicinal plants indicated for the treatment of AAT in this study.

The table also shows their scientific/botanical names, Family names, Common names, Local names, parts of plant used, Frequency and Percentage Distribution as obtained during the survey.

Fig. 5 shows the frequency and percentage distribution of medicinal plants used for the treatment of African Animal trypanosomosis in Nigeria.

#### 4. DISCUSSION

The Fulani ethnic group of Nigeria is popularly known for keeping Cattle either for pleasure (prestige) or for business [7]. It is also generally known that the Fulanis have good knowledge of herbs and plants that are used for medicinal purposes [8]. Most of the respondents in this study were Fulanis, and many admitted to having good knowledge of medicinal plants used for the treatment of both animal and human diseases. Majority of them also kept cattle at one time or the other, or are still keeping cattle either for prestige or for business.

Out of a total number of 80 questionnaires distributed to the respondents in this study, 78 were completed and retrieved. Literate respondents were given the questionnaires to fill in the provided spaces with appropriate answers to the questions raised. The guided dialogue interview technique was used for the non-literate respondents.

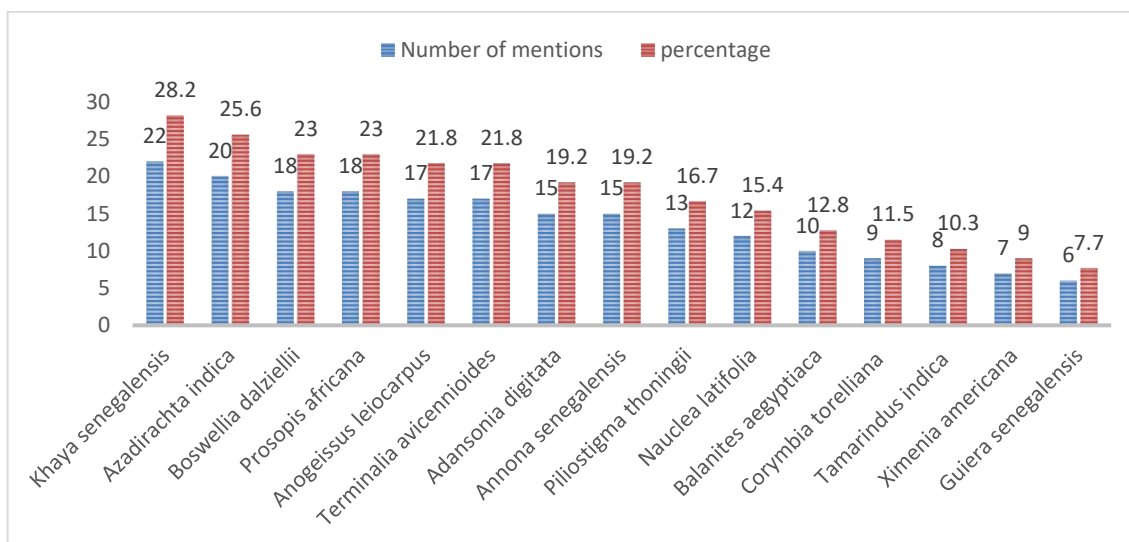


Fig. 5. Frequency and percentage distribution of the plants used for the treatment of Aat in Nigeria

**Table 2. Medicinal plants used in the treatment of African animal trypanosomosis in (Plateau and Kaduna States) of Nigeria**

NS	Botanical Name	Family	Common Name	Local Name	Part of plant used	Occurrence	Percentage
1	<i>Khaya senegalensis</i>	Meliaceae	African Mahagony	H-madachi F-Kahije/ dalihe	Bark/root	22	28.2%
2	<i>Azadirachta indica</i>	Meliaceae	Neem	H-Dogonyaro F-Ganyi	Bark/Leaves	20	25.6%
3	<i>Boswellia dalzielii</i>	Burseraceae	Frankincense	H-Ararabi F-Janawhi	Bark	18	23%
4	<i>Prosopis africana</i>	Mimosaceae	African mesquite Iron wood	H-Kiryra F-Kahi/Kohi	Bark/root	18	23%
5	<i>Anogeissus leiocarpus</i>	Combretaceae	Axle wood tree	H-Marke F-Kajoli	Bark	17	21.8%
6	<i>Terminalia avicennioides</i>	Combretaceae	-	H-Baushe F-Kulahi	Bark	17	21.8%
7	<i>Adansonia digitata</i>	Bombacaceae	Baobab	H-Kuka F-Bokki	Leaves	15	19.2%
8	<i>Annona senegalensis</i>	Annonaceae	Persild custard Apple	H-Gwandan-daji F-Dukuhi	Stem bark	15	19.2%
9	<i>Piliostigma thoningii.</i>	Caesalpiniaceae	Camel's foot	H-Kalgo	Leaves	13	16.7%
10	<i>Nauclea latifolia</i>	Rubiaceae	African peach	H-Tafashiya F-Bakure	Bark/Leaves	12	15.4%
11	<i>Balanites aegyptiaca</i>	Balanitaceae	Desert date	H-Aduwa F-Tanni	Bark/Root	10	12.8 %
12	<i>Corymbia torelliana</i>	Myrtaceae	Gumtree, cadaga, Cadaghi	H- Rastata	Bark	9	11.5%
13	<i>Tamarindus indica</i>	Caesalpiniaceae	Tamarind	H-Tsamiya F-Jabbi	Bark /Leaves	8	10.3%
14	<i>Ximenia americana</i>		Wild olive	Tsada	Bark/root	7	9%
15	<i>Guiera senegalensis</i>	Combretaceae		H-Sabara F-Geloki	Bark	6	7.7%



Information was received on the plant used, methods of herbal preparation, mode of administration, dosage estimation, the effectiveness of the herbal remedy and adverse effects observed. The objectives and purpose of the survey were clearly explained to the respondents to avoid suspicion. (Okoli et al., 2002). The respondents were asked to mention as many medicinal plants as they could remember that are used for the treatment of the disease. They were also requested to show the research officers the plants where they were available. Some of the mentioned medicinal plants were collected for identification and further laboratory analysis.

Most of the respondents knew African Animal Trypanosomosis was as a disease entity, and were able to describe the most noticeable symptoms of the disease which included: dull hair coat, ocular discharges, foul smell, pica, abortion, progressive weight loss and death [18]. The literate respondents were requested to fill the questionnaires, giving all the details on the part(s) of the plant used, the methods of herbal preparation, the mode of administration, dosage estimation, the effectiveness of the herbal remedy and possible adverse effects observed [18]. Those who could not write were verbally interviewed, and their responses recorded by the research team members. Most of the plant parts that were mentioned to be commonly used in herbal preparations included the leaves, stem barks, and the roots. These plant parts were either used fresh or dried. However, majority of the respondents indicated their preference to use the dry plants, stating that the dried plants were more effective and produced better treatment results. Collected plants were either dried in shady areas or directly under the sun.

The dosage forms and administration techniques generally used by most livestock farmers included the following:

#### 4.1 Effusions and Decoctions

The fresh plant parts were harvested and pounded with mortar and pestle to break them down into smaller particles. They were then soaked in water or boiled before administering to the sick animals by oral drenching.

#### 4.2 Combination with Feed

The plant parts were harvested, dried and pulverized to powder using mortar and pestle, and then combined with the animal's feed especially when treating the very sick animals.

In most cases, red potash was added to the preparation either in the water or in the feed before administering to the animals

Other treatment methods included generating smoke with the fresh herbs to drive away tsetse flies and other biting insects. The animals were gathered together in one place and the fresh medicinal plants are placed in the fire to generate smoke that will drive the flies.

In some cases, pastes/ointments were made from the plants and topically applied to skin of sick or animals to serve both as healing ointment or insect repellent [6].

The dosages often administered vary from one farmer to the other. In most instances, the preparations are given twice a day, once in the morning before the animals go out for grazing and once when they return from grazing [9]. Only very seldom are animals treated 3 times a day, because the herd's men go grazing and the older ones go to the markets, only the little children that cannot medicate any sick animal are left at home. More often than not, the treatment continues until the animal either recovers or dies [10].

In this study, *Khaya senegalensis* was indicated as the most commonly used medicinal plant for the treatment of AAT amongst the Fulanis and other herdsmen of Nigeria. This result is in agreement with the findings of Maikai et al. [6], who carried out a preliminary survey of medicinal plants used in the treatment of Animal Trypanosomosis in Kaduna State. In their study, *Khaya senegalensis* took the center stage as the major plant used for the treatment of the disease in Kaduna State just as was the case in the four Local government areas covered in this study. *Khaya senegalensis* is a plant that has been indicated in treatment of several disease conditions both in humans and in animals especially amongst many tribes in Northern Nigeria. It is therefore not uncommon to find the Fulanis using it for the treatment of animal diseases.

In a similar study, Veronica Offiah, [3] while conducting a survey of herbal remedies used by Fulani herdsmen in the management of animal diarrhea in Plateau State, Nigeria, discovered that *Khaya senegalensis* was the most common medicinal plant used for the treatment of diarrhea during the survey, with 26 (24.76%) mentions and constituting the highest mentioned medicinal plant for the treatment and management of animal diarrhea in Plateau State.

*Azadirachta indica* (neem plant) has been recognized for thousands of years especially among traditional medicine of West Africa [11]. The anti-microbial activities of some of the compounds obtained from *Azadirachta indica* have been found to be very significant in herbal medicinal formulations [12]. Oil from the leaves, seeds and barks have been found to have a broad-spectrum anti-bacterial action [13]. The oil has also been reported to have some anti-protozoan properties. In spite of this knowledge, very little attempts have been made to establish the anti-trypanosomal activity of *Azadirachta indica* [12]. However, in their study, Ngure et al., [14] established that the oral administration of varying concentrations of the aqueous extracts of *Azadirachta indica* for three day increased the survival rates of the rats infected with *Trypanosoma brucei brucei*.

*Boswellia dalzielii* (Burseraceae) is a tree that is commonly found in the Savannah Forest areas of Nigeria. It is known to have been used for the treatment of various ailments in humans [15] such as diarrhea, syphilis and to induce vomiting [16]. *Boswellia dalzielii* is also very commonly used among the Fulani herdsmen for the treatment of animal diseases. The trypanocidal activity of the different parts of *Boswellia dalzielii* have been tested in separate studies and found to vary according to extraction medium and part of plant used (Isolate et al., 2014). Atawodi and his team of researchers tested the activities of extracts of different parts of *Boswellia dalzielii* against *Trypanosoma brucei brucei*. His results revealed that methanol leaf, stem and root bark extracts of the plant at 10 mg/mL significantly immobilized the trypanosome [16]. However, in this study, the anti-trypanosomal activity of *Boswellia dalzielii* could not be evaluated because the plant was not found to be readily available within the research environment. Other limitations to this study included the difficulty in

accessing remote areas with vehicles and most respondents were contacted more in grazing areas other than their home homes as they often go out for grazing early in the morning [17-19].

## 5. CONCLUSION

The African continent is a reservoir of many useful plants with the potentials that can be used for the treatment of both human and animal diseases. This study has revealed fifteen medicinal plants that are used locally by livestock keepers in Nigeria for the treatment of African animal Trypanosomosis. These medicinal plants that can be harnessed for the development of antitrypanosomal medicaments that can be used for the treatment of the disease in the tsetse fly endemic areas of sub-Saharan Africa.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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