AN ETHNO-BOTANICAL SURVEY OF MEDICINAL PLANTS USED FOR THE TREATMENT OF AFRICAN ANIMAL TRYPANOSOMOSIS IN NIGERIA

Comment [R1]: Title Suggestion: Consider a concise and captivating title that reflects the main focus of your research. For example: "Traditional Medicinal Plants for Treating African Animal Trypanosomosis: An Ethno-botanical Survey in Nigeria"

Abstract

The Fulani pastoralist of Nigeria and other indigenous livestock farmers have used medicinal plant to treat various animal diseases for centuries, amongst which includes the African animal trypanosomosis (AAT). It is a severe debilitating parasitic disease of livestock and some wild animal species. It is caused by the genus *Trypanosomes* and transmitted by Tsetse flies. It affects about 60million cattle in Africa, with about US$1.5billion in annual loses.Eradication of the disease through chemotherapy and vaccine development has been hindered by drug resistance and antigenic variation. This study was designed to find medicinal plants with potent antitrypanosomal phytocompounds that can control the disease and boost livestock production in Africa.

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, 80 questionnaires were administered to the respondent who were predominantly Fulani pastoralists, and other indigenous livestock farmers. 78 questioners were fully completed and retrieved (97.5).

The findings in this study also revealed that most of the respondents have retained the tradition knowledge system of medicinal plants passed down to them for generations. 15 medicinal plants species belonging to 13 families were identified to be used by Nigerian pastoralist for the treatment African animal trypanosomosis (AAT). *These included Khaya senegalensis (28.2%), Azadirachta indica (25.6%), Boswell delzienii (23%), Prosopis Africana (23%), Anogeisusleocarpus and Terminalia avicennioides(21.8%), Adansonia digitata and Annona senegalensis (19.2%), Pilostigmathoningii(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%).*
These medicinal plants are used to prepare medicaments in different dosage forms such as decoctions, infusions and mixing the plant material in feed.

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.

Comment [R2]: The abstract is clear and informative. Ensure that it succinctly summarizes the key aspects of your research, including objectives, methods, major findings, and conclusions.

Keywords: Trypanosomosis, Tsetse flies, Ethnobotanical, Survey, Medicinal plants

Introduction

Beforethe 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 (Rasool Hassan, 2013). 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(Uzun & Kaya, 2016). The use of herbal medicaments is preferred by most rural farmers because they are a cheaper alternative to orthodox medicines (Veronica Offiah, 2012). 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 (Castro et al., 2015). Most of these plant compounds are also known to possess therapeutic potentials against most infectious and non-infectious diseases including cancer prevention (WHO, 2007).

Comment [R3]: Expand a bit more on the significance of African Animal Trypanosomosis, its impact on livestock, and why finding alternative treatments is crucial. This can help set a stronger context for your study.

Consider providing a brief outline of the objectives of your research at the end of the introduction.

MATERIAL AND METHODS

Instrument of study

A well-structured open-ended questionnaire was utilized as the study's instrument in conjunction with facilitated conversation, as described by (Offia*et al*., 2012). The respondents were asked to provide information on their understanding of African Animal Trypanosomosis as a disease entity, the medicinal plants used to treat the disease, the methods of processing the plants, the methods of administering the prepared medications, the quantity/number of administrations per day, and the outcomes of treatment with such plant preparations.

Comment [R4]: Clarify the criteria for selecting the respondents. How were the Fulani pastoralists and other indigenous livestock farmers chosen for the survey? Providing this information will enhance the transparency of your study.

Include information on the duration of the study and any ethical considerations.

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

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.

Bauchi State

Bauchi state is located in the North-East region of Nigeria. The geographical coordinates of Bauchi state are a latitude $10^{o}30$N and Longitude $10^{o}0$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 Fufulde . 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.

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 Plateau State's capital. The Jos Plateau is where the State gets its name. 2012b Veronica Offiah. With a land area of 26,899 square kilometers, Plateau State 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 (Maikai *et all* 2010).

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 km2. 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 km2 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.

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, FadanTakad, Bondong, Biniki, Fada, FadanAttakar, Fada Ciki Gari, and Zumuruk.

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/)

Comment [R5]: Ensure that the maps are based on accurate geospatial data. Ensure that the map is clear and legible. Choose appropriate colors, use descriptive labels, and avoid visual clutter so that the information can be easily understood. An appropriate scale allows readers to identify relevant details without losing the overall view of the area. Use layers of information to represent different aspects of the study. This may include demographic data, geographical features, land use patterns, among others. Explore advanced mapping technologies, such as Geographic Information Systems (GIS) or online mapping tools, to create interactive and dynamic maps.

Fig 2. Google Earth Geographical Positioning of JosEast

Latitude: 9° 53' 28“N, Longitude: 9° 7’ 5” E, Elevation: 1,095 m (3,593 feet) above sea level. Source: (https://mapcarta.com/)

Comment [R6]: Ensure that the maps are based on accurate geospatial data. Ensure that the map is clear and legible. Choose appropriate colors, use descriptive labels, and avoid visual clutter so that the information can be easily understood. An appropriate scale allows readers to identify relevant details without losing the overall view of the area. Use layers of information to represent different aspects of the study. This may include demographic data, geographical features, land use patterns, among others. Explore advanced mapping technologies, such as Geographic Information Systems (GIS) or online mapping tools, to create interactive and dynamic maps.

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/)

Comment [R7]: Ensure that the maps are based on accurate geospatial data. Ensure that the map is clear and legible. Choose appropriate colors, use descriptive labels, and avoid visual clutter so that the information can be easily understood. An appropriate scale allows readers to identify relevant details without losing the overall view of the area. Use layers of information to represent different aspects of the study. This may include demographic data, geographical features, land use patterns, among others. Explore advanced mapping technologies, such as Geographic Information Systems (GIS) or online mapping tools, to create interactive and dynamic maps.

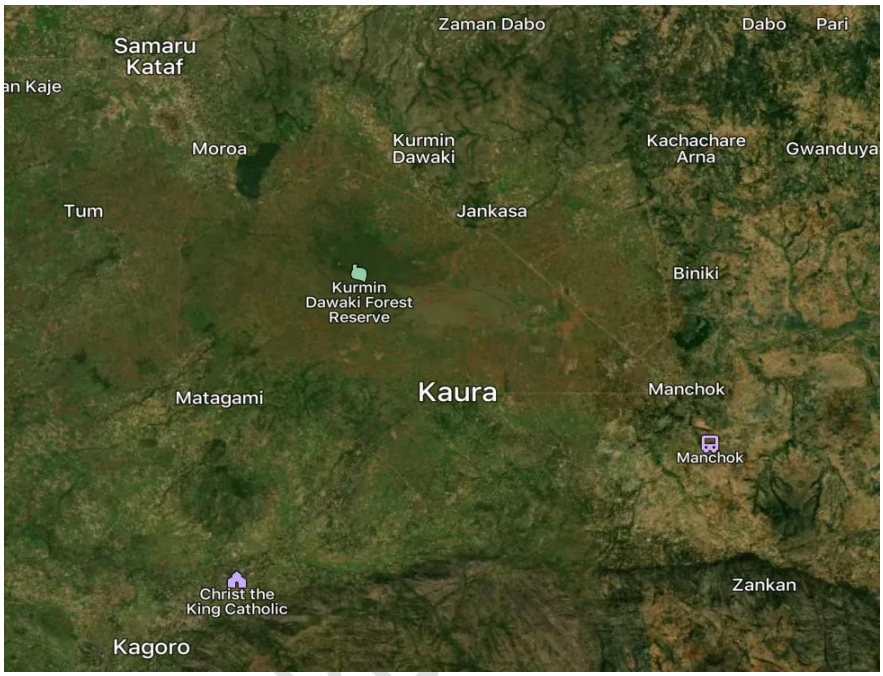


Fig 4. Google Earth Geographical Positioning of Kaura Local Government Area of Kaduna State.

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

Comment [R8]: Ensure that the maps are based on accurate geospatial data. Ensure that the map is clear and legible. Choose appropriate colors, use descriptive labels, and avoid visual clutter so that the information can be easily understood. An appropriate scale allows readers to identify relevant details without losing the overall view of the area. Use layers of information to represent different aspects of the study. This may include demographic data, geographical features, land use patterns, among others. Explore advanced mapping technologies, such as Geographic Information Systems (GIS) or online mapping tools, to create interactive and dynamic maps.

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 (Offia*et al*., 2012) based on the information required concerning medicinal plants used to treat AAT.

Sampling Techniques

The purposeful sampling technique was used in this study; because the technique requires the researcher to identify the segment of the populationthat 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.

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

RESULTS

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 dalziellii, Prosopis Africana, Anogeissusleiocarpus, Terminalia avicennioides, Adansonia digitata, Annona senegalensis, Piliostigmathoningii. Corymbiatorelliana, 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 dalzielliia*nd *Prosopis africanawere* each mentioned by 18 respondents (23%) as medicinal plants used to treat AAT.In like manner, *Anogeisusleocarpus* and *Terminalia avicennioides* were each mentioned by 17 respondents (21.8%) indicatedtheir 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 *Piliostigmathoningii*by 13 respondents (16.7%). *Nauclea latifolia*was mentioned by 12 respondents (15.4). *Balanites aegytica*was mentioned by 10 respondents (12.8). *Corymbiatorelliana* was mentioned by 9 respondents (11.5) *Tamarindus* indica was mentioned by (7.7%). respondents (10.3%) and *Ximenia americana* was mentioned by 7 respondents (9%) and *Guiera*senegalensis was mentioned by 6 respondents (7.7%)

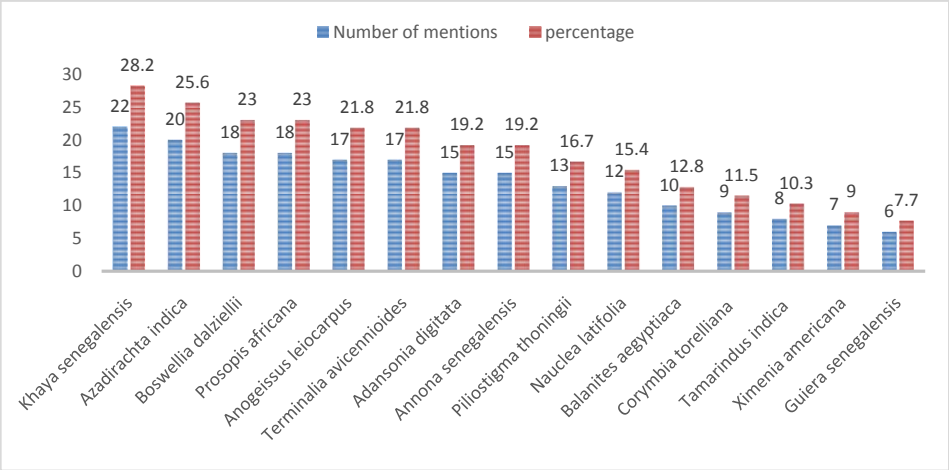
TheTable below shows the frequency and percentage distribution of the medicinal plants indicated for the treatment of AAT in this study. The table also shows their scientific/botanical names, Family names, Common names, Local names, parts of plant used, Frequency and Percentage Distribution as obtained during the survey.

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	*Khaya senegalensis*	Meliaceae	African Mahagony	H-madachi F-Kahije/ dalihe	Bark/root	22	28.2%
2	*Azadirachta indica*	Meliaceae	Neem	H-Dogonyaro F-Ganyi	Bark/Leaves	20	25.6%
3	*Boswellia dalziellii*	Burseraceae	Frankincense	H-Ararabi F-Janawhi	Bark	18	23%
4	*Prosopis africana*	Mimosaceae	African mesquite Iron wood	H-Kirya F-Kahi/Kohi	Bark/root	18	23%
5	*Anogeissusleiocarpus*	Combretaceae	Axle wood tree	H-Marke F-Kajoli	Bark	17	21.8%
6	*Terminalia avicennioides*	Combretaceae	-	H-Baushe F-Kulahi	Bark	17	21.8%
7	*Adansonia digitata*	Bombacaceae	Baobab	H-Kuka F-Bokki	Leaves	15	19.2%
8	*Annona senegalensis*	Annonaceae	Persild custard Apple	H-Gwandan-daji F-Dukuhi	Stem bark	15	19.2%
9	*Piliostigmathoningii.*	Caesalpiniaceae	Camel's foot	H-Kalgo	Leaves	13	16.7%
10	*Nauclea latifolia*	Rubiaceae	African peach	H-Tafashiya F-Bakure	Bark/Leaves	12	15.4%
11	*Balanites aegyptiaca*	Balanitaceae	Desert date	H-Aduwa F-Tanni	Bark/Root	10	12.8 %

12	*Corymbiatorelliana*	Myrtaceae	Gumtree, cadaga, Cadaghi	H- Rastata	Bark	9	11.5%
13	*Tamarindus indica*	Caesalpiniaceae	Tamarind	H-Tsamiya F-Jabbi	Bark /Leaves	8	10.3%
14	*Ximenia americana*		Wild olive	Tsada	Bark/root	7	9%
15	*Guiera senegalensis*	Combretaceae		H-Sabara F-Geloki	Bark	6	7.7%

Fig 5. FREQUENCY AND PERCENTAGE DISTRIBUTION OF THE PLANTS USED FOR THE TREATMENT OF AAT IN NIGERIA



The figure above shows the frequency and percentage distribution of medicinal plants used for the treatment of African Animal trypanosomosisin Nigeria.

Discussion

TheFulani ethnic group of Nigeria is popularly known for keeping Cattle either for pleasure (prestige) or for business (Odeniran et al., 2018). It is also generally known that the Fulanis have good knowledge of herbs and plants that are used for medicinal purposes (Hosseinzadeh et al., 2015). 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.

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 (Rashid et al., 2010).

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 (Elisha, et al., 2013). 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 (Elisha et al., 2013). 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.Collectedplants were either dried in shady areas or directly under the sun (Ugwoke et al., 2017).

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

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 oraldrenching

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. Theanimals were gathered togetherin one place and the fresh medicinal plants are place 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 repellant (Maikai et al., 2010).

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 (Agbedahunsi et al., 2006). 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 (Ikenna, 2008).

In this study, *Khaya senegalensis* was indicated as the most commonly usedmedicinal 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 (2010), 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 diseases 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, (2012) 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 (Ngure et al., 2009). The anti-microbial activities of some of the compounds obtained from *Azadirachta indica* have been found to be very significant in herbal medicinal formulations (Assefa, 2017). Oil from the leaves, seeds and barks have been found to have a broad-spectrum anti-bacterial action (Ngure et al., 2009). 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*(Assefa, 2017). However, in their study, Ngure et al., (2009) 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 (Evans, 2009) such as diarrhea, syphilis and to induce vomiting (Nwodo et al., 2015). 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 *Boswelliadalzielii*have been tested in separate studies and found to vary according to extraction medium and part of plant used(Isolate et al., 2014). Atawodiand his team of researchers tested the activities of extracts of different parts of *Boswelliadalzielii* against *Trypanosoma bruceibrucei*. His results revealed that methanol leaf, stem and root bark extracts of the plant at 10 mg/mL significantly immobilized the trypanosome(Nwodo et al., 2015). 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.

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 revealeda number of medicinal plants that can be harnessed for the development of medicaments that can be used for the treatment of African Animal Trypanosomosis.

Comment [R9]: Consider the use of current references https://doi.org/10.1590/0103-8478cr20220424

Comment [R10]: Consider addressing potential limitations of your study and suggesting directions for future research.

Comment [R11]: Summarize the main findings concisely and emphasize their implications for the development of plant-based medicaments for treating African Animal Trypanosomosis.

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Comment [R12]: Consider the use of current references

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