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Research Article

Patterns and Cultural Significance of Animal-Based Therapy in Northern Nigeria: An Ethnomedicinal Narrative Review

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ABSTRACT

The use of animals in traditional medicine represents a core part of African culture. Post-covid effects on global economy and the recent removal of oil subsidy in Nigeria specifically increased the reliance on traditional medicine as a cheaper alternative to orthodox medicine. Difficult accessibility of the people of Northern Nigeria to modern health care facilities due to large landmass and population further paved way to ethnomedicinal practices. However, studies on the use of animal products for medicine are poorly documented compared to phytomedicinal studies. This narrative review aimed to synthesize evidences on the use of animals for therapeutic practices in northern Nigeria. Data were collected from 37 published papers, books and ethnobiological surveys using relevant keywords across databases such as Google Scholar, PubMed, Scopus, Science Direct, Medline and journals' websites. Diversity Scores (D.S) and Zootherapeutic Index (ZI) were assigned to animals as thematic analysis of species' eco-relevance and diseases managed with them. We also inventoried parts and products of the animals used. It was revealed that *Bovidae* are the most relevant out of the 41 families of medicinal animals reported in northern Nigeria. The pattern of zootherapy practices follows region stability, highest in the relatively peaceful north-central compared to north-east and north-west. Diseases managed with animal products include cancer, malaria and erectile dysfunction. Erectile dysfunction has the highest number of interventions (10 animal species). Animal fats are the most widely used components (13.02%). The synthesis revealed that animals were selected for therapeutic uses based on perceived symbolic relationship rather than scientific validation. We highlighted concerns for conservation and potential zoonosis. This review provides insight into the intersection of culture, biodiversity and ethnomedicine in northern Nigeria. It may enhance future research on sustainable, evidence-based ethnomedicinal practices and offer an additional target for one-health approach to public health challenges.

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INTRODUCTION

Zoothérapie is an important branch of traditional medicine globally (Assefa *et al.*, 2025). In African nations including Nigeria, the use of plant and animal products provides a community centered system of therapy which is more accessible and affordable (Abiodun and Oladepo, 2018). The increasing population of the polygamous setting in northern Nigeria favours the integration of zoothérapie into ethnocultural tradition to complement orthodox medicine (Abubakar, 2005). Northern Nigeria is the reserve for faunal species including cattle, sheep, pangolin, horses, donkeys, hoopoes, cuckoos, puff adders, camels and hyraxes (Umar, 2021). Despite their historical role in folkloric healing, studies on medicinal animals are scarce compared with those on medicinal plants (Oladepo *et al.*, 2024).

Previous studies have reported the use of animals and animal products like excreta, fur, feathers, bones and glands for healing and cultural purposes (Sagan *et al.*, 2021). In contrast to extensive evidence of zootherapeutics from other parts of the world with extensive faunal reserves including Brazil and India, there is paucity of information about the practice in northern Nigeria. Moreover, the few available data are scattered in literature with limited synthesis.

Therefore, this narrative review is an attempt to bridge this gap. It aims to provide a narrative ethnomedicinal synthesis of the practice of zoothérapie in northern Nigeria. It critically examines the species diversity and therapeutic patterns while identifying the relevance of conservation, possible zoonosis and future directions.

The review is guided by the following research questions:

1. What animal species and products are used in folkloric management of diseases in northern Nigeria?
2. What cultural or ecological factors determine the selection of the animal products?
3. How do zoothérapie practice in northern Nigeria correlate to biodiversity conservation and public health relevance?

METHODS

Study area

Northern Nigeria

The choice of northern Nigeria for this review is informed by its cultural, ecological and socioeconomic uniqueness. The region is at a latitude of 11° 19' 48" (11.330) north, longitude of center 6° 53' 24" (Bello *et al.*, 2019); sharing a border with Cameroon, Chad and the Niger Republic (Figure 1). Nigeria is divided into six (6) geo-political regions; 3 in the north (north-central, north-west and north-east) and 3 in the south (south-south, south-west and south-east). Northern Nigeria comprises 19 states out of 36 (Figure 1) and 410 local governments out of the 774 in Nigeria with clear ecological and cultural diversity (Bello *et al.*, 2019). Furthermore, the region is a home to animals such as cattle, goats, sheep, snakes, rats, donkeys and camels often used in traditional medicine and therefore raising concerns for sustainable use of wildlives (Oloidi, 2021). The nomadic lifestyle of the northern tribes especially the Fulani also makes accessibility to modern healthcare limited (Tonukari, 2014). Moreover, studies on animal-based therapy in northern Nigeria are scarce compared with the several syntheses of phytomedicinal reviews across Nigeria. Therefore, the focus on this region would consolidate scattered evidence, correlate patterns of ethnomedicinal practice to regional settings and highlight relevance to conservation and public health.

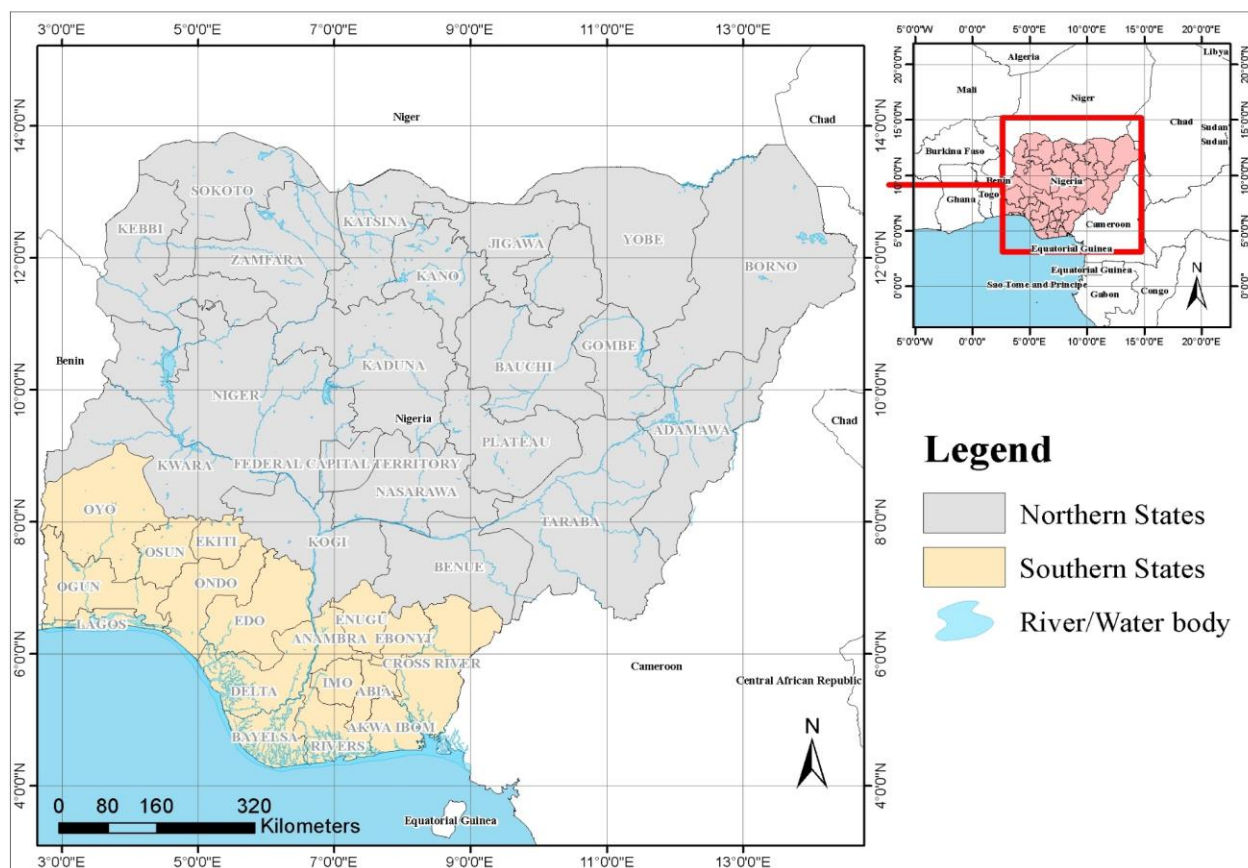


Figure 1: Map of the Northern Nigeria (Modified from the Administrative Map of Nigeria, 2021)

Search Method

This study employed a narrative and thematic review design rather than a quantitative systematic review or meta-analysis due to the heterogenous and qualitative nature of ethnomedicinal data. All available surveys on zootherapy of diseases in Northern Nigeria carried out between 1992 and 2024 were examined. This timeframe captures the period during which studies on animal-based therapy in Nigeria became accessible in scientific databases and research evolution in this field for more than three decades ensuring a balanced representation of historical and recent contributions. Online search for the resource materials was conducted between February, 2023 and May, 2024. We collected information from journals and books, as well as from reports, and abstracts found in online databases such as Google Scholar, PubMed, Scopus, Science Direct, Medline and journals' web sites. Inclusion criteria for the articles examined include researches on medicinal uses of animal species, published in English

language only and carried out in Northern Nigeria. Exclusion criteria are articles with other uses of animal products such as industrial utilizations; articles published in other languages other than English and studies of zootherapy practice in other parts of Nigeria outside the geographical scope. Combinations of keywords used for the search are 'Drug bioprospecting,' 'ethnomedicine,' 'Zootherapeutics,' 'Medicinal animals,' 'Fauna based therapy,' 'northern Nigeria' 'Animal -based treatment' and 'Traditional African Medicine'. Relevant information extracted include study location (states), animal species (English, scientific and local names), parts used, disease treated, author(s) and year of publication. To ensure consistency, data extraction was conducted independently by two reviewers and cross-checked for precision. Any discrepancies were corrected by consensus and data thematically organized into tables with sources (Tables 5-9) to ensure transparency and reproducibility of findings. Thereafter, data

were analysed to identify recurring animal species, parts, diseases treated and conservation patterns. This forms the basis for calculating ethnobiological indices such as Zootherapeutic Index, Diversity Score and Number of Intervention presented in the results.

Analysis of Data

Data collected were prepared into an inventory of animal species used for managing diseases in northern Nigeria, popularity of zootherapeutics in the three geo-political regions of Northern Nigeria and formulations

of animal parts used for therapy. Animals documented for zootherapeutic usages in northern Nigeria were assigned Zootherapeutic Index as adapted from Alves and Rosa (2007); defined as the extent of relevance of an animal product in the management of diseases in Nigeria (Alves and Rosa, 2007). Zootherapeutic Index (ZI) is calculated as the frequency of use of animal species divided by 22, the modal frequency (of the most commonly used animal species) in northern Nigeria; then multiplied by 100.

Mathematically expressed as:

$$\text{Zootherapeutic Index (ZI)} = \frac{\text{frequency of use of animal species} \times 100}{\text{modal frequency (of the most commonly used animal species) in northern Nigeria}}$$

The Diversity Scores (D.S) of zootherapeutic animal products were also determined derived following Costa-Neto (1999). These represent the frequency of use or reports of animals for medicine as related to places in different parts of northern Nigeria.

D.S is calculated as the total number of places where an animal is reported for medicinal use in northern Nigeria and then divided by 14, the highest number of places of use (Costa-Neto, 1999)

$$\text{D.S} = \frac{\text{number of places where animal is used in northern Nigeria}}{\text{highest number of places of use}} \times 100$$

The number of interventions (NOI) of a disease simply depicts the number of animal products used for managing a particular ailment or clinical symptom; adapted from Begossi (1996) as a proxy for ethnopharmacological prominence of the ailment (Begossi, 1996). NOI is calculated by summing the different animal materials and parts used in all reported studies for managing that disease.

$$\text{NOI} = \text{A.P}_W + \text{A.P}_E + \text{A.P}_C$$

A.P_W is the number of animal products used for the disease in North West; A.P_E is the number of animal products used for the disease in North East; A.P_C is the number of animal products used for the disease in North Central;

Similarly, the percentage use of animal parts was determined by dividing the frequency of usage of animal part by 169, the total number of usages for animal parts reported in the review, then multiplying by 100 (Oladepo *et al.*, 2024).

$$\text{Mathematically, percentage use of animal parts} = \frac{\text{frequency of usage of animal part} \times 100}{\text{total number of usages for animal parts reported}}$$

Higher ZI values indicate species used for a wider range of diseases and a perceived greater therapeutic versatility while a lower ZI

value suggests that the specie is less known for medicinal purposes or are culturally specialized for specific diseases in northern

Nigeria. Similarly, large values of D.S signify species popularity across different regions and accepted by users even if it is used for a single or few diseases. Furthermore, elevated NOI values reflect how convinced or frequently the people of northern Nigeria manage an ailment with zootherapeutics.

RESULTS

Families and species of fauna commonly used for managing diseases in Northern Nigeria

This review indicated that mammals (Bovidae) are the most relevant animal species for zootherapeutic practice in Northern Nigeria (Table 1). It is used to manage 22 clinical conditions with a Zootherapeutic Index (ZI) of 100, the maximum possible score (Alves and Rosa, 2007) compared to other animal families (Table 1). It is interesting to note that Apidae, Suidae, Anatidae and Sciuridae are the least frequently used animal species for managing diseases in Northern Nigeria with one (1) therapeutic usage reported for each of the specie (Table 1). A total of forty-one (41) animal families are reported in this review as the zootherapeutics of the northern Nigeria. Moreover, some species are found more in a particular region than others; Bovidae (eight), Cercopithecidae (four), Cathartidae (four) and Muridae (two) are more popularly used for treatment in the North-East than the other two regions (Table 2); Hippopotamidae (three), Felidae (three), Manidae (two) and Camelidae (two) are more in the North-Central while Pantherinae (one), Accipitridae (one) Viperidae (one) are only reported in the North-West for zootherapy (Table 2). Vegetation and forest distributions, prevalent culture and beliefs and socio-economic status of the different geo-political regions of Northern Nigeria may contribute to this variance in the popularity use of animal species in those regions. For example, Bovidae especially cattle are essentially more in the North-Eastern Nigeria where the Fulani herdsmen are indigenous.

Zootherapy practices in Northern Nigeria

North-Central Nigeria is the most popular region of Northern Nigeria for the practice of zootherapy whereas the North-West is the least popular with 42 and 18 animal species reported for use respectively (Table 2). In the North-East, 2 studies on zootherapy practice

were found from Adamawa, 1 each from Taraba, Borno and Yobe and 2 from Bauchi (Table 5). Inavailability of any zootherapeutic studies from Gombe might suggest under-reporting and neglect of studies related to animal remedies in favour of phytomedicine. Only Kaduna (two) and Kastina (one) out of the six states in the North-West (Table 6) while three states in the North-Central (4 in Niger, 1 in Plateau and 2 in Kwara) were reported for the practice of managing diseases with animals and animal products (Table 7). Seventeen (17) animals were used for managing unidentified disease conditions in Borno (Table 8).

Diseases and symptoms treated with animal species in Northern Nigeria

Several diseases and conditions ranging from infectious, inflammatory, metabolic and reproductive disorders were managed with animal products in northern Nigeria. These include cancer, rheumatism, epilepsy, body pain, breast pain, burns, fever, sexually transmitted diseases (STD), malaria, sterility, erectile dysfunction, hearing disorders, hypertension, and wound (Table 4). They are possibly informed by prevalence of the disease in that area and rate of refractoriness and disease prognosis after orthodox management. Poor prognosis after the conventional treatment often influence patients' decision for traditional medicine. NOI values are calculated to specifically measure the degree of usage of zootherapy for a particular disease. Erectile dysfunction has the highest number of interventions (9 animal species) whereas breast pain, sterility in women, prostate cancer, burns and scars have the smallest number of interventions with one (1) animal species reported for their management (Table 4). Erectile dysfunction is common in Northern Nigeria, the popularity of polygamy in the region may also necessitate the increased urge of seeking interventions to enable men sexual performance including traditional medicine.

Formulations of animal products used in treating diseases in Northern Nigeria

Medicinal animal products consist of animal's bone, skin, milk, honey, fat, fur and head used raw or in cooked forms. (Table 3). Animal fats are the most widely used parts (14.08%), others like skin, hair, limbs, tusks and milk are

also documented (Table 3). It was observed that some parts are employed for logically related cases; penis of lion used for managing erectile dysfunction, Lion teeth for managing teething problems in children (Born and Penny, 2007); venom used to treat snake bite (Salome *et al.*, 2018); monkey skull used to treat head ache; bat eyes for treating blindness (Osunsina *et al.*, 2012) e.t.c. Other uses have no clear relationship with the animal parts like the use of python skin for back ache (Salome *et al.*, 2018).

These zootherapeutics are consumed in different ways. Hard parts of animals, such as teeth, nails, shells, from snakes, fish scales, bone and cartilage generally are dried and crushed to powder; fat, body secretion and oil may be swallowed or rubbed topically (Sagan *et al.*, 2021).

DISCUSSION

Socio-cultural framework

Many cultures in northern Nigeria such as Hausa and Kanuri believe that animals with special traits of physical strengths including venomous snakes, symbolise potency and often embeds therapeutic values (Alves and Rosa, 2013; Soewu and Ayodele, 2009). Socio-economic drivers enhance the use of animals like cattle, camel and goats for medicinal purposes in Niger, Kwara and Plateau states because these are animals are readily available through subsistence animal husbandry in many households especially in rural settings. Similarly, the interconnection between Islamic belief and traditional medicine blend spiritual and pharmacological paradigms (Kwame and Mananu, 2023). Swine and dogs are rarely reported as zootherapeutics because they are considered impure by the Islamic belief which forms an important culture of northern Nigeria. Dog was only reported in plateau (where Islamic culture is less popular) for managing erectile dysfunction, malaria and diabetes. In addition, gender role in transmission of the knowledge of ethnomedicine may determine which animals are used for which diseases (Mahawar and Jaroli, 2008). Table 4 revealed that wild species which are usually hunted by elderly men are used for managing serious conditions including rheumatism and fracture (lion fat); pile (duiker kidney); pain (elephant

meat); insanity (vulture) and snakebite envenomation (leopard skin). In contrast mild and feminine related conditions possibly managed by women were often treated with domestic animals or easily assessable animal products. These are documented in table 4 including menstrual pain and anaemia (tortoise shell), labour (guinea fowl and water buck meat), ear ache (camel dung and bush fowl meat); wound and convulsion (cow urine); child intelligence (cow milk); cough (honey bee); breast pain (lizard fat); anaemia (chicken feather and camel urine); malaria (cattle bile) and swelling (mouse). Folkloric use of mammals, insects, amphibians, reptiles, avian fauna and other animal species in Northern Nigeria (Salome *et al.*, 2018) shows a cultural correlation between zootherapeutics of northern and southern Nigeria. This review aligns with a previous review of zotherapy practice in southern Nigeria in which Bovidae was reported as the most commonly used fauna family for medicinal purposes (Oladepo *et al.*, 2024). Similarly, the findings agree with the review of zotherapy in North-East India (Jugli *et al.*, 2019) but in contrast with the report in the Indian states of Manipur where fish-based medicine is the most prevalent (Hussain and Tynsonng, 2021) and Arunachal Pradesh where insects are the most used animal product medicine (Jugli *et al.*, 2019). The disparity in the types of animal species reported most for zotherapeutic practices in the Northern Nigeria and some parts of India may be related to the climatic and ecological distributions of the study areas. Northern Nigeria does not have water bodies as found in Manipur India and therefore higher reports of aquatic-based medicines in the latter.

The impacts of terrorism, insurgency and banditry may contribute to the reduced popularity of zotherapy practices in North-West and North-East Nigeria (Tables 5 and 6). These two regions are the most affected of insurgency in recent years which may reduce animal production and thus use of animal products for medicine. Fadare *et al.* observed that terrorism is an important factor that undermines livestock production (Fadare *et al.* 2022). Insurgency and the insecurity in the two regions may also cause under-reporting of the zotherapeutic practices.

It is worth noting that animals with poisonous venoms and stings are also employed in management of diseases. Rock python, honey bee, black cobra, trinidad burrowing snake and viper are used in Kaduna state (Table 6) for back ache, cough, rheumatism, high blood pressure, skin diseases, arthritis, insomnia and snake bite (Salome *et al.*, 2018). Furthermore, python, cobra and bee honey are used in Niger state (Table 7) for managing rheumatism, fracture, wound, back ache, and snake bite (Fingesi, 2023). Similar uses in Plateau state, (Table 7) include python and bee for managing epilepsy, dislocation, stomach ache, sore throat, ulcers, back ache, rheumatism, skin diseases, immune suppression, and snake bite (Muhammad *et al.*, 2022). Drugs have been previously developed venoms including captopril, an Angiotensin Converting Enzyme (ACE) inhibitor antihypertensive; eptifibatide and tirofiban, antiplatelet agents and batroxobin, an antithrobotic agent. All cases of the use of poisonous animals and insects for zootherapy are from the North-West and North-Central regions (Tables 6 and 7). Some of the poisonous animal species are used for treating the bite from such animal, for instance venoms of viper and python are used in Kaduna and Niger states for treating snake bite (Salome *et al.*, 2018; Fingesi, 2023). This logic may be correlated to the principle of 'like cures like' in the ancient Ayurvedic and Traditional Chinese medicine.

Zoological materials are eaten as food, ingested orally or applied topically in Zaria, Kaduna state for treating ulcers, hypertension, rheumatism, wounds, snake bites, burns, hair loss, haemorrhoid, cough, chest pain, insomnia, convulsion, skin rashes and arthritis (Salome *et al.*, 2018). These routes of administration may cause spilling of zoonotic diseases. However, animal products are sterilized by burning before use in the culture of people of Mokwa, Niger state (Table 7). Pangolin bone is burned to treat strokes and python oil is used to treat wounds or bone fractures. Additionally, Monitor Lizards and Civet Cats' skins are ingested to treat coughs and asthma respectively (Fingesi, 2023). Many of the animals and

animal products were sourced from far distance in the bush indicating that continued cropping of animal products for medicine may lead to the extinction of some local species in the long run (Fingesi, 2023). A similar observation was connected to how *Saiga tatarica* (antelopes) became enlisted as a critically endangered species in Central Asia (Berger *et al.*, 2010).

Born and Penny reported 22 parts and products of lion (*Panthera leo*) for medicinal uses in communities surrounding Yankari Game Reserve, Bauchi State in which almost all respondents interviewed (107) personally used lion body parts in the last 3 years for medicinal purposes, indicating a high acceptance of zootherapy practice in the region (Born and Penny, 2008). This may equally reflect the courageous culture of the Hausa/Fulani community of the region because such a high familiarity of usage of a wild animal such as lion can only be seen with risk-daring people despite unassessability. This assumption is corroborated by the fact that other fierce animals like elephant dung is also used to manage dizziness and yellow fever; hyena skin for whooping cough, convulsion; python fat for back pain and dislocation/fracture. Furthermore, most animal species reported for medicinal purposes in Northern Nigeria are indigenous. This underscores the importance of local ecosystem in ethnopharmacology (Alves and Alves, 2011). The choice of different animal species and their parts could be based on their morpho-physiological properties, behavioural ecology and bioactive ingredients (Soewu, 2008). It was observed that some parts are employed for logically related cases; penis of lion used for managing erectile dysfunction, Lion's teeth for managing teething problems in children, (Born and Penny, 2008); venom used to treat snake bites (Salome *et al.*, 2018); monkey skull used to treat head ache and bat eyes for treating blindness (Osunsina *et al.*, 2012). Other uses have no clear relationship with the animal parts like the use of python skins for back ache (Salome *et al.*, 2018).

Correlations with other forms of traditional medicine

Treatment with animal species and animal products is accepted among the people of northern Nigeria to be efficient just like other

forms of complementary therapy including phytochemicals and minerals or synthetic alternatives. However, it is more difficult to collect and prepare zoochemicals than plant materials and minerals. Animals are mobile and therefore not readily available to harvest unlike plants that have non-locomotor movements. All these may account for the small volumes of documented studies found on zootherapy practice compared to phytomedicine.

Cross-indexing of zootherapy in other parts of the world

Approximately 290 species of animal are used for zootherapy of malarial symptoms and other diseases in Brazil (Alves, 2009) while Table 10 reflects that 51 animal species are used for managing 68 different illnesses in the semi-arid region of Caatinga Biome (Alves and Alves, 2011). The current review aligns with findings on the zootherapy practices in north east India where animal products are also used to manage cancer, malaria and infertility (Khiron *et al.*, 2017; Environ *et al.*, 2020). - However, this review documented less number of animal families (41) used for medicinal purposes in northern Nigeria. This disparity may arise from under-reporting of zootherapy practice in Nigeria which has been highlighted in literatures (Pretorius and Smith, 2023).

Ethics and control measures in the use of animal products

Sustainable practice of zootherapy and animal hunting for food should be encouraged and enforced. There is need to control trading in bush meat, deforestation, climate change, desert encroachment, urbanization and indiscriminate hunting to conserve and save animal species from extinction (Oladepo *et al.*, 2024). Ozone layer destruction, global warming and climate change may result in desert encroachment and extinction of fauna species. Regulatory guidelines established to control the use of wild lives and other natural products categorize animal species into different statuses of availability in the ecosystem. These guidelines should be regularly reviewed to reflect updated status of animal species and the need for conservation. A standard reference on the conservation status of animal species on a global level is the Convention on International Trade in Endangered Species of Wild Fauna and Flora

(CITES) appendices (CITES, 2024). Furthermore, local regulatory framework in Nigeria includes the Endangered Species (Control of International Trade and Traffic) Decree No 11 of 1985 (Federal Republic of Nigeria, 2011).

Limitations in the practice of zootherapy

Zootherapy plays a significant role in the complementary and alternative medicine, however it poses some challenges. There are no adequate scientific validations, standardization and quality control. The possible side effects of animal products used for medicines in northern Nigeria have not been adequately studied, though some studies reported diarrhoea, abdominal pain and vomiting (Assefa *et al.*, 2025). These may be caused by the lack of adherence to dosage measurements during administration of the zootherapeutics and unorthodox methods of the preparation. Moreover, there is possible public health challenge due to indiscriminate use of animals such as monkeys, rats, dogs which may increase zoonotic transmission of diseases (Oladepo *et al.*, 2024). Diseases that can be transmitted through human-animal interactions include, lassa fever, anthrax, coronaviruses, lyssaviruses (e.g. rabies), filoviruses (e.g., Marburg viruses and potentially Ebola viruses), and henipaviruses (e.g. Nipah and Hendra viruses), arenaviruses (e.g., Lujo virus and lymphocytic choriomeningitis virus), hantaviruses, orthopoxviruses (e. g., vaccinia, cowpox, and monkeypox viruses) and bacterial diseases (e. g., plague, leptospirosis, rat bite fever, salmonella, and tularemia). Regulatory bodies in the public health should intensify public enlightenment on the risk of zoonoses spill during zootherapy. Traditional medical practioners should consider sterilization during preparation of zootherapeutics. Furthermore, under-reporting is common especially in Traditional African Medicine arising from non-transparent attitude of traditional healers who regard the ethnomedicinal knowledge as a family secret.

Another limitation of zootherapy is the threat to the conservation of animal species especially the endangered or protected species such as vultures, pangolins and turtles. In addition, overdependence on zootherapy and other forms of complementary alternative

therapy (CAM) may result in adverse epidemiological events including abuse, addiction, toxicity and may divert attentions from orthodox medicine.

Nanotechnology in zootherapeutics

Part of the challenges of Traditional African Medicine is complex prescription, lack of standard evaluation methods, and effective drug delivery system (Zhang *et al.*, 2021). Nanotechnology, like it benefits modern medicine by versatile formulation and ease of surface modification, can also be a potential tool for the development of traditional medicines including zootherapeutics. Nanoparticles (NPs) can deliver active zootherapeutic compounds at target sites therefore reducing toxicity. Zoochemicals such as peptides, enzymes and lipids often undergo rapid metabolism which limits their bioavailability in plasma. Nanoencapsulation may potentially solve this challenge. Furthermore, emerging advances in zootherapeutics and nanotechnology include the venom-derived nanoparticles for cancer and microbial infections (Joglekar *et al.*, 2022); chitosan nanoparticles derived from crustacean shells for wound healing (Bashir *et al.*, 2022) and nano-emulsified animal fats for cosmetics and dermatological applications. Therefore, further efforts in nanotechnology incorporation in zootherapeutic research may help to overcome limitations to traditional medicine including rapid biodegradability, inadequate standardization and toxicity concerns. The integration will enhance translational research in ethnomedicine for development of novel and sustainable therapeutic agents.

Climate change and the future of zotherapy practice in northern Nigeria

Climate change is an emerging global challenge to livestock production and wildlife welfarism reducing breeding and habitat resilience. Nwosu and co-workers reported that various stressors accompany the greenhouse effects and global warming concepts of the climate change. These include decrease yield in forage and pasture harvest, modified epidemiology of animal pests and diseases (Nwosu and Ogbu, 2011). They impact on animal population and practice of zotherapy in the affected areas. In addition, maximum and minimum temperatures are

increasing in the northern regions of Nigeria; flood and erosion incidences are more frequent. These lead to heat stress on animals and water scarcity (Ojo *et al.*, 2021). Although, many wildlife species such as sea turtles exhibit adaptive physiological and behavioural strategies to cope with the accompanied effects of climate change, there is need for human intervention to rescue the biodiversity (Rahul and Dhiren, 2023). Clean energy alternatives should be prioritized, sensitization on the ethical use of environment must be carried out regularly among the general masses and government should implement policies on afforestation.

Therefore, consideration of climate change in ethnomedicinal research is key for biodiversity conservation and sustainable use of animal species for medicines.

Dissemination of the knowledge of zootherapeutics in northern Nigeria

Hunters, farmers, Fulani herders and trado-medical practioners are often the custodians of zootherapeutic skills in northern Nigeria. These cartegories of the population are usually aged and unlettered, making it challenging to document the knowledge. They sometimes hoard the information about medicinal uses of animals for socio-cultural reasons.

CONCLUSION

This review shows that mammals (Bovidae) are commonly used for managing reproductive and metabolic disorders. It also revealed that zotherapy is more reported in north-central than north-east and north-west regions reflecting the impact of security and stability on availability of zootherapeutics and ethnomedicinal practice.

The predominance of mammalian species in northern Nigeria zotherapy which agrees with findings in other parts of the world such as India and Brazil may suggest deep cultural knowledge of the people. Fauna-based trado-medical preparations are widely used in northern Nigeria but the practice is poorly documented compared to other regions and scientific validations of the claimed therapeutic benefits of animal products are scarce.

Future researches should focus the following aspects:

1. Extensive field surveys to document animal based treatment practices in northern Nigeria.
2. Preclinical studies on extracts of the various animal products reported for pharmacological activities to justify their local usage.
3. Identification and isolation of potentially active zoochemicals.
4. Studies on the sociological and policy thematics which aim to control

indiscriminate zootherapy practices and conserve the animal species to ensure their sustainability for use.

List of abbreviations

D.S- Diversity Score

Z.I- Zootherapeutic Index

NOI- Number of Interventions

WHO- **World Health Organization**

STD- Sexually Transmitted Diseases

TCM- Traditional Chinese Medicine

CAM- Complementary Alternative Therapy

Table 1: Zootherapeutic Index of Animal Products for Managing Diseases in Northern Nigeria

S/No	Animal Families	Frequency in disease management (F.D)	Frequency in unidentified clinical cases (F.U)	Sum of frequency	Zootherapeutic Index (ZI)
1	Cercopithecidae	2	3	5	22.73
2	Elapidae	6	0	6	27.27
3	Apidae	1	0	1	4.55
4	Felidae	18	0	18	81.82
5	Elephantidae	3	1	4	18.18
6	Canidae	9	0	9	40.91
7	Suidae	0	1	1	4.55
8	Anatidae	1	0	1	4.55
9	Hominidae	3	0	3	13.64
10	Sciuridae	0	1	1	4.55
11	Numidadae	2	0	2	9.09
12	Thryonomyidae	0	1	1	4.55
13	Orycteropodidae	2	0	2	9.09
14	Pythonidae	12	0	12	54.55
15	Pantherinae	3	0	3	13.64
16	Steruthionidae	1	0	1	4.55
17	Plecoglossidae	5	0	5	22.73
18	Crocodylidae	2	0	2	9.09
19	Erethizontidae	1	1	2	9.09
20	Manidae	4	0	4	18.18
21	Bovidae	17	5	22	100.00
22	Testudinidae	4	0	4	18.18
23	Achatinadae	6	0	6	27.27
24	Aganidae	2	0	2	9.09
25	Hyaenidae	1	1	2	9.09
26	Cathartidae	4	0	4	18.18
27	Phasianidae	2	0	2	9.09
28	Bucerotidae	1	0	1	4.55
29	Hippopotamidae	7	0	7	31.82
30	Leporidae	3	1	4	18.18
31	Viverridae	1	1	2	9.09
32	Accipitridae	1	0	1	4.55
33	Muridae	1	1	2	9.09
34	Varanidae	7	0	7	31.82

35	Viperidae	2	0	2	9.09
36	Camelidae	5	0	5	22.73
37	Colubridae	2	0	2	9.09
38	Erinaceidae	3	0	3	13.64
39	Pteropodidae	1	0	1	4.55
40	Alligatoridae	2	0	2	9.09
41	Phoeniculidae	1	0	1	4.55

*Zootherapeutic Index (ZI) denoting the number of disease conditions managed with animal species

Table 2: Diversity Scores of Animals Used For Zootherapy in Northern Nigeria

S/N	Animal Families	North-East(X_E)	North-West(X_W)	North-Central(X_C)	Unidentified States (X_U)	Frequency(X_0)	Diversity Scores (D.S)
1	Cercopithecidae	4	0	1	0	5	0.357
2	Elapidae	0	1	1	0	2	0.143
3	Apidae	0	1	1	0	2	0.143
4	Felidae	2	0	5	0	7	0.500
5	Elephantidae	1	1	0	0	2	0.143
6	Canidae	1	0	1	0	2	0.143
7	Suidae	1	0	0	0	1	0.071
8	Anatidae	0	0	1	0	1	0.071
9	Hominidae	1	0	1	0	2	0.143
10	Sciuridae	1	0	0	0	1	0.071
11	Numididae	0	0	1	0	1	0.071
12	Thryonomyidae	1	0	0	0	1	0.071
13	Orycteropodidae	0	0	1	0	1	0.071
14	Pythonidae	1	1	2	1	5	0.357
15	Pantherinae	0	1	0	0	1	0.071
16	Steruthionidae	0	0	1	0	1	0.071
17	Plecoglossidae	0	0	1	0	1	0.071
18	Crocodylidae	0	1	1	0	2	0.143
19	Erethizontidae	1	0	1	0	2	0.143
20	Manidae	0	0	2	0	2	0.143
21	Bovidae	8	0	6	0	14	1.000
22	Testudinidae	1	0	1	1	3	0.214
23	Archatinidae	0	1	1	1	3	0.214
24	Aganidae	1	1	0	0	2	0.143
25	Hyaenidae	1	1	0	0	2	0.143
26	Cathartidae	4	2	1	0	7	0.500
27	Phasianidae	1	0	1	0	2	0.143
28	Bucerotidae	0	0	1	0	1	0.071
29	Hippopotamidae	1	0	3	0	4	0.286
30	Leporidae	1	0	1	0	2	0.143
31	Viverridae	1	0	1	0	2	0.143
32	Accipitridae	0	1	0	0	1	0.071
33	Muridae	2	0	0	0	2	0.143
34	Varanidae	1	2	2	0	5	0.357
35	Viperidae	0	1	0	0	1	0.071

36	Camelidae	0	0	2	0	2	0.143
37	Colubridae	0	1	1	0	2	0.143
38	Erinaceidae	0	1	0	0	1	0.071
39	Pteropodidae	1	0	0	0	1	0.071
40	Alligatoridae	1	0	1	0	2	0.143
41	Phoeniculidae	0	1	0	0	1	0.071
	TOTAL	38	18	43	3	102	

*Diversity Score (D.S) depicting number of areas/states reported for animal use

Table 3: Parts and Products Used for Zootherapy in Northern Nigeria

S/N	Parts	FNE	FNW	FNC	FUS	Frequency of usage (Fo)	Percentage use
1	Whole animal	2	0	5	1	8	4.73
2	Kidney	0	0	1	0	1	0.59
3	Ear	2	0	1	0	3	1.78
4	Venom	0	3	0	0	3	1.78
5	Tail	2	2	1	0	5	2.96
6	Eggs	0	1	1	0	2	1.18
7	Head	0	4	3	0	7	4.14
8	Teeth	3	1	0	0	4	2.37
9	Honey	0	1	1	0	2	1.18
10	Flesh/meat	9	2	5	1	17	10.06
11	Bone	2	1	5	2	10	5.92
12	Dung /faeces	1	0	5	0	6	3.55
13	Limbs	0	0	1	0	1	0.59
14	Liver	1	0	2	0	3	1.78
15	Intestine	2	0	2	0	4	2.37
16	Skull	2	0	0	0	2	1.18
17	Milk	0	0	3	0	3	1.78
18	Fat /oil	7	2	13	0	22	13.02
19	Hair/thorn	0	3	1	0	4	2.37
20	Leg	3	0	0	0	3	1.78
21	Skin	3	6	6	0	15	8.88
22	Shell	2	1	0	0	3	1.78
23	Urine	0	0	4	0	4	2.37
24	Bile /gall bladder	2	0	3	0	5	2.96
25	Feathers	0	1	1	0	2	1.18
26	Wax	0	1	0	0	1	0.59
27	Penis	1	0	5	0	6	3.55
28	Foot	4	0	0	0	4	2.37
29	Anus	2	0	0	0	2	1.18
30	Eye	2	0	0	0	2	1.18

31	Heart	0	0	1	0	1	0.59
32	Testicles	0	0	1	0	1	0.59
33	Tusk	0	1	1	0	2	1.18
34	Brain	1	0	1	0	2	1.18
35	Bone marrow	0	0	1	0	1	0.59
36	Lung	1	0	0	0	1	0.59
37	Vein	1	0	0	0	1	0.59
38	Breast	1	0	0	0	1	0.59
39	Nose	1	0	0	0	1	0.59
40	Saliva	1	0	0	0	1	0.59
41	Throat	1	0	0	0	1	0.59
42	Claws	1	0	0	0	1	0.59
	Total	61	30	74	4	169	100

*FNW –frequency of use in the North-West; FNC–frequency of use in the North-Central; FNE–frequency of use in the North-East; FUS–frequency of use in unidentified states of Northern Nigeria

Table 4: Diseases Managed with Zootherapeutics in Northern Nigeria

S/N	Diseases and clinical symptoms	Zootherapeutics	Number of Interventions (NOI)
1	Rheumatism	Python, Lion, Bull, Cow, Giant African snail, Black cobra	6
2	Fracture and dislocation	Lion, Crocodile, Guinea fowl, Python, Chimpanzee, Hippopotamus	6
3	Breast pains	Monitor lizard	1
4	Backache	Black Snake, python, Rock python, Lion	4
5	Erectile dysfunction	Ayu, Dog, Dog, Gorilla, Wild cat, Hippopotamus, Crocodile, Pangolin, African comb duck, Serval, Lion	10
6	Ear ache	Camel, Buffalo, Bush fowl	4
7	Cataract	Camel	1
8	Epilepsy	Vulture, Python, Monitor lizard	3
9	Insanity	Vulture, Lion, Pangolin	3
10	Stroke	Vulture, Pangolin, Snail	2
11	Difficult labour	Vulture, Hippopotamus, Aardvark, Guinea fowl Water buck, Tortoise	6
12	Sterility in women	Lion	1
13	Hearing disorder	Duicker, Aardvark, Lion	3
14	Suppressed immunity	Hippopotamus, Grey horn bill, Dog , Bee , Inguana lizard, Lion	6
15	Body pains	Monitor lizard, Bull, Leopard, Elephant, Lion	5
16	Apnoea breathing	Hare, Red lizard, Four-toed hedgehog	3
17	Fever	Hare	1
18	Scorpion sting	Baboon	1
19	Stomache ache	Porcupine, Bee, Giant African snail, Lion	4
20	Wound	African buffalo, Cattle, Cobra, Lion	4
21	Kwashiorkor	Ostrich, Cattle	2
22	Cold	Hippopotamus, Four-toed hedgehog, Python	3

23	Burns and scars	Python	1
24	Snake venom	Python, Leopard, Trinidad burrowing snake, Viper	4
25	Prostate cancer	Ayu	1
26	Lactogenesis disorder	Ayu, Lion	2
27	Anaemia and sickle cell	Tortoise, Chicken, Camel	3
28	Malaria	Cattle, Dog	2
29	Ulcer	Cattle, Goat, Giant African snail, Monitor lizard	4
30	Weak memory	Cattle, Cameroon hoopoe	3
31	Whitlow	Bull	1
32	High blood pressure	Camel, Giant African snail, Black cobra	3
33	Kidney stone	Camel	1
34	Rabies	Dog	1
35	Diabetes	Dog	1
36	Poisoning	Dog	1
37	Skin disorders	Lion, Black cobra, African crown eagle, Spotted hyena, Four-toed hedgehog, Bush buck	6
38	Convulsion	Cow, Leopard, Lion	3
39	Viral infections	Cow	1
40	Joint stiffness	Nile crocodile, Black cobra, Lion	4
41	Cough	Honey bee, Red lizard, Lion, Monitor lizard	3
42	Head ache	African elephant, Patas monkey, Lion	3
43	Nose bleeding	African elephant	1
44	Insomnia	Viper	1
45	Teething sickness in children	Bosch monitor lizard, Lion	2
46	Pile	Duicker	1
47	Polio	Crocodile	1
48	Cancer	Hippopotamus, Pangolin	2
49	Sight disorders	Straw coloured bat	1
50	Oedema	Mouse	1
51	Menstrual pain	Tortoise	1
52	Asthma	Lion, Civet cat	2
53	Hepatitis	Snail	1

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