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Animals traded for traditional medicine in Ghana: their zootherapeutic uses and implications for biodiversity conservation

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Abstract

The use of animals for zootherapeutic purposes has been reported worldwide, and with the patronage of complementary and alternative medicines being on the ascendency, the trade and use of animal parts will only escalate. Many more of these animals used in traditional medicine will be pushed to extinction if policies for their sustainable use and conservation are not formulated. There have been studies across the world which assessed the trade and use of animals in traditional medicine including Ghana. However, all previous Ghanaian studies were conducted in a few specific cities. It therefore makes it imperative for a nationwide study which would provide more comprehensive information on the trade and use of animals in traditional medicine and its conservation implications. Using direct observation and semi-structured questionnaires, data were collected from 133 vendors of animal parts used in traditional medicines in 48 markets located across all 16 administrative regions of Ghana. Analysis of the data showed that the trade in wild animal parts for traditional medicine was more prevalent in the urban centres of Ghana. Overall, 75 identifiable animal species were traded on Ghanaian traditional medicine markets. Using their relative frequency of citation values, chameleons (*Chamaeleo* spp.; 0.81), lions (*Panthera leo*; 0.81) and the West African crocodile (*Crocodylus suchus*; 0.67) were the most commonly traded animals in Ghana. Majority of the vendors (59.1%) indicated that their clients use the animal parts for medicinal purposes mainly for skin diseases, epilepsy and fractures, while clients of 28.2% of the vendors use the animal parts for spiritual or mystical purposes, such as protection against spiritual attacks, spiritual healing and money rituals. Up to 54.2% of the animals were classified as Least Concern by IUCN, 14.7% were threatened, with 51.2% of CITES-listed ones experiencing a decreasing population trend. This study also found that 68.5% of the traded animal species are not listed on CITES, but among those listed, 69.6% are classified under Appendix II. Considering the level of representation of animals of conservation concerns, the harvesting and trade of animal parts for traditional medicine must be regulated. This call is even more urgent since 40.0% of the top ten traded animals are mammals; a class of animals with long gestation periods and are not prolific breeders.

Keywords Mystical, Zootherapy, Trade, Chameleon, Phyla, Medicine, Ecozones

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Introduction

Humans interact with both biotic and abiotic components of their environment including animals. The interactions between humans and animals predate history, with several rock paintings of animals such as horses, bison and deer, , found in caves of the Palaeolithic period signifying the roles animals play in the lives of people [6, 48]. Human–animal interaction continues even up to the present, as humans have been able to domesticate some animals for food, as pets and for other purposes. Although this interaction had existed for thousands of years, it was only until the later parts of the nineteenth century that the area of study termed ethnozoology was born. This refers to 'the study of the knowledge people possess about fauna in their localities and the culturally-mediated relations that humans develop with these animals in the environments surrounding them' [6, 11].

To survive, humans have over the years made efforts to reduce or eliminate the discomfort associated with diseases and prevent fatality by the use of various techniques and substances mostly from their immediate environment, referred to as traditional medicine [33]. The World Health Organization (WHO) estimates that up to 80% of the world's population depends on traditional medicines from animals and plants, especially to take care of their primary health needs [79]. However, the proportion varies around the world with a study in Ethiopia recording a high 90% percentage use of natural materials as their traditional medicine [56, 74, 80]. There is no doubt that the use of plants in traditional medicine far outweighs that of animals. However, a plethora of records showed the use of animals and/or their products by various cultures from olden times to the present period of modern civilisation [7, 34, 48, 68, 80].

With increasing human populations and interest in the use of natural products for the healthcare needs of persons even in the highly technologically developed countries, there is increased demand for traditional medicine. This has resulted in the overexploitation of numerous wild animal species with dire consequences for the survival of the ecosystem since the extinction of such animals would lead to the loss of the very important ecosystem services and goods obtained from them [23, 73]. There are several examples of some animals whose use in traditional medicine has led to a threat to their existence. The vulture population in West Africa has declined due to several factors including their use for traditional medicine [14, 26, 30]. According to Daboné et al. [26], between the 1970s and 2019, the Hooded Vultures *Necrosyrtes monachus* population in the West African sub-region has declined by 58–65%. In Burkina Faso, the number of Hooded Vultures per 100 km decreased from 122 to 75 over the last five decades which is a decline of 38% [26]. The effect of the use of vultures in traditional medicine on their survival was succinctly illustrated by Ogada et al. [55] who reported that the trade of these vultures for traditional medicine accounted for 29% of the nearly eight thousand vulture deaths recorded across twenty-six countries in Africa. Another animal under threat as a result of their use in traditional medicine is the wild tiger. Tigers have a home range in southern and south-eastern Asia, and large areas of China [81]. The use of tiger bones for rheumatism and related ailments, the skin made into magical amulets and the penis being an ingredient of allegedly powerful sexual tonics in Asia are making tiger parts, items of great demand [53, 27]. According to David Shepherd Wildlife Foundation, [27], as few as 3800 tigers remain in the wild, a 96% population decline over a century with their extinction reported in Laos, Vietnam and Cambodia since 2010.

The use of animals as medicines in health care is not delineated by location, economic endowment or the culture of people. Several studies have reported the use of animal-based products in traditional medicine in developed countries such as Spain, China, Brazil and Japan [8, 25, 39, 49, 64]. The Brazilain study by Alves et al. [8] reported the use of various parts and products of 37 species for conditions such as asthma, epilepsy, body aches and wound healing, among others in the city of Santa Cruz. In Japan, as reported by Takahashi et al. [64], gallstone *Calculus bovis* from cattle is used in traditional medicine against anti-arrhythmic events. African countries such as South Africa [60], Benin [31] and Nigeria [1, 2, 68] have also reported the use of animal-based medicines among their population. From Benin, Djagoun et al. [31] found 87 wild mammals used in traditional medicine. Adeola [1] reported that some animals such as *Gorilla gorilla*, *Pan troglodytes* and *Orycteropus afer* were used as aphrodisiacs. In the Oyo State of Nigeria, Ajagun et al. [2] reported that 43 animals, especially *Chamaeleo senegalensis*, *Bufo regularis*, *Felis silvestris* and *Eidolon helvum*, are used in the treatments of epilepsy, rheumatism, fever, wound healing and mystical purposes such as spiritual protection, command of authority and favour. In Ghana, Ntiamoa-Baidu [54] and Dove [32] found the use of some animal parts and their products in traditional medicine. Boakye, et al. [19] conducted a study in Kumasi, the second-largest city in Ghana, and showed that various parts of the African pangolins (*Phataginus tetradactyla*), white-bellied pangolin (*Phataginus tricuspis*) and the giant ground pangolin (*Smutsia gigantea*) are employed in traditional medicine in the city. The scales of the pangolin were reportedly used for mystical purposes such as spiritual protection and financial rituals but also for the treatment of

rheumatism and convulsions. In terms of the number of animal species being traded for traditional medicine in Ghana, Boakye et al. [21] reported 32 species in the Kumasi Central market, while Gbogbo and Daniels [35] recorded 43 species from their study in Accra, the capital city of Ghana.

Variations in ecological zones in Ghana as well as the specific cultural requirements across the country could bring about differences in the types of animals used in traditional medicine across Ghana and hence the need to undertake possibly the first-of-its-kind national survey. The increasing interest in animal-based traditional medicine also presents some possibility of extinction if they are not sustainably extracted. Consequently, it is imperative to assess the conservation implications of the trade of these animals in Ghana. To this end, the present study assessed the trade and use of animals in traditional medicine across all 16 administrative regions of Ghana and evaluated the conservation implications of the trade. Besides determining the zootherapeutic uses of these animal parts, the study further assessed the taxonomic classes of importance in traditional medicine in Ghana and whether the ecological zone of a traditional medicine market would influence the species diversity.

Study area

The Republic of Ghana with a land size of 238,540 km^2 and a population of 30.8 million people as of 2021 is located in West Africa (Fig. 1) and bordered to the east by the Republic of Togo, the west by La Cote D'Ivoire, the north by Burkina Faso and the south by the Gulf of Guinea and the Atlantic Ocean [15, 37]. Based on the variations in rainfall patterns and the vegetation cover, Ghana is made up of four major ecological zones: coastal savanna, forest, transitional and guinea savanna [78].

The coastal savanna is a strip of land of about 20,000 km^2 area covering the south-eastern coast of Ghana including areas near the capital, Accra. The forest zone, classified into rain forest and semi-deciduous forest, covers a land area of 135,670 km^2 including areas to the midsection of the country from the south-western parts across to the eastern part. The rainfall pattern in the forest zone is bi-modal, giving a semi-equatorial climate while the vegetation is a semi-deciduous forest [78]. The Guinea savanna zone covers a total land area of about 125,430 km^2 and experiences a tropical continental climate [78]. The transitional zone is a forest–savanna ecological space between the Guinea savanna of northern Ghana and the semi-deciduous forest of the south and runs from the west to the eastern part of the country

Fig. 1 Map of Ghana showing the cities and towns where the vendors of animal-based traditional medicines who participated in the study were located

[46]. With this diversity of vegetation, Ghana is reported to harbour 221 amphibian and reptile species, 724 bird species and 225 mammalian species [16].

According to Attuquayefio and Fobil [13], efforts to protect the forest and its resources in Ghana started in 1906 when the colonial government enacted a law against the felling of commercial trees and subsequently established the Forestry Department in 1909. According to IUCN/PACO [42], there are 21 Wildlife Protected Areas in Ghana occupying a land space of 13,476 km^2 or 5.6% of the country. The protected area network includes one Strict Nature Reserve, seven National Parks, two Wildlife Sanctuaries, six Resource Reserves, five coastal wetlands and one inland wetland.

Methods

Study design

A cross-sectional study design was employed in the collection of data from vendors of animal-based traditional medicines in 48 markets in major towns and cities across the 16 administrative regions of Ghana. The fieldwork began in January 2020 and ended in July 2022.

Research tools

A semi-structured questionnaire and an interview guide were pretested and used to collect the data. Audio/video devices were used in recording the interactions between the researchers and the respondents. The recorded conversations were repeatedly played, and the responses were appropriately entered into Microsoft Excel. Photographs of animal samples were taken and catalogued. The questionnaire and the interview guide were developed de novo for a Doctor of Philosophy degree programme at the Department of Animal Biology and Conservation Sciences, University of Ghana, Accra. The questionnaire was divided into various sections for the collection of data on the vendor's sociodemographic characteristics, market characteristics, practice information, level of patronage of animal parts and their roles in traditional medicine, socioeconomic importance of the animal-based medicine trade, and vendor's knowledge of and conservation concerns. For vendors who permitted the taking of inventory of their animal parts being traded for traditional medicine, after taking photographs of a sample, the vendors were interviewed on the roles of these animals in traditional medicine.

Sample size determination

The sample size for the vendors in this study was determined based on a similar nationwide survey among traditional medicine vendors in the Republic of Benin [31]. The Benin study surveyed a total of 22 markets in 18 districts out of the 77 from which 110 vendors were interviewed. With the landmass of Ghana (238,535 km^2) being 2.1 times larger than Benin's (114,763 km^2), surveying approximately 46 markets and interacting with more than 110 vendors who are knowledgeable about the use of these animals in traditional medicine were considered appropriate. In this study, 133 qualified vendors who mainly sold dried animal parts for traditional medicine were successfully enrolled for the study. In addition to the animal parts, a few vendors sold other items such as herbs, strips of red, black or white fabric and metal amulets. However, only 42 permitted the taking of inventory of the animal parts they had among their wares with all but a few allowing the researchers to take photographs of the animal wares.

Sampling techniques

In markets with three or fewer vendors, all were selected to participate in the study. However, where there were more than three willing vendors, the convenience sampling technique was applied in selecting a maximum of three vendors. The three respondents selected were those who displayed animal wares of the greatest species diversity.

Sample identification

Since the animals on display were mostly not whole pieces, the vendors using their knowledge of their morphological features and other characteristics provided the researchers with the local names or common names of the animal species. However, where the listed animal or part was identified by the authors as a different animal from what the vendors claimed they were, we reported the vendors' claims in asterisks. Photographs of these animal parts were taken and compared with images from reference books such as The Kingdom Field Guide to African Mammals [45] and Lézards, crocodiles et tortues d'Afrique Occidentale et du Sahara [69]. For whole animals or parts that the on-field researchers could not identify, their photographs were reviewed by experts at the University of Ghana and the Wildlife Division of the Forestry Commission of Ghana.

Data analysis

Data underwent validation, editing and coding in Microsoft Excel. Data analysis was performed using the statistical software SPSS (Statistical Package for the Social Sciences) version 26, Microsoft Excel, Version 2208 and GraphPad Prism, Version 10.2.3. Descriptive statistical methods such as measures of frequency as tables and graphs were applied. The quantitative ethnobiological parameter, relative frequency of citation (RFC), was used to assess the relative importance of the various animals used for traditional medicine in Ghana.

The RFC was obtained by dividing the number of vendors who are trading in a species they indicate to be used in traditional medicine (Fc) by the total number of participants in the survey (N) [65]

$$RFC = Fc/N$$

Conservation status

The conservation status of all the listed animals was determined using the International Union for Conservation of Nature (IUCN) Red List Categories and Criteria (2022–2 Version) internet site https://www.iucnredlist.org/. This also provided information on the population trend of the animals. The level of trade control of the animals was indicated as measured by the CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) Appendices I, II and III through a search engine on https://www.speciesplus.net/.

Ethical considerations

Ethical clearance with certificate number ECBAS 011/20–21 was provided by the Ethics Committee for Basic and Applied Science of the University of Ghana. During the collection of data, the participants were informed that accepting to be a participant was indicative of consent. The approved consent form was not used because vendors were apprehensive about signing documents because they were not sure whether the researcher was investigating their activities.

Results

Sociodemographic characteristics of vendors of animals for traditional medicine

The sociodemographic characteristics of vendors of animal-based medicines are shown in Table 1. The majority of the respondents were males (81; 60.9%), married (97; 75.2%) and believers of the Islam religion (56; 65.6%). Most of them were also between the ages of 51–60 years (57; 38.6%), had no formal education (41; 31.1%), plied their trade in open stalls (63; 48.5%), traded in markets located in the peri-urban communities in Ghana (52; 39.4%) and also traded in the Guinea savanna ecozone of Ghana (57; 42.9%). Majority of the vendors (65; 59.1%) indicated that their clients used animal parts mainly as medicines, while 31 (28.2%) indicated that they were for ritual or spiritual purposes.

Diseases clients treat using ABM

The top ten diseases that animal parts were used to treat were; (i) skin disorders such as rashes, infections, ulcers, sores and chicken pox (38; 11.2%), (ii) epilepsy (18; 5.3%), (iii) fracture (16; 4.7%), (iv) swollen legs and other inflammations (15; 4.4%), (v) arthritis (13; 3.8%), (vi) abdominal pains (11; 3.2%), (vii) boils (11; 3.2%), (viii) convulsion (11; 3.2%), (ix) hypertension (11; 3.2%) and (x) infertility (11; 3.2%) (Table 2).

Animals used for spiritual or ritual purposes

Among the top 10 spiritually related uses, the most important was for protection against spiritual attacks (120; 41.8%). Other uses included (i) healing of spiritually related diseases (20; 7.0%), (ii) performance of money rituals (17; 5.9%), (iii) conferring of fearfulness and physical strength (15; 5.2%), (iv) love charms (13; 4.5%), (v) raising the profile of trade or business to attract more clients (13; 4.5%), (vi) charming people for their possessions or attention (12; 4.2%), (vii) reversal of curses (11; 3.8%), (viii) conferring success in life or promotion at workplace (10; 3.5%) and (ix) attracting good luck (8; 2.8%). Table 3 shows the mystical uses clients of the vendors indicated they use the animal parts for in traditional medicine.

Animal species traded in traditional medicine, their distribution in the ecological zones of Ghana and their conservation status

Based on the relative frequency of citation of the animals sold for traditional medicine in Ghana, the top 10 (Figs. 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12) most frequently sold animals out of the total of 75 identifiable animal species in the Ghanaian market are as follows (Table 4): (i) chameleons (*Chamaeleo* spp.; 0.81), (ii) lions (*Panthera leo*; 0.81), (iii) West African crocodiles (*Crocodylus suchus*; 0.67), (iv) elephants (*Loxodonta africana*; 0.62), (v) 'tigers' (*Panthera tigris*; 0.57), (vi) tortoises (*Kinixys homeana*. 0.55), (vii) pythons (*Python sebae*/*Python regius*; 0.52), (viii) patas monkeys *(Erythrocebus patas*; 0.48), (ix) hedgehogs (*Atelerix albiventris;* 0.4) and (x) African electric catfish (*Malapterurus electricus*; 0.4). Animal species traded for traditional medicine in Ghana belong to 73 taxonomic families. Animals belonging to the Bovidae family (6; 8.2%) followed by the Felidae (5; 6.8%) were the most represented families. Other notable families with (2; 2.7%) members were the Equidae, Canidae, Muridae and Accipitridae. Whereas some animal species were found in all four major ecological zones, there were others found in fewer than four ecozones.

Distribution of animals traded for traditional medicine in the four main ecological zones in Ghana

Tables 5 and 6 show the distribution of the animal species traded in the four ecological zones; coastal savanna, forest, transitional and Guinea savanna. Up to 59 (78.7%) of the 75 animal species recorded nationally in this survey were found in the transitional/Guinea savanna ecozones, followed by the forest ecozone, 54 (72.0%) with the least of the numbers found in the coastal savanna ecozone, 49

Table 1 Sociodemographic characteristics of vendors of ABM

Variable	Subgroup	Frequency	Percentage
Sex ($n=133$)	Female	52	39.1
	Male	81	60.9
Age (years) $n=132$	30 years or less	14	10.6
	31–40	36	27.3
	41–50	27	20.5
	51–60	51	38.6
	>60	4	3.0
Highest educational level ($n=132$)	None	41	31.1
	Primary	23	17.4
	Junior High School/Middle School	31	23.5
	Senior High School	26	19.7
	Tertiary	11	8.3
Religious affiliation ($n=131$)	Traditional African Religion	10	7.6
	Christianity	35	26.7
	Islam	86	65.6
Marital status ($n=129$)	Single	18	14.0
	Married	97	75.2
	Divorced/Widowed	14	10.9
Type of vending space ($n=130$)	Open space	46	35.4
	Opened stall	63	48.5
	Closed stall	21	16.2
Type of settlement of market location ($n=132$)	Rural	35	26.5
	Peri-urban	52	39.4
	Urban	45	34.1
Ecological zone of market location	Coastal savannah	14	10.5
	Forest	52	39.1
	Transition	10	7.5
	Guinea savannah	57	42.9
Clients' main reasons for using animal medicines ($n=110$)	Medicinal purposes	65	59.1
	Ritual/spiritual purposes	31	28.2
	Both medicinal and ritual purposes	14	12.7

(65.3%) (Table 5). There was, however, no significant difference in the number of animal species recorded across the ecological zones in Ghana (p-value = 0.1914). Most, 25 (33.3%) of the 75 animal species found in this national survey were present in all four ecozones. Besides the 25 animal species, 10 (13.3%) were present in all other three areas but not the transitional zone. For the individual ecozones, the Guinea savanna presented 11 (14.7%) animal species not found in any other zone with the forest and coastal savanna also recording 7 (9.3%) and 4 (5.3%), respectively (Table 6).

Conservation status and trade control levels of animals traded for traditional medicine

Table 7 shows categorisation of animals traded for traditional medicine based on the IUCN and CITES classification schemes. Majority of animals (38; 52.8%) are of Least Concern, 11 (15.3%) are Threatened, five (6.9%) are Vulnerable, five (6.9%) are Endangered and one (1.4%) are Critically Endangered. Although most (24; 32.9%) of the animals were not listed, a good number were on a decreasing population trend (21; 28.8%) increasing to 52.5% if the unlisted and unknown animals were excluded. Majority of the animals (51; 69.9%) are not listed in any of the CITES Appendices but for those listed, most of them were under Appendix II (16; 21.9%) with the proportion in this category increasing to 72.7% after the exclusion of the unlisted animals.

Phyla and classes of animals traded for traditional medicine in Ghana

Animals belonging to four phyla and 11 classes were being traded for traditional medicine in Ghanaian markets (Fig. 13). Majority (65; 86.7%) of these animals

Table 2 Diseases that clients of vendors indicated they used ABM to treat

Diseases animal parts are mostly used to treat	Number of mentions	Percentage
Skin disorders (Rashes & infections, ulcers, sores, chicken pox)	38	11.2
Epilepsy	18	5.3
Fracture	16	4.7
Swollen legs & other inflammations	15	4.4
Arthritis	13	3.8
Others	13	3.8
Abdominal pains	11	3.2
Boils	11	3.2
Convulsion	11	3.2
Hypertension	11	3.2
Infertility	11	3.2
Headache	10	3.0
Asthma	9	2.7
Body pains	9	2.7
Haemorrhoids	9	2.7
Mental disorders	9	2.7
Diabetes	7	2.1
Erectile dysfunction	7	2.1
Fever	7	2.1
Peptic ulcer disease	7	2.1
Antidote to snakebites	6	1.8
Malaria	6	1.8
Poison antidote	6	1.8
Stroke	6	1.8
Ascites	5	1.5
Cough	5	1.5
Gonorrhoea	5	1.5
Kwashiorkor	5	1.5
Menstrual pains	5	1.5
Vitality	5	1.5
Burns	4	1.2
Delayed child walking	4	1.2
Weak bones in children	4	1.2
Hepatitis B	3	0.9
Hernia	3	0.9
Keloids	3	0.9
Mumps	3	0.9
Other reproductive disorders (fibroid, miscarriage)	3	0.9
Constipation	2	0.6
Anaemia	2	0.6
Insomnia	2	0.6
Kidney disease	2	0.6
Leprosy	2	0.6
Pneumonia	2	0.6
Sore throat	2	0.6
Typhoid fever	2	0.6

Table 3 Spiritual or ritual purposes of animals traded for traditional medicine in Ghana

Mystical (Spiritual/magical) uses	Number of mentions	Percentage
Protection against spiritual attack	120	41.8
Healing of spiritual diseases	20	7.0
Performance of money rituals to become rich	17	5.9
Conferring fearfulness and being physically strong	15	5.2
Making love charms	13	4.5
Raising the profile of trade or business to attract more clients	13	4.5
Charming people for their possessions or attention	12	4.2
Reversal of curses	11	3.8
Courting successes in life or promotion at the workplace	10	3.5
Attracting good luck	8	2.8
Stopping recurrent nightmares	8	2.8
Resolution of marital problems	6	2.1
Causing harm to others	6	2.1
Protection against guns and other weapon attacks	5	1.7
Breaking apart spiritual marriages	4	1.4
Protection of pregnancy and easing childbirth	3	1
Increasing farm yields	2	0.7
Neutralisation of charms	2	0.7
Prevention of spiritual poisoning	2	0.7
Vanishing into thin air when in danger	2	0.7
Winning a court case	2	0.7
Developing the ability to see spiritually	1	0.3
Avoiding snake bite envenomation	1	0.3
Making goalkeepers excel during football matches	1	0.3
Increasing the size of the male genital	1	0.3
Performance of widowhood rites	1	0.3
Scare people off personal property	1	0.3

Fig. 2 Whole chameleon (*Chamaeleo* spp.)

Fig. 3 Skin of West African crocodile (*Crocodylus suchus*)

Fig. 4 Skin of lion (*Panthera leo*)

Fig. 5 Skin of African elephant (*Loxodonta africana*)

Fig. 6 Skin of African royal python (*Python regius*)

Fig. 7 Skin African rock python (*Python sebae*)

belong to the phylum Chordata, followed by Mollusca (5; 6.7%), Arthropoda (3; 4.0%) and Echinodermata (2; 2.7%). Most of the animals belonged to the taxonomic class Mammalia (37; 49.3%), followed by the Aves (15; 20.0%), the Reptilia (11; 14.7%) and then the Gastropoda (4; 5.3%). Whereas two animals (2.7%) were in the class Insecta, other classes such as the Actinopterygii, Amphibia, Arachnida, Asteroidea, Cephalopoda and Echinoidea were each represented by one animal (1.3%).

Discussion

Characteristics of vendors of animal-based medicines in Ghana

This study found that about two-thirds of the vendors were males (60.9%) contrary to most previous studies in Nigeria [2, 52, 63] and Ghana [35], where the majority or all of the vendors were females. Studies in Togo, Nigeria and South Africa, however, reported the involvement of more males in the animal-based medicine trade [28, 41,

Fig. 8 Shell of hinge-back tortoise (*Kinixys homeana*)

Fig. 9 Head and skin of patas monkey (*Erythrocebus patas*)

Fig. 10 Skin of four-toed hedgehog (*Atelerix albiventris*)

Fig. 11 Skin of African electric catfish (*Malapterurus electricus*)

68]. The difference could be the inclusion criteria in this study which required that a qualified vendor should be able to tell the uses of at least one of the animal parts he or she sold. In most markets, the women vendors claimed only sold these items without knowing what patrons used them for.

This study also found that about two-thirds (65.6%) of the vendors were adherents of the Islamic faith, similar to reports by Ajagun et al. [2] and Soewu et al. [63]. Plausible reasons for the over-representation of followers of Islam over Christians or African Traditionalists include firstly that most of the vendors hailed from the guinea savanna ecological zone, the largest of the ecozones with Islam-dominated populations. Also, the Ghana Statistical Service [36] reported that the northern region and then the largest region in the guinea savanna ecological zone had a population of 60.0% Muslims, 21.0% Christians and 16.0% Traditionalists. Assessment of the marital status of the vendors also indicated that up to three-quarters (75.2%) were married, a proportion lower than the 92.4% reported by [52]. This is not surprising

Fig. 12 Skin of 'tiger' *Panthera tigris*

since nine out of 10 vendors (89.8%) were above 30 years, an age at which most Ghanaians would have married. Ghana Statistical Service (GSS), Ghana Health Service (GHS) and ICF Macro [38] showed that the median age at first marriage was 19.8 years for women and 25.9 years for men. In terms of the location of the markets for animal-based medicines, this study found that less than a third of the vendors (26.5%) plied their trade in rural markets. It would then have been expected that there should be more patronage of animal parts in rural areas where access to modern health facilities and personnel remained a challenge, but the opposite was observed in this study. This could be attributed to the higher income levels of urban dwellers who could afford these animal parts, some of which are expensive. This assertion is corroborated by Thorsen and Pouliot [67] in Nepal.

The age distribution of vendors indicated that about a third (38.6%) of respondents were between the ages of 51 and 60 years. However, Nnamuka et al. [52] reported ages 41–50 years to be the modal age range while Ajagun et al. [2] found half (50%) of the vendors belonging to the 31–45 years age bracket. Soewu et al. [63] also indicated that most of the vendors of traditional medicine they surveyed were between the ages of 40 and 49 years. It is not too clear what might account for Ghana's higher modal age. It can, however, be attributed to the current increasing interest in formal education in Ghana as a result of the introduction of a free secondary education policy of the government. The trade in animal-based traditional medicine has now been left in the hands of the aged which could lead to the loss of traditional knowledge when they pass on without transmitting it to the younger ones. Some vendors clearly indicated that their children who would have learned the trade have gone to school so they will have to continue even into old age.

Uses of animals for traditional medicine in Ghana

According to the vendors, their clients indicated they used the parts of the 75 animal species for medicinal, mystical and other purposes, similar to reports by Nieman et al. [51] in South Africa and Timothy et al. [68] in Nigeria. In the South African study [51], most of the animals were used for spiritual/magical purposes rather than medicinal similar to what Gbogbo and Daniels [35] reported in Ghana where 70% of the uses of these animals were for spiritual purposes. This is contrary to the findings of this study in which about three-fifths (59.1%) of the vendors said their clients were using the animals for medicinal purposes, while about a quarter (28.2%) intended to use these animal parts for mystical purposes. The differences in the proportions of various forms of use can be attributed to differences in the scope of the study. While the South African study was conducted among traditional healers in 17 townships and informal settlements in the rural and peri-urban landscapes in the Boland Region of the West Cape Province, the Ghanaian study was conducted among vendors of traditional medicine plying their trade in seven markets located in the Accra Metropolitan Area.

Forty-seven different types of diseases were reported to require the use of animal parts for treatment, with skin diseases being the most common, followed by epilepsy. Kebebew et al. [43] also reported skin-related diseases as the disorder most commonly treated with animal parts in Ethiopia. Respiratory diseases were listed by Haileselasie [40] and Alves et al. [10], while Yohannes and Chane [82] and Ajagun et al. [2] reported stomach pain and rheumatism, respectively, as disease conditions most commonly treated with animal parts. Although skin disorders are among the top 10 diseases reported at out-patient departments of health facilities in Ghana, malaria was the topmost disease [72]; therefore, it is not so clear why skin disorders were the main medical condition animal parts are used to treat in this study.

The spiritual importance of the animal parts among Ghanaian users had been shown in this study with 27 different mystical or spiritual uses indicated by the vendors. The African belief in the supernatural and the possibility of deriving goodness as well as harm from the spiritual realm may be a factor that may account for the patronage of these animal parts for mystical purposes [61]. Several studies [2, 20, 35, 47, 50, 59, 62, 68, 83] have reported various uses of animal parts for protection of self and property, boosting of businesses, charming of others and even improving crop yields in farms. This is not surprising considering how spiritually aware Africans are. It is, however, worth stating that the application of animal parts for mystical purposes is not only common among Africans since some other

Table 4 Relative frequency of citation of animals used in traditional medicine in Ghana and their conservation statuses ($n=42$)

Common name	Scientific name	Class	Distribution across ecozones*	Family	IUCN Status**	CITES status***	Current population trends****	Number of citations	Relative frequency of citation
Chameleon	*Chamaeleo* spp.	Reptilia	4CFTG	Chamaeleonidae	Variable	II	Variable	34	0.81
Lion	*Panthera leo*	Mammalia	4CFTG	Felidae	Vulnerable	II	Decreasing	34	0.81
West African crocodile	*Crocodylus suchus*	Reptilia	4CFTG	Crocodylidae	Not evaluated	Not listed	Not listed	28	0.67
African elephant	*Loxodonta africana*	Mammalia	4CFTG	Elephantidae	Endangered	II	Decreasing	26	0.62
'Tiger'	*Panthera tigris*	Mammalia	4CFTG	Felidae	Endangered	I	Decreasing	24	0.57
Home's hinge-back tortoise	*Kinixys homeana*	Reptilia	4CFTG	Testudinidae	Vulnerable	II	Decreasing	23	0.55
African rock python/Royal python	*Python sebae/ Python regius*	Reptilia	4CFTG	Pythonidae	Near Threatened	II	Decreasing	22	0.52
Patas monkey	*Erythrocebus patas*	Mammalia	4CFTG	Cercopithecidae,	Near Threatened	II	Decreasing	20	0.48
Four-toed hedgehog	*Atelerix albiventris*	Mammalia	4CFTG	Erinaceidae	Least Concern	Not listed	Stable	17	0.40
African electric catfish	*Malapterurus electricus*	Actinopterygii	4CFTG	Malapteruridae	Least Concern	Not listed	Unknown	17	0.40
Hippopotamus	*Hippopotamus amphibius*	Mammalia	3CTG	Hippopotamidae	Vulnerable	II	Stable	14	0.33
Horse	*Equus caballus*	Mammalia	4CFTG	Equidae	Domesticated	Not listed	Not listed	14	0.33
Giant African snail	*Achatina achatina*	Gastropoda	4CFTG	Achatinidae	Not evaluated	Not listed	Not listed	13	0.31
Common chimpanzee	*Pan troglodytes*	Mammalia	3CFG	Hominidae	Endangered	I	Decreasing	13	0.31
Domestic cattle	*Bos taurus*	Mammalia	4CFTG	Bovidae	Domesticated	Not listed	Not listed	12	0.29
Spotted hyena	*Crocuta crocuta*	Mammalia	4CFTG	Hyaenidae	Least Concern	Not listed	Decreasing	12	0.29
African buffalo	*Syncerus caffer caffer*	Mammalia	3CFG	Bovidae	Least Concern	Not listed	Not listed	12	0.29
Leopard	*Panthera pardus*	Mammalia	4CFTG	Felidae	Vulnerable	I	Decreasing	12	0.29
African ground squirrel	*Xerus* spp.	Mammalia	4CFTG	Sciuridae	Least Concern	Not listed	Stable	11	0.26
Black cobra	*Naja melanoleuca*	Reptilia	4CFTG	Elapidae	Least Concern	Not listed	Decreasing	11	0.26
Donkey	*Equus asinus*	Mammalia	3CFG	Equidae	Domesticated	Not listed	Not listed	10	0.24
Brushed tail porcupine	*Atherurus africanus*	Mammalia	2FG	Hystricidae	Least Concern	Not listed	Unknown	9	0.21
Hooded Vulture	*Necrosyrtes monachus*	Aves	4CFTG	Accipitridae	Critically Endangered	II	Decreasing	9	0.21
Nile monitor lizard	*Varanus niloticus*	Reptilia	4CFTG	Varanidae	Least Concern	II	Stable	8	0.19
African golden wolf	*Canis lupaster*	Mammalia	4CFTG	Canidae	Least Concern	Not listed	Decreasing	8	0.19
Pied crow	*Corvus albus*	Aves	3CTG	Corvidae	Least Concern	Not listed	Stable	7	0.17

Table 4 (continued)

Common name	Scientific name	Class	Distribution across ecozones*	Family	IUCN Status**	CITES status***	Current population trends****	Number of citations	Relative frequency of citation
Domestic sheep	*Ovis aries*	Mammalia	4CFTG	Bovidae	Domesticated	Not listed	Not listed	7	0.17
Barn owl	*Tyto alba*	Aves	3CFG	Tytonidae	Least Concern	II	Stable	7	0.17
Domestic cat	*Felis catus*	Mammalia	3FTG	Felidae	Domesticated	Not listed	Not listed	7	0.17
Common warthog	*Phacochoerus africanus*	Mammalia	3CFG	Suidae	Least Concern	Not listed	Decreasing	7	0.17
True eagle	*Aquila* spp.	Aves	3CFG	Aquilinae	Variable	Variable	Not listed	6	0.14
Hawk (Black kite)	*Milvus migrans*	Aves	4CFTG	Accipitridae	Least Concern	II	Stable	5	0.12
African common toad	*Sclerophrys regularis*	Amphibia	2CG	Bufonidae	Least Concern	Not listed	Stable	5	0.12
Common duiker	*Sylvicapra grimmia*	Mammalia	3CTG	Bovidae	Least Concern	Not listed	Decreasing	5	0.12
Puff adder	*Bitis arietans*	Reptilia	4CFTG	Viperidae	Least Concern	Not listed	Stable	5	0.12
Dromedary camel	*Camelus dromedarius*	Mammalia	2FG	Camelidae	Domesticated	Not listed	Not listed	5	0.12
Roam antelope	*Hippotragus equinus*	Mammalia	1G	Bovidae	Least Concern	Not listed	Decreasing	5	0.12
Bushbuck	*Tragelaphus scriptus*	Mammalia	3CFG	Bovidae	Least Concern	Not listed	Stable	5	0.12
Rainbow lizard	*Agama agama*	Reptilia	2FG	Agamidae	Least Concern	Not listed	Stable	4	0.10
Domestic goat	*Capra hircus*	Mammalia	3FTG	Bovidae	Domesticated	Not listed	Not listed	4	0.10
Black rat	*Rattus rattus*	Mammalia	3CTG	Muridae	Least Concern	Not listed	Stable	4	0.10
Money cowrie	*Monetaria moneta*	Gastropoda	4CFTG	Cypraeidae	Not evaluated	Not listed	Not listed	4	0.10
Emperor scorpion	*Pandinus imperator*	Arachnida	3CFG	Scorpionidae	Not evaluated	II	Not listed	4	0.10
House mouse	*Mus musculus*	Mammalia	4CFTG	Muridae	Least Concern	Not listed	Stable	4	0.10
Straw-coloured fruit bat	*Eidolon helvum*	Mammalia	3CFG	Pteropodidae	Near Threatened	Not listed	Decreasing	4	0.10
Senegal flap-shell turtle	*Cyclanorbis senegalensis*	Reptilia	3CFG	Trionychidae	Vulnerable	II	Decreasing	4	0.10
Sea snail	*Pseudoliva zebrina*	Gastropoda	1G	Pseudolividae	Not evaluated	Not listed	Not listed	4	0.10
Grey parrot	*Psittacus erithacus*	Aves	2CF	Psittacidae	Endangered	I	Decreasing	3	0.07
Domestic dog	*Canis lupus familiaris*	Mammalia	2CF	Canidae	Domesticated	Not listed	Not listed	3	0.07
Grasscutter	*Thryonomys swinderianus*	Mammalia	2FG	Thryonomyidae	Least Concern	Not listed	Unknown	3	0.07
Cattle Egret	*Bubulcus ibis*	Aves	2FG	Ardeidae	Least Concern	Not listed	Increasing	2	0.05
African savannah hare	*Lepus victoriae*	Mammalia	1G	Leporidae	Least Concern	Not listed	Stable	2	0.05
African civet	*Civettictis civetta*	Mammalia	1F	Viverridae	Least Concern	III	Unknown	2	0.05

Table 4 (continued)

Common name	Scientific name	Class	Distribution across ecozones*	Family	IUCN Status**	CITES status***	Current population trends****	Number of citations	Relative frequency of citation
Stone Partridge	*Ptilopachus petrosus*	Aves	2CF	Odontophoridae	Least Concern	Not listed	Stable	2	0.05
Domestic duck	*Anas platyrhynchos domesticus*	Aves	2CF	Anatidae	Domesticated	Not listed	Not listed	2	0.05
West African long-tailed shrew	*Crocidura muricauda*	Mammalia	2CF	Soricidae	Least Concern	Not listed	Unknown	2	0.05
Sand boa	*Eryx muelleri*	Reptilia	1F	Boidae	Least Concern	II	Stable	2	0.05
African wildcat	*Felis lybica*	Mammalia	1G	Felidae	Least Concern	II	Unknown	2	0.05
Helmeted Guinea fowl	*Numida meleagris*	Aves	2FG	Numididae	Least Concern	Not listed	Stable	1	0.02
Village weaver bird	*Ploceus cucullatus*	Aves	1C	Ploceidae	Least Concern	Not listed	Stable	1	0.02
Senegal bushbaby	*Galago senegalensis*	Mammalia	1C	Galagidae	Least Concern	II	Decreasing	1	0.02
Whale	Unidentified	Mammalia	1C	Variable	Unidentified	Variable	Variable	1	0.02
Aardvark	*Orycteropus afer*	Mammalia	1G	Orycteropodidae	Least Concern	Not listed	Unknown	1	0.02
Domestic Pigeon	*Columba livia domestica*	Aves	1G	Columbidae	Domesticated	Not listed	Not listed	1	0.02
African grey Woodpecker	*Mesopicos goertae*	Aves	1G	Picidae	Least Concern	Not listed	Not listed	1	0.02
House cricket	*Acheta domesticus*	Insecta	1F	Gryllidae	Least Concern	Not listed	Not listed	1	0.02
White-bellied Pangolin	*Phataginus tricuspis*	Mammalia	1F	Manidae	Endangered	I	Decreasing	1	0.02
Common starfish	*Asterias rubens*	Asteroidea	1C	Asteriidae	Not evaluated	Not listed	Not listed	1	0.02
Sea urchin	*Echinus* spp.	Echinoidea	1G	Echinidae	Near Threatened	Not listed	Not listed	1	0.02
Plated lizard	*Gerrhosaurus major*	Reptilia	1G	Gerrhosauridae	Least Concern	Not listed	Unknown	1	0.02
Ostrich	*Struthio camelus*	Aves	1F	Struthionidae	Least Concern	Not listed	Decreasing	1	0.02
Cockroach	*Periplaneta americana*	Insecta	1G	Blattidae	Not evaluated	Not listed	Not listed	1	0.02
Common octopus	*Octopus vulgaris*	Cephalopoda	1F	Octopodidae	Least Concern	Not listed	Unknown	1	0.02
Domestic fowl	*Gallus gallus domesticus*	Aves	1F	Phasianidae	Domesticated	Not listed	Not listed	1	0.02
Moon snail	*Natica monodi*	Gastropoda	1G	Naticidae	Not evaluated	Not listed	Not listed	1	0.02

*The figure shows the number of ecological zones the animal species was found being traded for traditional medicine with the letters indicating the ecological zones they were found in: *C* coastal savanna, *F* forest ecozone, *T* transitional zone and *G* Guinea savanna ecozone. Sources: * *https://www.iucnredlist.org/. *** https://www.speciesplus.net/. **** https://www.speciesplus.net/

studies have reported the use of animal parts for non-medicinal purposes in some European countries such as Spain, Italy and Albania [17, 39, 58]. Similar reports of the use of animals for magical/spiritual conditions have been reported in Brazil [57, 66].

Local importance of traded animals

The local importance of each species for traditional medicine as measured by the relative frequency of citation (RFC) index (Tardio and Santayana 2008) indicated the top five most important animals traded by the

Table 5 Number of animal species found in the ecological zones in Ghana

Ecozone	Proportion of national animal species present	Percentage present	Proportion of national animal species absent	Percentage absent	Chi-square (*df*)	*p*-value
Coastal savanna	49	65.3	26	34.7	3.307 (2)	0.1914
Forest	54	72.0	21	28.0		
Transitional/Guinea savanna*	59	78.7	16	21.3		

*There were 32 (42.7%) animal species traded for traditional medicine in the transition ecological zone but all of these are also found in the guinea savanna zone

Table 6 Distribution of animal species traded for traditional medicine present in Ghana's ecological zone(s) only

Ecozone(s)	Number of animal species	Percentage
All four ecozones	25	33.3
Coastal savanna, forest and Guinea savanna only	10	13.3
Coastal savanna, transitional and Guinea savanna only	4	5.3
Forest, transitional and Guinea savannas only	2	2.7
Coastal savanna and forest only	5	6.7
Coastal savanna and Guinea savanna only	1	1.3
Forest and Guinea savannas only	6	8.0
Coastal savanna only	4	5.3
Forest only	7	9.3
Guinea savanna only	11	14.7

Table 7 Conservation status and trade control levels of animals traded for traditional medicine

Conservation policy	Types	Number of animal species	Percentage
IUCN General categories ($n=72$)	Domesticated	11	15.3
	Not evaluated	8	11.1
	Least Concern	38	52.8
	Near Threatened	4	5.6
	Endangered	5	6.9
	Critically endangered	1	1.4
	Vulnerable	5	6.9
IUCN Population trend ($n=73$)	Not listed	24	32.9
	Unknown	9	12.3
	Stable	18	24.7
	Decreasing	21	28.8
	Increasing	1	1.4
CITES ($n=73$)	Not listed	51	69.9
	Appendix I	5	6.8
	Appendix II	16	21.9
	Appendix III	1	1.4

vendors as chameleons (*Chamaeleo* spp.), lions (*Panthera leo*), elephants (*Loxodonta africana*), tigers (*Panthera tigris*) and West African crocodiles (*Crocodylus suchus*). Boakye et al. [21] in Ghana and D'Cruze et al. [28] in Togo had also reported the chameleon to be the most traded animal. Although Gbogbo and Daniels [35] reported the forest-hinged tortoise (*Kinixys erosa*) as the most traded animal in Accra, Ghana, the second most traded were chameleons. The versatility of chameleons in the management of both physical diseases and spiritual conditions, as well as their availability, accessibility and low prices, may account for their high RFC. For lions, tigers, elephants and crocodiles, the high

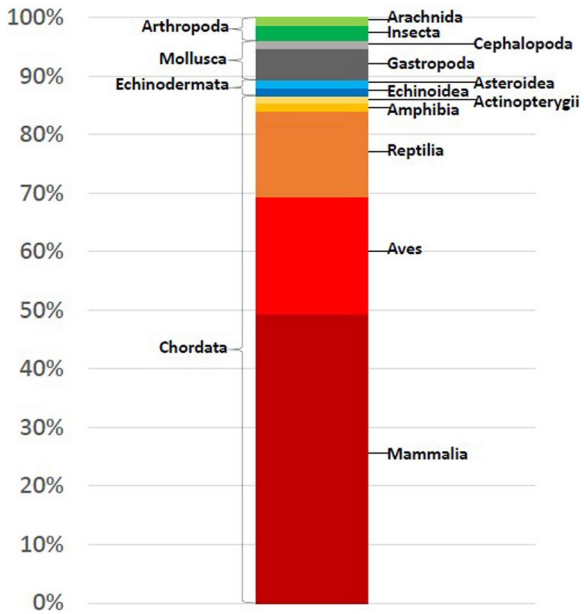

Fig. 13 Phyla and classes of animals traded for traditional medicine in Ghana

RFC indicates their importance in traditional medicine in Ghana, possibly due to the possession of some attributes that users can relate to in their application in traditional medicine. For instance, lions are associated with bravery and strength and hence their use for mystical purposes that provide physical or spiritual fortitude. This study found the African savanna elephant, *Loxodonta africana,* and the West African crocodile, *Crocodylus suchus* to be used for the treatment of skin rashes and for protection against injury from bullets and sharp objects possibly due to their thick and tough skins. The top two most important taxonomic families by way of citation in this study were the Bovidae (domestic cattle, African buffalo, domestic sheep, etc.) and the Felidae (lion, tiger, leopard, etc.) unlike Accipitridae and Cercopithecidae [21] reported in Kumasi, Ghana or the Aganidae as indicated by Alade et al. [3] in Nigeria. The bravery and charismatic attributes of the top most traded members of the Felidae in this study make their trade and demand high. They play important roles in rituals associated with the provision of spiritual fortification and protection. An important component of African cultures is the drum used for entertainment, social and spiritually related events [12]. These drums are mainly carved from wood with their percussive surface made from animal skins, especially those from the Bovidae (cattle, goats, sheep) which may account for their high trade volumes in traditional medicine markets in Ghana [4, 12, 22].

Animals traded in Ghanaian traditional medicine markets

A total of 75 animal species from 11 classes were being sold by traditional medicine vendors in Ghana. These numbers are higher than those reported from several other places in Africa, Europe, Asia and the Americas [75], Quave et al. [5, 58], Alves and Alves, [9], Whiting et al. [77], Djagoun et al. [31], [18, 21, 35, 51, 82]. Quave et al. [58] reported a higher species number of 80 because the study was conducted in three European countries and Nepal, while Alves & Alves [9] had 584 species and 10 classes of animals from several countries in Latin America where the richest biomes are located. Djagoun et al. [31] in a nationwide study in the Republic of Benin also reported 87 mammals which is a number higher than similar studies conducted in Ghana. The plausible reason for the higher number of animal species traded for traditional medicine in the Republic of Benin than in Ghana could be because Benin has more than twice the number of followers of traditional religion (11.6%) than Ghana (5.0%); hence, there is a higher demand for more diverse types of animals [70, 71]. The study sites and their spread, the species richness of the specific geographical region and types of the respondents may account for differences between some previous studies and the numbers reported in this study. For studies that reported a lower number of species and classes, most of them were carried out among specific ethnic groups, or specific districts or communities and the study sites were communities not marketplaces as reported in this study.

Out of the 11 different animal classes being sold by the traditional medicine vendors in this study, more than half (49.3%) of the animals are mammals, followed by birds and reptiles, which is similar to that reported by Kendie et al. [44], Kebebew et al. [43], Boakye et al. [21] and Teixeira et al. [66]. However, reports by Yohannes and Chane [82], Whiting et al. [77] and Nieman et al., [51] found more reptiles than birds after mammals. Gbogbo and Daniels [35], however, reported more reptiles and birds than mammals in their study in markets in Accra. The differences could be attributed to the study sites and participants as well as the geographical coverage of the studies.

Distribution of animal species used for traditional medicine based on ecological zones

In West Africa, most animal species are found within and around tropical rainforests with the species richness generally decreasing as the savanna vegetation is encountered [29]. Also, according to Mensah et al. (2006) and Sinsin et al. (2008) as cited in Djagoun et al. [31], generally the abundance of animal species in their natural habitat leads to an increase in their numbers in the traditional

medicine markets in that locality. The results of this study rather present a contrary situation since the Guinea savanna ecological zone reported the highest number of animal species in their traditional medicine market with the coastal savanna presenting the least with the difference not statistically significant (p-value = 0.1914). For animals that were specifically found in the various ecological zones, the northerly situated Guinea savanna has the highest of 11 compared to the 7 reported in the forest zone. These results show that in the case of Ghana, other factors besides the ecological location of the traditional medicine markets influence the animal species sold in them. For instance, moon snails (*Natica monodi*) and Sea urchins (Echinus spp.) are marine creatures, but they were reported only in the Guinea savanna ecozone. Also, the Common octopus (*Octopus vulgaris*), a marine animal was found only in the forest ecozone. The only Hippopotamus (*Hippopotamus amphibius*) sanctuary in Ghana is located in Wechaiu in the Upper West region of Ghana which is in the Guinea savanna ecozone, but markets in the coastal savanna sold parts of this animal. This shows the availability of an animal species in the traditional medicine market is not determined by the abundance of that animal in a habitat. The possible factors that may account for the presence or absence of an animal species in a market may be a demand factor influenced by cultural beliefs. Although not reported here, more than half of the patrons of animal parts for traditional medicine were from the Mole-Dagbani ethnic group who inhabit the Guinea savanna ecozones in Ghana. Wholesalers were the main suppliers for more than half of these traders in animal parts. Furthermore, almost 90% of traders indicated they travel outside their localities and even to neighbouring countries such as Nigeria, Burkina Faso, Benin among others to purchase their animal parts and products.

Conservation implications

The international trade in wildlife, its parts and derivatives is estimated to be expanding in both volume and value terms. For each species, trade may have positive and negative consequences for conservation and the long-term survival of species and biological diversity [24]. In this study, 15.2% of all the animals traded are among the threatened species according to the IUCN Red List, with the proportion increasing to 40.0% among the top 10 traded species. Again, more than a quarter (28.8%) of the animals are experiencing a decreasing population trend but the rate is higher (52.5%) if those animals not listed or whose status remained unknown are excluded. A revelation of 60.0% of the top 10 traded animal species in this study experiencing a decreasing population trend is rather disturbing to conservationists. Although a majority (69.9%) of the animals being traded for traditional medicine in Ghana are not listed in CITES Appendices, there are conservation implications when the top 10 traded animals have 20.0% listed in Appendix I and even a greater proportion of 60% in Appendix II. Intra-country differences in the level of trade in threatened animal species can be seen in Ghana as the 14.7% recorded in this study was lower than the 19% recorded in Kumasi by Boakye et al. [21] but higher than the 13.0% indicated by Gbogbo and Daniels [35] in their Accra survey. These high proportions of threatened animals and internationally regulated animal species found in this study, clearly indicate that this unregulated trade and use of animals in traditional medicine has implications for the conservation of biodiversity. Even, the presence of the vulnerable lions and the endangered elephants in the top 10 should be of concern considering the roles they play in the ecosystem. Being predators of herbivores such as zebras and wildebeest, a reduction of the lion population as a result of high levels of trade in traditional medicine will affect the conditions of grasslands and forests and the ecosystem services they provide. A reduction in the population of elephants which are obligatory dispersers of several trees with large tough seed coats will affect the germination and development of such trees which will affect the biodiversity in such ecosystems [76].

Conclusion

The trade of animal parts and products for traditional medicine in Ghana is widespread, especially in market centres in the urban area. These animals are used mainly for medicinal purposes, especially skin diseases, but their use for mystical purposes is also prevalent. Again, with the topmost traded animals being those in CITES Appendices I and II, means there is some laxity in the enforcement of laws that are to ensure sustainable use of animal resources. Although a majority of animals traded for traditional medicine may not be currently of conservation concern and not listed under CITES, policymakers and other stakeholders in Ghana and beyond would have to start working on ensuring the survival of the threatened ones and prevent the sliding of the non-threatened species into extinction so the biodiversity will be conserved for the use of the future generation.

Abbreviations

IUCN	International Union for Conservation of Nature
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
WHO	World Health Organization
IUCN/PACO	IUCN (International Union for Conservation of Nature) Central and West Africa Programme (PACO)
RFC	Relative frequency of citation
SPSS	Statistical package for the social sciences
C	Coastal savanna ecozone
F	Forest ecozone

T	Transitional ecozone
G	Guinea savanna ecozone
ABM	Animal-based medicine

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Author contributions
E.P.K.A. conceived the idea, drafted the study tool, collected and analysed the data, and wrote the manuscript. D.K.A., F.G., J.A.S. and BYO supervised the research work and wrote the manuscript. S.G. and E.A. also wrote the manuscript. All authors reviewed the manuscript.

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Declarations

Ethical approval
Ethical clearance with certificate number ECBAS 011/20–21 was provided by the Ethics Committee for Basic and Applied Science of the University of Ghana.

Consent for publication
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Competing interests
The authors declare no competing interests.

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