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DIVERSITY OF POISONOUS PLANTS AND THEIR ANTIDOTES, AFFECTING RUMINANT LIVESTOCK PRODUCTION ON RANGELANDS IN GHANA

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ABSTRACT

The survival of the extensive livestock system, the practice for most farmers in the livestock industry in Ghana depends heavily on the natural pastures as forage resource. To efficiently use the rangelands, knowledge of the species composition, especially that of poisonous plants is essential. Documented knowledge in Ghana is scanty; documentation and dissemination of the knowledge resource would enable a wider access and wider benefit to stakeholders. A study was conducted in Ghana on poisonous plants with the aim to discover the existence and diversity of poisonous plants and associated antidotes affecting livestock for documentation and preservation of knowledge. 70 different items were cited; 22 were poisonous plants for which antidotes were not cited, 28 were poisonous plants with known antidotes and 32 antidotes. There were 575 citations of plants from 194 reported cases of suspected plant poisoning, categorized as poisonous plants for which no antidotes were cited (146), poisonous plants with cited antidotes (147) and antidotes (282). 50 plants species were identified and belonged to 29 plant families. Some plants were known only by local names. There was an extensive knowledge of the diversity of poisonous plants and antidotes within the ecological zones along with possible antidotes.

Keywords: Poisonous plants, livestock, Indigenous knowledge, diversity, Ghana, Rangelands

Introduction

Documenting indigenous environmental knowledge has for some time now, become a growing concern. The acronym TEK, which stands for "Traditional Environmental Knowledge" (Williams, Baines, & Brownlee, 1993) has become widely used to describe environmental knowledge attributable to indigenous people, as has IK – Indigenous Knowledge (D. W. Brokensha, Warren, & Werner, 1980; Cunningham, 1991; Warren, 1991). Ethnoecology was introduced (Toledo, 1992) later in the same light of describing and finding use for the knowledge resource. The profusion of acronyms and headings suggests the rapid emergence of this perspective within several independent academic networks (Hunn, 1999).

The focus of science and research has been to integrate IK as a key to sustainable development (D. Brokensha & Warren, 1980; Chambers, Pacey, & Thrupp, 1989;

Erdelen, 2002; Homann & Rischkowsky, 2001; Warren, 1989). As a consequence, a wealth of information on IK pertaining to soils, plants and animals has been compiled (Bizimana, 1994). Nevertheless, examples of the integration of IK into the research process and its application within the development context remain scarce as rightly observed by Homann & Rischkowsky (2001).

Changing landscape, especially in agriculture and general deforestation, affects the composition of plant and animal species. In the case of agriculture and poisonous plants, the effect of deteriorating rangelands from grazing pressure on some wild species may pave way for the spread of undesirable and/or poisonous plant species because the resulting niche may favour the latter, increasing their abundance and the associated problems. On the contrary, renewable resources including plant species that are valuable to rural communities, including antidotes to poisonous plants, may face extinction from over exploitation and deforestation (Kiringe, 2005; Southgate & Sanders, 1990) and the effects of changing climate may threaten the survival of vital flora and fauna and, by extension, the people who depend on the ecosystem for their survival. Persistent rising temperatures, changing rainfall patterns and seasons and increasing grazing pressures on natural pastures resulting from some degrading communal grazing fields stemming from poor management practices and opening up of the country to transhumant livestock movements, put pressure on resource availability, especially the botanical composition of the rangelands that support the system.

The survival of the extensive livestock system which is the practice for most farmers in the livestock industry in Ghana depends heavily on the natural pastures as a forage resource. In competitive systems, the livestock obtain a substantial proportion of their dietary needs from rangelands and pastures of the country and it is not uncommon to find poisonous plants growing on cultivated or natural, and private or public grazing lands (James, Nielsen, & Panter, 1992). Poisonous plants on rangelands have socio-economic effects and impacts the livestock industry in various ways. Due to the elusive, hard-to-define, almost impossible-to-count nature of the problem, it has made it very difficult to set an actual value on the economic losses sustained because of livestock poisoning due to plant ingestion, however, it is generally recognized as one of the most important economic impediments to profitable livestock production (James *et al.*, 1992). For an efficient use of the rangelands, a good knowledge of the species composition, especially that of the poisonous plants is essential. Documented knowledge of such plants is scanty in Ghana; the CSIR-Animal Research Institute attempted a study aimed at documenting poisonous plants on rangelands in Ghana around 1970 - 1975 (annual reports), but has no records of the findings. Preceding this work, Irvine, assisted by Dokosi (Irvine, 1961), and later

Dokosi alone (Dokosi, 1998) in their general accounts of the woody plants of Ghana and Herbs of Ghana respectively, also list plants reported as poisonous in Ghana. A documentation of existing information specifically on poisonous plants and the livestock industry and dissemination of such knowledge resource would enable a wider access and a wider benefit to stakeholders.

The aim of this study was to expand the existing information and diversity of poisonous plants affecting livestock production on Ghanaian rangelands and document them as a means of preservation of knowledge to augment

plant information on livestock health services and management of the productivity of the rangelands.

Experimental

Ghana is situated on the west coast of Africa, extending from latitude 4^1/2 N to about latitude 11^o N and between longitudes 1$^1/_2$ ^{o} E to 3$^1/_2$ ^{o} W with a total area of 238 540 km^2. The country has a north-south extent of about 670 km and a maximum east-west extent of about 560 km. It shares borders with Côte d'Ivoire and Burkina Faso to the west, Burkina Faso to the north, and Togo to the east. To the south are the Gulf of Guinea and the Atlantic Ocean.

Ecologically, Ghana is diverse, but the forest, savannah, and rainfall distribution are the dominant factors affecting human activities (Dickson & Benneh, 1970; Owen, ; Phillips). The Vegetation consists of hardwoods and scattered trees and secondary climbers, shrubs, and soft woody plants. In addition to the scattered trees and secondary vegetation, some grass species have appeared to form a derived savannah. The wooded savannah, the largest vegetation zone, consists mostly of grasses and acacias (Dickson & Benneh, 1970; Harvey). The grasses are sensitive to trampling by livestock and to selective grazing and are replaced easily by less nutritious grasses and by acacias and thickets.

A structured questionnaire interview was conducted in 2003 with respondents from three zones in Ghana (northern zone, middle belt and southern zone) pooled together for the study with major stakeholders in the livestock industry in Ghana. All persons selected for the study gave their oral informed consent prior to their inclusion in the study.

One respondent could provide more than one report, depending on the number of different accounts of plant poisoning of livestock provided. An incident of plant poisoning with possible strategy(ies) for managing the situation, while items listed in a report as potentially poisonous to livestock, an antidote or other, represents a citation. Several materials could be cited in a report. At the end of interviews, respondents could choose between two options to provide plant and/or other material samples cited in discussion; either taking the author to the field to fetch the plant or going alone to obtain samples, which were brought back to the author. Voucher specimens of plants cited were pressed with the aid of a field press to absorb excess moisture and preserve plants in good condition for later study. The pressed material was labelled with collection date, local name, location and recorded use (poison or antidote). Voucher specimens have been deposited at the University of Aberdeen Herbarium (ABD) and the Animal Research Institute, Ghana.

The plants were identified using Irvine (1961) & Dokosi (1998) and confirmed by comparing them with herbarium specimens in the Ghana Herbarium, University of Ghana. Occasionally specimens provided did not have enough features for a conclusive identification and some respondents provided local names; but could not provide species names, these remained unidentified and have been noted in the results. Nomenclature follows the African flowering plants database (2008), the International Plant Names Index (2008) and the Germplasm Resources Information Network (GRIN, 2007).

Data collected from respondents gathered was compared with information gathered from previous surveys/reports in Irvine (1961), Abbiw (1990) & Dokosi (1998). Data available in the literature from other sources on the plants were secured using National Centre for Biotechnology Information

(NBCI, 1988), African flowering plants database (2008) and general online search engines such as Google. PC-ord programme was used for assessment of attenuation of new species added with each new reported case of plant poisoning and SPSS version 16, was used for cross tabulations of information.

Results

Socio economic backgrounds of informants

The distribution of respondents across the zones (Fig. 1) as well as various socio-economic classifications are shown in Table 1. Out of 194 reports across the country, 115 were located in the northern zone, 37 in the middle belt and 42 in the southern zone. Four occupational groups of stakeholders were consulted viz peasant livestock farmers, commercial livestock farmers, herbalists and the extensionists/ veterinarians. There were zonal variations in the representation of gender, cohabitations, and educational attainments of respondents but in general, the majority of respondents were males and married. About half of the respondents had no form of formal education; while the rest had various attainments from basic education to tertiary. Efforts were made to have representations of the various occupational groups; however, the middle zone was deficient in the commercial livestock farmers and extensionist/ veterinarians.

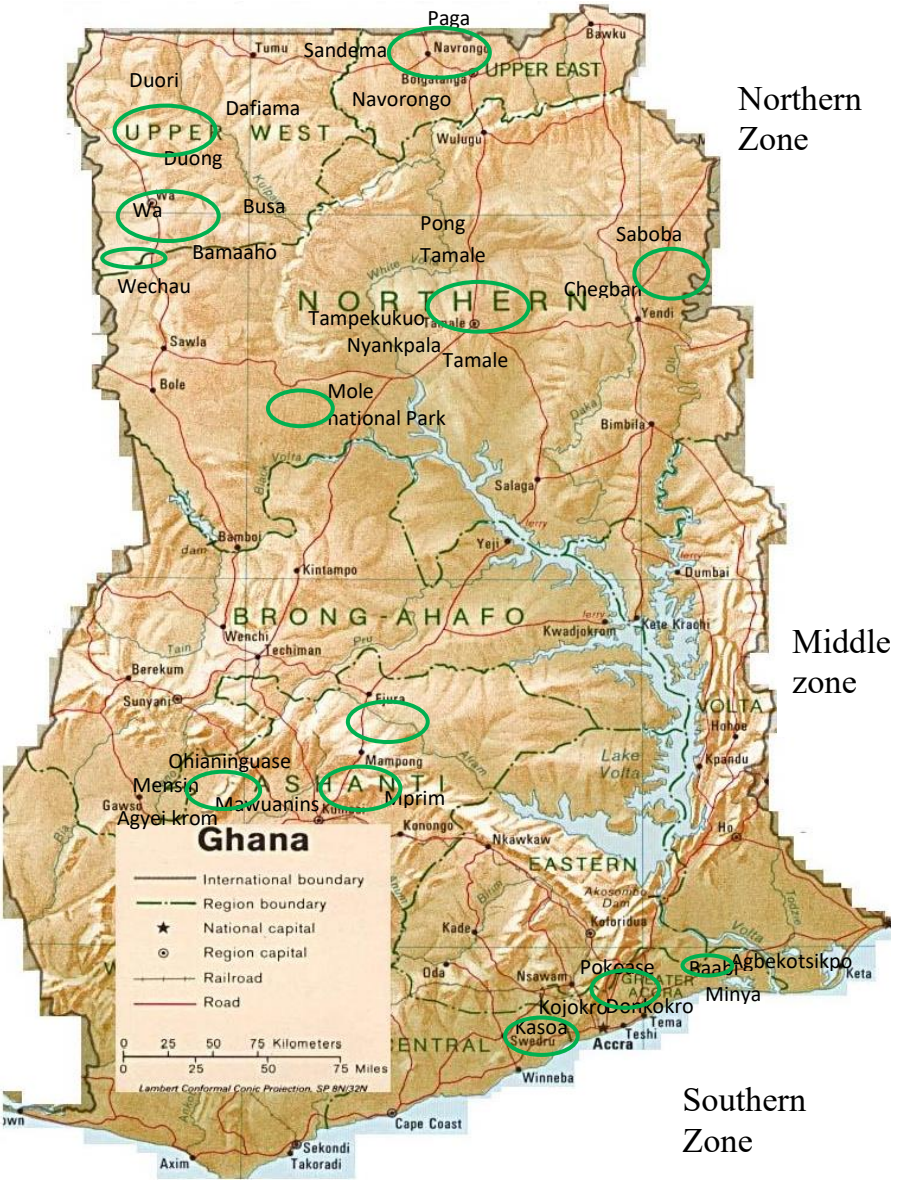

Fig. 1 Map of Ghana indicating zonal demarcation and location of study sites. The green mark-ups indicate locations of aggregated communities in a zone where studies were conducted and community names have been placed near mark-ups. Map obtained by Courtesy of the University of Texas Libraries, the University of Texas at Austin.

TABLE 1

Distribution of respondents across occupational groups, zones, gender, marital status and educational attainments.

Zone	Occupation	Sex		Marital status		Education Level			Total
		Male	Female	Single	Married	Non	Basic/ Secondary	Tertiary	
Northern zone	Peasant livestock farmers	44	24	0	68	44	11	13	68
	Commercial livestock farmers	24	0	0	24	20	4	0	24
	Herbalists	5	0	0	5	4	1	0	5
	Extensionist/ veterinarian	17	1	1	17	0	0	18	18
Zone Total		**90**	**25**	**1**	**114**	**68**	**16**	**31**	**115**
Middle Belt	Peasant livestock farmers	9	4	0	13	6	7		13
	Herbalist	22	2	0	24	7	15	2	24
Zone Total		**31**	**6**	**0**	**37**	**13**	**22**	**2**	**37**
Southern zone	Peasant livestock farmers	13	12	3	22	10	15	0	25
	Commercial livestock farmers	0	9	0	9	9	0	0	9
	Herbalists	1	0	0	1	0	1	0	1
	Extensionist/ veterinarian	4	3	7	0	0	0	7	7
Zone Total		**18**	**24**	**10**	**32**	**19**	**16**	**7**	**42**
Grand Total		**139**	**55**	**11**	**183**	**100**	**53**	**40**	**194**

Poisonous Plants and Antidotes

One hundred and ninety-four (194) reported cases of poisonous plants were studied from 90 interviewed respondents (questionnaire forms completed). The Sorensen (Bray-Curtis) species area curve shows the change in the number of new species to the cumulative number of reports (Fig. 2). The

number of new species added to attained information on poisonous plants affecting ruminant livestock (cattle, sheep and goats) approached a minimum beyond 100 reports and contributions of fresh information beyond what had been obtained at that point from new reports continuously became minimal. A total of 42 poisonous plants were reported and of these, 37 were identified to species or genus.

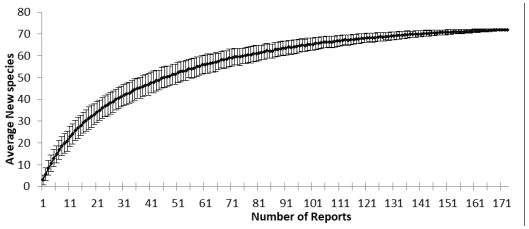

Fig. 2: Cumulative increase in the total number of new plants cited (poisonous plants and antidotes) with increasing number of reports; based on the Sorensen (Bray-Curtis) species-area curve analysis. Error bars denote standard deviations of mean new species.

575 citations from 194 reported cases of suspected plant poisoning categorized as poisonous plants for which no antidotes were cited (146), poisonous plants with cited antidotes (147) and antidotes (282). There were 50 identified plant species belonging to 29 plant families. Fourteen plant species were known only by local names because they could not be identified due to the lack of specimens. Some antidotes to plant poisoning (e.g., ear cutting treatment, saltpetre solution, smoked cobwebs and sodium chloride solution) were not classed as plants; others such as charcoal were not specific to any plant species. Mushrooms, which were cited as treatable poisons, had no samples for further identification. In total, 70 different items were cited (plants and non-plants); there were 22 poisonous plants for which antidotes were not cited. Twenty-eight poisonous plants with known antidotes (TABLE 2) and 32 antidotes (TABLE 3). Two plant species (*Thevetia peruviana* (Pers.) K. Schum. and *Elaeis guineensis* Jacq.) had different plant parts functioning as antidote and poisons to livestock. Ten materials were cited with more than one function (either as a poisonous plant with/without a known antidote or an antidote); none was, however, found with all three categories of plant groups.

The dominant poisonous plant families encountered were the Fabaceae (9), Poaceae (6), Euphorbiaceae (6), Urticaceae (2) and Apocynaceae (2). All other poisonous plant families encountered had single species. About half the cited poisonous plants cited (20) were native to Ghana or the African continent while with the rest were introduced. *Erythrophleoum suaveolens,* and *Erythrophleum africannum* both poisonous plants were reported in their respective habitats; *E. suaveolens* in the south and middle belt and *E. africanum* in the northern savanna (northern zone).

The largest plant family representation of antidotes were the Fabaceae (3) and Euphorbiaceae (2). All other identified plant families used as antidotes to plant poisoning had single species cited.

The northern zone respondents cited 26 different species of poisonous plant. Within this zone the following poisonous plants species were cited more than ten times, *Erythrophleum africanum* (35), *Ochna rhizomatosa (19), Cleome viscosa* (17), *Boerhavia erecta* (15), *Zea mays* (14), *Sorghum sp.* (12), *Stillingea sylvatica* (11), *Moringa oleifera* (11), *Lepisanthes senegalensis (*11) and *Anadelphia afzeliana* (11).

In the middle belt, 18 poisonous plant species were cited. *Hillaria latifolia (*12*)* was most cited. The southern zone respondents cited eight (8) different species of poisonous plants however, none of them

was cited more than 10 times. Antidotes cited (18) in the northern zone had varying frequencies of citation; saltpetre solution (50), *Vitelleria paradoxa (29),* ear cutting practice (15*),* sodium chloride solution (13), *Elaeis guineensis (12),* and *Khaya sp. (11).* Similarly, the middle belt recorded 15 items or practices as antidotes to plant poisoning. Of these infusions of *Mangifera indica* bark (10), and *Elaeis guineensis oil (27)* were cited the most. The southern zone had 7 items or practices as antidotes to plant poisoning of ruminant livestock. Of these, *Elaeis guineensis* pulp oil had the highest frequency (15) of citations.

TABLE 2

Citation of poisonous plants across Ghana, with records of poisoning in relevant references set in Ghana. Other references provide reported cases of toxic properties in plants not cited by local authors. Frequencies represent citations within zone (MB = Middle belt, NZ = northern Zone, SZ = southern zone) of each plant.

S/N	Poisonous plant	Family	Plant origin	Reported part	Frequency				Reference		
					MB	NZ	SZ	Total	(Irvine, 1961)	(Dokosi, 1998)	Other
1	Akwatia esiesieson (Twi)	Not identified		Shoot	8			8			
2	*Albizia coriaria* Welw.	Fabaceae	Native	Leaf	2			2	√		(Vickery & Vickery, 1979)
3	*Laportea ovalifolia* (Shum. And Thonn)	Urticaceae	Southern America	Shoot	4			4			(Agra, Baracho, Nurit, Basílio, & Coelho, 2007)
4	*Anadelphia afzeliana* Stapf.	Poaceae	Native	Shoot		11		11			
5	*Balanites aegyptiacus* Delile	Zygophyllaceae	Native	Roots		2		2	√		(Vickery & Vickery, 1979)
6	*Boerhavia erecta* L	Nyctaginaceae	Native	Shoot		15		15		√	
7	Bomere (Fulani)	Poaceae		Shoot		2		2			
8	*Bryophyllum pinnatum* (Lam.) Oken	Crassulaceae	Madagascar	Shoot	4			4		√	
9	*Cassia* sp.	Fabaceae		Shoot		2		2	√		
10	*Chromolaena odorata* (L.) R.M. King & H Rob.	Asteraceae	North & South America	Shoot	2		6	8			(Prasad, Narayana, Jayakumar, & Srikanth, 2005)
11	*Cleome viscosa* L.	Capparaceae	Pantropical/ Tropical Asia	Shoot		17		17		√	(Iltis, 1960)
12	*Crotalaria retusa* L.	Fabaceae	Native	Shoot		2		2		√	
13	*Elaeis guineensis* Jacq.	Arecaceae	Native	Leaves	2			2	√		

S/N	Poisonous plant	Family	Plant origin	Reported part	Frequency				Reference		
					MB	NZ	SZ	Total	(Irvine, 1961)	(Dokosi, 1998)	Other
14	*Erythrophleum africanum* (Welw.ex Benth) Harms	Fabaceae	Native	Shoot		35		35	√		(Vickery & Vickery, 1979)
15	*Erythrophleum suaveolens* (Guill. & Perr) Brenan	Fabaceae	Native	Shoot	5			5	√		(Vickery & Vickery, 1979)
16	*Euphorbia arbuscula* Balf. F.	Euphorbiaceae	Yamen	Shoot		2		2			
17	*Ficus exasperata* Vahl	Moraceae	Native	Shoot	6		1	7	√		
18	*Gossypium* sp.	Malvaceae	Exotic	Seeds		9		9			(Rikin, Atsmon, & Gitler, 1980)
19	*Hilleria latifolia* (Lam.) H. Walt	Phytolacaceae	South America	Shoot	12		1	13		√	
20	*Icacina senegalensis* A Juss	Icacinaceae	Native	Roots		3		3	√		
21	*Jatropha curcas* L	Euphorbiaceae	Exotic	Shoot		1	2	3	√		
22	Kpaang muor	Not identified		Shoot		6	2	8			
23	*Lepisanthes senegalensis* (Poir.) Leenh. (= *Aphania senegalensis* Radlk.)	Sapindaceae	Native	Shoot		11		11	√		(Burkill, 1985; Vickery & Vickery, 1979)
24	*Manihot esculentum* Crantz	Euphorbiaceae	South America	Tubers	1	2	8	11	√		(Vickery & Vickery, 1979)
25	*Mareya micrantha* (Benth.) Müll.Arg.	Euphorbiaceae	Native	Shoot	1			1	√		
26	*Mimosa pudica* L.	Fabaceae	Pantropical	Shoot	1			1		√	
27	*Moringa oleifera* Lam.	Moringaceae	Indian subcontinent	Root		11		11	√		
28	Mushroom	Not identified				3		3			
29	*Nicotiana tabacum* L.	Solanaceae	South America	Shoot	2	1		3			(Panter, James, & Gardner, 1999)
30	Nyadoro	Poaceae		Leaves		2		2			
31	*Ochna rhizomatosa* (Van Tiegh.) Keay	Ochnaceae	Native	Shoot		19		19	√		
32	*Pouzolzia guineensis* Benth.	Urticaceae	Native	Shoot	5		1	6	√		
33	*Rauwolfia vomitora* Afz.	Apocynaceae	Native	Shoot			2		√		
34	*Ricinus comunis* L	Euphorbiaceae	Native	Shoot		1		1	√		
35	*Senna alata* (L.) Roxb (=Cassia alata L.)	Fabaceae	Southern America	Shoot		3		3	√		

S/N	Poisonous plant	Family	Plant origin	Reported part	Frequency				Reference		
					MB	NZ	SZ	Total	(Irvine, 1961)	(Dokosi, 1998)	Other
36	*Senna occidentalis* (L.) Link. (= *Cassia occidentalis* L)	Fabaceae	Native	Shoot	2			2	√		
37	*Setaria palmifolia* (K.D.Koenig) Stapf.	Poaceae	Asia	Shoot	8			8			
38	*Sorghum* sp.	Poaceae	Native	Seeds		12		12			(Lauriault, Sawyer, & Baker, 2003)
39	*Stillingia sylvatica* Garden ex L.	Euphorbiaceae	North America	Roots		11		11			(BICHY, 1985)
40	*Thevetia peruviena* (pers). K Shum.	Apocynaceae	Neotropical		7			7	√		
41	*Vigna unguiculata* (L.) Walp.	Fabaceae	Native	Shoot		1		1			
42	*Zea mays L.*	Poaceae	North America		2	14		16		(Jones, 1998)	
	Grand Total				74	198	23	293			

TABLE 3

Citation of Antidotes to poisonous plants; frequencies represent citations within zone (MB = Middle belt, NZ = northern Zone, SZ = southern zone) of each plant.

S/N	Plant species	Family	Reported Part	Plant Origin	Frequencies				References of Curative properties	
					MB	NZ	SZ	Total	(Irvine, 1961)	(Dokosi, 1998)
1	*Allium cepa* L.	Alliaceae	Bulb	Cultivated			2	2		√
2	*Arachis hypogaea* L.	Fabaceae	Seed oil	Cultivated		4		4		
3	*Cardiospermum halicacabum* L.	Sapindaceae	Shoot	Native	2			2		√
4	*Ceiba pentandra* (L.) Gaertn.	Malvaceae	Seeds	Native		3		3	√	
5	*Citrus limon* (L.) Burm. f.	Rutaceae	Fruit	Cultivated	2			2	√	
6	*Elaeis guineensis* Jacq.	Arecaceae	Pulp oil	Native	27	12	15	54	√	
7	*Euphorbia hirta* L. (= *Chamaesyce hirta* (L.) Millsp.)	Euphorbiaceae	Shoot	Pantropical			1	1		√
8	*Ficus capensis* Thunb. (=Ficus sur Forssk.)	Moraceae	Bark/leaf	Native	2			2	√	
9	*Griffonia simplicifolia* (Vahl. Ex D C.) Bail.	Fabaceae	Shoot	Native	2			2	√	
10	*Indigofera hirsuta*	Fabaceae	Shoot	Native		4		4		√
11	*Khaya* sp.	Meliaceae	Bark		5	11		16	√	
12	*Mangifera indica* L.	Anacardiaceae	Bark	Exotic	10			10	√	
13	*Mareya micrantha* (Benth.) Müll. Arg.	Euphorbiaceae	Leaf	Native	7			7	√	
14	*Mitragyna inermis* (Wild.) O. Kuntze	Rubiaceae	Shoot	Native			3	3	√	

S/N	Plant species	Family	Reported Part	Plant Origin	Frequencies				References of Curative properties	
					MB	NZ	SZ	Total	(Irvine, 1961)	(Dokosi, 1998)
15	*Persea americana* Mill.	Lauraceae	Leaf	North, & South America	4			4	√	
16	*Sansevieria liberica* Gerome &Labroy	Ruscaceae	Leaf	Native			3	3		√
17	*Thevetia peruviena* (Pers.) K. Shum	Apocynaceae	Leaf	Neotropical	5			5	√	
18	*Vetiveria fulvibarbis* (Trin.) Stapf.	Poaceae	Shoot	Native		6		6		
19	*Vitelleria paradoxa* F. C Gaertn	Sapotaceae	Seed oil	Native	4	29		33	√	
20	Bichelinche (Komkomba)	Not identified	Shoot			3		3		
21	Chegbani 2	Not identified	Shoot			1		1		
22	Ikpanbuyi (Komkomba)	Not identified	Shoot			3		3		
23	Itire (Komkomba)	Not identified	Shoot			6		6		
24	Kulung (Dagbani)	Not identified	Shoot			1		1		
25	Linangnal (Komkomba)	Not identified	Shoot			3		3		
26	Ogyai Nchini (Twi)	Not identified	Shoot		2			2		
27	Sansaa (Dagaare)	Not identified	Shoot			3		3		
28	Charcoal	Other			4			4		
29	Ear cutting	Other				15		15		
30	Saltpetre Solution	Other			2	50	4	56		
31	Smoked Cobwebs	Other				3		3		
32	Sodium chloride Solution	Other			2	13	4	19		
	Grand Total				80	170	32	282		

Discussion

Either Irvine (1961) or Dokosi (1998) have already previously reported in Ghana all but 11 of the species identified in this study. Of these 11 previously unreported poisonous plants by these two authors in Ghana, (*Laportea ovalifolia, Anadelphia afzeliana, Chromolaena odorata, Euphorbia arbuscula*, *Gossypium sp., Nicotiana tabacum, Seteria palmifolia, Sorghum sp., Stillingia sylvatica*, *Vigna unguiculata* and *Zea mays*), only four could not be found to have some supporting evidence of toxic effect in the literature, viz: *Anadelphia afzeliana, Euphorbia arbuscula, Setaria palmifolia* and *Vigna unguiculata.* This indicates an apparently high level of recognition of toxicity by the respondents. This could stem from the fact that respondents who could not offer any information on any reports of plant poisoning were not included in the study. Consequently, questionnaires that did not contribute any reports (and many of them were found) on the subject were excluded from the study. It is worth noting that *Chromolaena odorata,* is an invasive plant introduced into Ghana around 1965 (Hoevers & M'boob, 1993), after fieldwork by Irvine

and Dokosi had been completed. While the list of poisonous plants and antidotes is by no means exhaustive, the information obtained is representative of the locations/zones under study and the cumulative citations reports show that not much more information resides in the livestock holder communities. Some preceding authors (Dokosi, 1998; Irvine, 1961) have provided longer lists of poisonous plants and antidotes from Ghana. However, these workers obtained their data much earlier (Irvine, between 1934 - 37 and Dokosi & Irvine in 1961) at a time when the vegetation was different from today and changed in climatic conditions.

Poisonous plants may have changed in diversity and abundance and the pattern of dependence of people on herbal treatments might have been greater then due to limited orthodox medicines at the time. Some of the areas in this study (e.g. the Upper East region) are notable now for high levels of environmental degradation, deforestation and loss of soil cover, stemming from extremely high population densities of both humans and livestock that has not been accompanied by agricultural development (Adu, 1972; Anon, 1983; Benneh, 1973a, 1973b; Blench, 1999; Clacey & Ramsay, 1955; LACOSREP, 2006; Slaymaker & Blench, 2002). These ecological pressures could increase the exploitation of plant antidotes for medicinal purposes and for some poisonous plants, the increase in population densities along with pressures associated with tilling smaller farm size make the poisonous plants, where recognized, easy targets for eradication from grazing lands by farmers. Others may have been deliberately eradicated by non-farmer human activity. For instance the CSIR- Animal Research Institute (Institute, 1977), conducted a project to identify poisonous plant species on grazing lands in Ghana and efforts were made to eradicate them from the fields. The current study was undertaken for a shorter period than either Irvine (1961) or Dokosi (1998) and this may have limited the information on poisonous plants and antidotes obtained through questionnaire. These earlier authors included a list of all plants poisonous to humans and other animals but this study only recorded plants poisonous to cattle, sheep and goats only. More detailed IK on woody plants and herbs would require longer survey, perhaps involving many years living among informants. Information on poisonous plants are specialized and some poisonous plants may still exist, which the indigenous people on the land now, do not yet know about. Commercially available plant resources such as palm oil (pulp oil from *Elaeis guineensis),* saltpetre, sodium chloride and *Vitelleria paradoxa* are widely available across zones and have other uses (e.g., in human diets) and are readily used as antidotes. Materials used in human nutrition but which could also have detrimental effects following misapplication in livestock feed e.g., *Zea mays, Sorghum sp., Nicotiana tabacum,* are often under reported by indigenous people because they find it hard to accept the facts that the science presents.

Existing documented knowledge on the poisonous plants, antidotes, affected livestock species remain scattered across several reference materials; to have them all in one document enhances their accessibility with minimal effort. For those undocumented knowledges, they reside in people who may not readily share even within the same community. Identifying such human repositories can be a major challenge to the untrained enquirer where the time and resources involved in such endeavour can be challenging. Considering when this study was carried out, some of the

respondents may have passed on and taken with them these invaluable knowledge resources. Their knowledge lives in the documentation from their reports, which would further improve the understanding and management of plant poisoning among livestock on the Ghanaian rangelands.

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Conflict of Interest

The authors declare that they have no conflict of interest.

Ethical standards

This manuscript does not contain ethical issues and no infraction were made.

Informed consent

Informed consent was obtained from all individual participants included in the study

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