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Ethnobotanical study of some Ghanaian anti-malarial plants

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Abstract

An ethnobotanical study was conducted in the Wechiau Community Hippopotamus Sanctuary area in Ghana, through interviews and quadrate studies, to investigate the range and abundance of species used in the treatment of malaria. Forty-one species belonging to 17 families were encountered during the study. Of the 17 families studied Leguminosae and Anacardiaceae predominated in terms of number of species used to treat malaria. Eight plant species namely, *Afraegle paniculata* (Rutaceae), *Haematostaphis barteri* (Anacardiaceae), *Indigo era pulchra* (Leguminosae), *Monanthotaxis* sp. (Annonaceae), *Ozoroa insignis* (Anacardiaceae), *Strychnos innocua* (Loganiaceae), *Strychnos spinosa* (Loganiaceae) and *Xeroderris stuhlmannii* (Leguminosae) have not previously been documented for the treatment of malaria in Ghana. The results are discussed and recommendations made for future research to support the conservation and sustainable harvesting of the species reported to have medicinal properties.

Keywords: Ethnobotany; Malaria; Wechiau; Medicinal plants; Conservation

1. Introduction

Malaria is caused by a single celled protozoan parasites called *Plasmodium* and transmitted to man thought the anopheles mosquito. It is one of the major fatal diseases in the world, especially in the tropics and is endemic in some 102 countries with more than half of the world population at risk (Symth, 1994).

In spite of control programmes in many countries there has been very little improvement in the control of malaria and infections can reduce the effectiveness of labour and can lead to both economic and human loses. Control of malaria is complex because of the appearance of drug resistant strains of *Plasmodium* and with the discovering that man may become infested with species of simian (monkey) malaria (Symth, 1994). At the same time the anopheles mosquito have developed resistance to many insecticides (Srisilam and Veersham, 2003). Thus it is important to search for new anti-malarial compounds, either synthetic or natural compounds that kill either the vector or parasite.

The use of plant-derived drugs for the treatment of malaria has a long and successful tradition. For example, quinine isolated from *Cinchona* and quinghaosu from *Artemisia annua* L. illustrates the potential value of investigating traditionally used anti-malarial plants for developing pharmaceutical anti-malarial drugs (Srisilam and Veersham, 2003). In Ghana, several plant species including *Alstonei boonei* De Willd (Apocynaceae), *Azadirachta indica* A. Juss, (Meliaceae), *Cryptolepis sanguinolenta* (Lindl.) Schttr. (Asclepidaceae), *Morinda lucida* Benth. (Rubiaceae), *Nauclea latifolia* Sm. (Rubiaceae) and *Ocimum viride* Willd. (Lamiaceae) are used in the treatment of malaria (Ayitey-Smith, 1989; Abbiw, 1990; Mshana et al., 2001).

The aim of this study was to collate information from an indigenous group of people living in the Wechiau Community Hippopotamus Sanctuary area of Ghana about their current traditional uses of plants for the treatment of malaria.

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2. Materials and methods

2.1. Study area

The study area at Wechiau is about 42 km southwest of Wa in the Upper West Region of Ghana and positioned on latitude 09°49′762 N and longitude 02°40′965 W. The area has been demarcated as a conservation sanctuary called Wechiau Community Hippopotamus Sanctuary and covers an area of 40 km^2 along the banks of the Black Volta River. The vegetation is Guinea savannah. There are two main ethnic groups in the area namely the Brefo and Wale. The area has an estimated population of 8700 people. The sanctuary is one of the few in Ghana where local people are taking full control of the management of their natural resources.

2.2. Ethnobotanical survey

The following three techniques were used to obtain information about the species of plants used in the treatment of malaria in the study area:

1. Field interviews; involved walking with local people in the areas where they normally collected their medicinal plants while interviewing them. After picking a plant, they consulted among themselves the anti-malarial uses of the plant. The three local people involved in this study were those selected by the sanctuary management board as having the greatest knowledge about the traditional uses of plants in the area.
2. House-to-house interviews; 14 local people were interviewed using a questionnaire. Local trained guides served

Table 1
Methods of identification and percentage of people with knowledge their anti-malarial use (PPK) and preference ranking (PR) of species used to treat malaria in the Wechiau Community Hippopotamus Sanctuary, Ghana

Species (voucher numbers)	Families	Method of interviews			PPK	PR
		Field	House-to-house	Plants collected by people		
Acanthospermum hispidum DC (GC 47761)	Asteraceae		*		9.8	1
Afraegle paniculata (Shum & Thonn.) Engl. (GC 47780)	Rutaceae		*		4.8	1
Afzelia africana Sm. (GC 47762)	Leguminosae		*		9.8	1
Anogeissus leiocarpa Guill & Perr. (GC 47763)	Combretaceae	*	*		4.8	2
Azadirachta indica A. Juss. (GC 47764)	Meliaceae		*		29.3	2
Carica papaya L. (GC 47765)	Caricaceae		*		9.8	2
Cassia sieberiana DC (GC 47799, AA)	Leguminosae	*			9.8	3
Cochlospermum tinctorium Perr. (GC 47766)	Bixaceae			*	9.8	3
Combretum ghasalense Engl. & Diels (GC47767)	Combretaceae		*	*	9.8	2
Combretum sp. L. (GC 47768)	Combretaceae		*		4.8	1
Ficus gnaphalocarpa Steud. ex Miq. (GC 47769)	Moraceae	*			14.6	1
Ficus platyphylla Del. (GC4770)	Moraceae		*		4.8	1
Gardenia ternifolia Schum. & Thonn (GC 47771)	Rubiaceae	*	*		9.8	2
Haematostaphis barteri Hook. f. (GC 47772)	Anacardiaceae	*			9.8	3
Hyptis spicigera Lam. (GC 47773)	Lamiaceae		*		4.8	1
Indigofera pulchra Willd. (GC 47774)	Papilionaceae		*	*	9.8	3
Jatropha curcas L. (GC 47775)	Euphorbiaceae		*		9.8	1
Jatropha gossypiifolia L. (GC 47776)	Euphorbiaceae		*		9.8	1
Khaya senegalensis A.Juss. (GC 47777)	Meliaceae	*	*		4.8	2
Lannea acida A. Rich. (GC 47778)	Anacardiaceae		*		9.8	1
Leucas martinicensis (Jacq.) R. Br. (GC 47779)	Lamiaceae		*		9.8	1
Mangifera indica L. (GC 47780)	Anacardiacae		*		24.4	1
Mitragyna inermis (Willd). K. Schum. (GC 47799)	Rubiaceae	*	*	*	24.4	3
Monanthotaxis sp. Baill. (GC 47781)	Annonaceae	*			19.5	2
Nauclea latifolia Sm. (GC 47782)	Rubiacaea	*	*		4.8	2
Ocimum canum L. (GC 47800)	Lamiaceae		*		4.8	1
Ozoroa insignis Del. (GC 47783)	Anacardiaceae	*			4.8	2
Parinari polyandra Benth. (GC 47784)	Chrysobalanaceae	*			4.8	2
Parkia biglobosa (Jacq.) R Br. ex G. Don. (GC 47785)	Leguminosae		*		4.8	2
Paullinia pinnata L. (GC 47786)	Sapindaceae			*	4.8	1
Pericopsis laxiflora (Benth ex Baker) (GC 47787)	Leguminosae		*		9.8	1
Pseudocedrela kotschyi Harms (GC 47798)	Meliaceae	*			14.6	3
Pterocarpus erinaceus Cam (GC 47789)	Leguminosae		*		4.8	1
Ricinus communis L. (GC 47790)	Euphorbiaceae		*		4.8	1
Senna occidentalis L. (GC 47791)	Leguminosae		*		4.8	2
Sterculia setigera Del. (GC 47792)	Sterculiaceae		*		4.8	1
Strychnos innocua Del. (GC 47793)	Loganiaceae		*	*	4.8	3
Strychnos spinosa Lam. (GC 47794)	Loganiaceae		*		4.8	2
Tamarindus indica L. (GC 47795)	Leguminosae	*			4.8	2
Vernonia amygdalina Del. (GC 47796)	Asteraceae		*	*	14.6	3
Xeroderris stuhlmannii (Taub.) Mendonca. (GC 47797)	Leguminosae	*	*		4.8	1

as interpreters during the conduct of the interviews. The questionnaire had prompts for the source of information, identify of the plant species, methods of preparation, prescription and administration.

3. Interviews with herbalist; four herbalists in the area were identified with the assistance of the sanctuary management board. It was arranged for them to collect plants they used in the treatment of malaria. They were then interviewed about how they used these plants.

In addition to the above techniques, samples of the species identified as having anti-malarial activity were collected and further informal interviews were conducted in order to collect information about other uses of these species in the sanctuary. Vouchers of the species collected during the study were deposited at the Ghana Herbarium (GC), Legon, Ghana (Table 1). The identification of the species was authenticated by comparison with herbarium vouchers and with the Flora of West Tropical Africa (Hutchinson and Dalziel, 1937). The authorities of the species were confirmed using the Electronic Plant Information Centre (EPIC, 2004).

Twenty-two people from the Brefo (17) and Wale (5) areas were interviewed over a period of 6 months. In most cases they were interviewed on more than one occasion. Twelve out of the 22 (54.5%) people interviewed were males and all of them were older than 20 years. The people interviewed included Christians, Muslims and believers of local spiritual tradition and other non-religious people. Only two of the people had some level of formal education.

2.3. Distributional ranges of species

To determine the distributional ranges of the anti-malarial plants identified through the ethnobotanical surveys, quadrates of sizes, 25 m × 25 m, 5 m × 5 m and 1 m × 1 m were randomly taken in the study area. Forty-one quadrates of each size were studied. The 25 m × 25 m and 5 m × 5 m quadrates were used to assess species of trees and shrubs, whereas the 1 m × 1 m quadrates were used to assess the herbaceous or ground cover species.

2.4. Data analyses

The information obtained through the ethnobotanical interviews was analysed with regard to the following parameters:

(i) Taxonomic diversity, growth forms and parts of the plant used to treat malaria.

(ii) The percentage of people who have knowledge about the use of a species in the treatment of malaria was evaluated using the formula (PPK): (number of people interviewed citing species/number of people interviewed) × 100.

(iii) Preference ranking (PR) method was similar to that used by Martin (1995). In this case the plants were ranked according to their level of effectiveness in the treatment of malaria by the local people. Each rank is given an integer (1, 2 or 3) with the most effective plants assigned a value of 3. For example, if a plant was thought to be very effective in the treatment of malaria it was given a value 3.

The data from the ecological sampling were used to determine the distribution and density of the anti-malarial plants from the sanctuary area. The distribution of the plants was determined from the number of times a species occurred in the total number of quadrates examined. The density of a species was also evaluated from the mean number of individuals of the species per unit area.

3. Results

3.1. Anti-malarial plants

A total of 41 species from 36 genera and 17 plant families were identified during the ethnobotanical surveys as being used to treat malaria. The species, their families, survey method used to identify their uses, percentage of people interviewed with knowledge about their use to treat malaria and the preference ranking of the species are presented in Table 1. The greatest number of species used to treat malaria in the sanctuary were identified during the house-to-house and field interviews which identified 31 (75.6%) and 14 (34%) of the species, respectively. Only seven species were identified by asking herbalists to collect anti-malaria plants. However, five of these seven species were considered to be very effective anti-malarial species (Table 1). There was some overlap in the species identified using the different interviewing methods. *Mitragyna inermis* (Willd) K. Schum was the only species identify by all three survey methods. The other species frequently identified included *Azadirachta indica* and *Mangifera indica* L. (Table 1: high PPK values). Eight species were reported to be most effective for the treatment of malaria in the sanctuary included the most frequently cited, *Mitragyna inermis*, as well as *Cassia sieberiana* DC, *Cochlospermum tinctorium* Perr, *Haematostaphis barteri* Hook. f., *Indigofera pulchra* Willd., *Pseudocedrela kostchyi* Harms, *Strychnos innocua* Del., and *Vernonia amygdalina* Del.

Of the 17 families containing anti-malarial species the most predominant family in terms of number of species was the Leguminosae with nine species (Table 1). A list of the local names, habits and how the plants are used in the treatment of malaria in the area are presented in Table 2. Trees constituted 62% of the total plant species used to treat malaria in the study area and only two (5%) species were climbers. A total of 45 herbal preparations were recorded as some preparations included the use of more than one species. For example, *Azadirachta indica* and *Ocimum canum* L. were often used in more than one of the preparations. Most of the preparation involved boiling the leaves and then drinking the infusion.

Table 2
Growth forms and local names of species of plants that are used to treat malaria in the Wechiau Community Hippopotamus Sanctuary, Ghana and information about the other uses of these species

Species	Growth forms	Lobi name	Wale name	How plants are used to treat malaria and other uses
Acanthospermum hispidum	Herb	Bongore		Malaria: grind whole plant with hot pepper, sieve and drink as required.
Afraegle paniculata	Tree			Malaria: boil roots and drink as required. Other uses: extract of boiled roots used to treat stomach aches
Afzelia africana	Tree			Malaria: boil leaves and drink as required. Other uses: leaves fed to livestock; stems used to carve lobi sculptures
Anogeisus leiocarpus	Tree	Sisinrah	Siirah	Malaria: boil leaves and twigs, and massage body with decoction for 3 days. Other uses: extract of boiled stem bark used to treat stomach aches
Azadirachta indica	Tree	Akagyatia		Malaria: (1) pound leaves, sieve and use for enema. (2) Boil leaves with leaves of *Jatropha gossypifolia* and *Combretum* sp., drink and use for steam baths. Other uses: grown as a shade tree; leaf extracts used to treat fevers
Carica papaya	Tree	Kwalentia		Malaria: boil leaves with leaves of *Azadirachta indica*. Drink as desired and use for steam baths. Other uses: peeled fruits eaten raw
Cassia sieberiana	Shrub		Vabine	Malaria: boil chopped roots and drink as desired. Add sugar to taste. Other uses: extract of boiled roots used to treat stomach aches and taken as aphrodisiac
Cochlospermum tinctorium	Herb		Gbelonbile	Malaria: boil chopped roots and drink as desired. Other uses: extract of boiled roots used to treat yellow fever
Combretum ghasalense	Shrub	Popal	Kpamara	Malaria: boil leaves with that of *Jatropha gossipifolia* and whole plant of *Ocimum canum*, and drink. Use also for steam baths. Other uses: used as fuel wood
Combretum sp.	Shrub	Kpekakra		Malaria: boil leaves with stem bark of *Mangifera indica*, leaves of *Azadirachta indica* and drink as desired. Other uses: leaves fed to livestock
Ficus gnaphalocarpa	Tree	Konkon		Malaria: pound roots with roots of *Gardenia ternifolia* and *Anogessius leiocarpus*. Mould into ball and dry. Mash in water and drink
Ficus platyphylla	Tree		Selinge	Malaria: boil leaves and stems barks, drink as desired. Massage body with decoction. Other uses: extract of boiled leaves used as a "body builder"
Gardenia tenifolia	Shrub	Dajeda	Dajugo	Malaria: boil leaves and twigs, and drink as desired. Other uses: planted around houses as a hedge
Haematostaphis barteri	Tree	Dole	Genbereni	Malaria: boil leaves with leaves of *Pseudocedrela kotschyi* and *Ficus ghaphalocarpa*. Drink mornings and evenings and massage body. Other uses: fruits eaten raw
Hyptis spicigera	Herb	Donbeleva		Malaria: boil leaves and drink. Other uses: insect repellent against mosquitoes
Indigofera pulchra	Herb	Balesama		Malaria: boil whole plants, drink and massage body
Jatropha curcas	Shrub	Nato		Malaria: boils leaves with leaves of *Azadirachta indica* and *Carica papaya*. Drink and use for bathing. Other uses: planted as a hedge. Latex from twigs used to treat mouth sores
Jatropha gossypiifolia	Shrub	Natogyere		Malaria: boil leaves with leaves of *Combretum ghaselensis* and whole plant of *Ocimum canum*,and drink. Use also for steam baths. Other uses: planted as a hedge
Khaya senegalensis	Tree		Koke	Malaria: boil stem bark and drink. Other uses: stems and leaves boiled together and extract drunk as a blood tonic; stems used for building boats
Lannea acida	Tree	Manvora/Vaaworo	Gbentore	Malaria: boil leaves with leaves of *Azadirachta indica* and *Mangifera indica*. Drink and use in steam baths. Other uses: timber used in house building
Leucas martinicensis	Herb	Donbeleva		Malaria: boil whole plant with *Hyptis spicigeria* and drink as required
Mangifera indica	Tree	Mango	Mango	Malaria: boil stems barks and drink as required. Other uses: fruits eaten raw
Mitragyna inermis	Tree	Yiela	Yiele	Malaria: (1) Boil leaves and twigs, and drinks. (2) Boil twigs with whole plant of *Indigofera pulchra*. Drink 3 times daily. Other uses: branches used for roofing houses
Monanthotaxis sp.	Climber	Woretia		Malaria: boil leaves and drink three times daily. Massage body with decoction. Other uses: extract of boiled roots boiled taken to treat stomach aches

Table 2 (*Continued*)

Species	Growth forms	Lobi name	Wale name	How plants are used to treat malaria and other uses
Nauclea latifolia	Shrub	Gongan	Gounge	Malaria: (1) pound roots, add lemon juice and palm wine, and drink as desired. (2) Boil leaves and drink as desired. Other uses: fruits eaten raw
Ocimum canum	Herb	Worobagnui		Malaria: (1) boil whole plant with leaves of *Azadirachta indica*, *Combretum ghaselensis* and *Mitrgyana inermis* and drink. (2) Boil leaves with that of *Mangifera indica*, *Mitragyna inermis* and whole plants of *Indigofera indica* and drink. Use also for steam baths. Other uses: seeds soaked and infusion applied to eyes to treat eye problems
Ozoroa insignis	Shrub		Dato	Malaria: boils leaves and twigs, and drink. Other uses: used as fuel wood
Parinari polyandra	Shrub		Bongekapala	Malaria: boil leaves, drink and use for bathing
Parkia biglobosa	Tree	Dowa	Dowa	Malaria: boil leaves and steam barks, and drink as required. Other uses: extract of boiled stem bark, fruits and seeds used to treat stomach aches. Fruit eaten raw and seed used as spice
Paullinia pinnata	Shrub	Chiau		Malaria: boil leaves and drink. Bath mornings and evenings
Pericopsis laxiflora	Tree			Malaria: boil leaves with that of *Combretum* sp. and *Pericopsis laxiflora*, and drink as required. Other uses: timber used for roofing
Pseudocedrela kotschyi	Tree	Kpela	Kpela	Malaria: boil twigs and leaves, and drink as required. Other uses: extracts from boiled stem bark used to treat stomach aches and timber used for building
Pterocarpus erinaceus	Tree		Pulinyie	Malaria: boils leaves with leaves of *Afzelia africana*. Drink and use for steam baths. Other uses: leaves used to feed livestock and branches used for fuel wood
Ricinus communis	Shrub	Beton		Malaria: squeeze leaves in a pot to ferment. Bath with fermented solution. Other uses: planted as a hedge
Senna occidentalis	Herb	Bontore		Malaria: boil leaves with leaves of *Mangifera indica* and *Carica papaya*. Drink and bath decoction. Other uses: boil whole plant and extract drunk to reduce swelling
Sterculia setigera	Tree	Bulinyanie		Malaria: boil leaves and drink. Other uses: branches used for roofing
Strychnos innocua	Tree	Kolan	Polea	Malaria: boil leaves and drink as required
Strychnos spinosa	Tree	Dajekokora	Polane	Malaria: boil leaves and drink. Grind twigs, add to pomade and smear on body. Other uses: fruit eaten raw
Tamarindus indica	Tree			Malaria: boil leaves and stem bark, and drink. Other uses: leaves cooked with porridge to make it taste sour. Fruit eaten raw
Vernonia amygdalina	Shrub	Jankpantire		Malaria: boil leaves in a maize dough solution ('Konbire' in Lobi) and drink
Xeroderris stuhlmannii	Tree			Malaria: boil leaves with that of *Combretum* sp. and *Pericopsis laxiflora*, and drink as required. Other uses: branches used for roofing

Information about the other uses of the anti-malarial plants species in the sanctuary is outlined in Table 2. For example, boiled roots of *Cassia sieberiana* were used to treat stomach aches and also as an aphrodisiac. The boiled stem bark and leaves of *Khaya senegalensis* A. Juss. were also drunk as a blood tonic and the boiled roots of *Monathotaxis* sp. Baill. were used to treat stomach aches. In contrast, many of the species including *Mitragyna inermis*, *Lannea acida* A. Rich., *Khaya senegalensis* and *Xerroderis stuhlmannii* (Taub.) Mendonca. were used as sources of timber. Species such as *Combretum ghaselensis* Engl. & Diels, *Ozoroa insignis* Del. and *Pterocarpus erinaceus* Cam. were used as domestic sources of energy. *Combretum* L. sp. and *Pterocarpus erinaceus* were also used for feeding livestock and *Afzelia africana* Sm. was used to carve the popular lobi sculptures.

3.2. Distributional ranges of anti-malarial plants in study area

Thirteen of the 41 species used in the treatment of malaria were found around the vicinity of habitations. These species were often those frequently used by the residents, such as *Acanthospermum hispidum* DC, *Azadirachta indica*, *Carica papaya* L., *Indigofera pulchra*, *Mangifera indica*, *Jatropha curcas* L., *Jatropha gossypiifolia* L., *Hyptis spicigera* Lam., *Leucas martinicensis* (Jacq.) R. Br, *Ocimum canum*, *Ricinus communis* L., *Senna occidentalis* L., and occasionally *Parkia biglobosa* (Jacq.) R. Br. Ex G. Dom. The remaining 28 species were found in the wild. Of these 28 species, 17 was recorded during the ecological survey and their distribution and density are presented in Table 3. Of these species, the most widely distributed species were *Combretum ghasalense*, *Pterocar-*

Table 3
Distribution and density of species used to treat malaria in the core area of Wechiau Community Hippopotamus Sanctuary

Species	Numbers of quadrates included/total	Relative frequency	Density (m^2)	Relative density
Afzelia africana	6	5.3	0.0061	4.2
Anogeissus leiocarpa	12	10.6	0.0061	4.2
Cassia sieberenia	5	4.4	0.0072	5.0
Cochlospermum tinctorium	2	1.8	0.0016	1.1
Combretum ghasalense	25	22.1	0.034	23.4
Combretum sp.	11	9.7	0.012	8.3
Gardenia ternifolia	2	1.8	0.0016	1.1
Haematostaphis barteri	2	1.8	0.0032	2.2
Lannea acida	5	4.4	0.0048	3.3
Mitragyna inermis	15	13.3	0.012	8.3
Nauclea latifolia	2	1.8	0.0016	1.1
Ozoroa insignis	1	0.9	0.0016	1.1
Parkia biglobosa	2	1.8	0.0016	1.1
Pseudocedrela kotschyi	3	2.7	0.042	28.9
Pterocarpus erinaceus	17	15.0	0.0057	3.9
Sterculia setegera	2	1.8	0.0016	1.1
Tamarindus indica	4	3.5	0.0024	1.7

pus erinaceous, *Mitragyna inermis* and *Anogeissus leiocarpa* Guill & Perr. Some of the species reported to treat malaria were not found during the quadrat studies. Such species were flagged as 'rare' in the sanctuary and included two of the species classed as being most effective in the treatment of malaria, *Strychnos spinosa* Lam. and *Vernonia amygdalina*, as well as *Afraegle paniculata* (Shum & Thonn.) Engl., *Ficus gnaphalocarpa* Steud ex Miq., *Ficus platyphylla* Del., *Khaya senegalensis*, *Monanthotaxis* sp., *Parinari polyandra* Benth., *Paullinia pinnata* L., *Pericopsid laxiflora* (Benth. & Baker), *Strychnos innocua* and *Xeroderris stuhlmannii*.

4. Discussion

The present survey has provided information about 41 of species of plants used in the treatment of malaria in the Wechiau Community Hippopotamus Sanctuary area of Ghana. The species used in the treatment of malaria represent 19.5% of the 210 species reported for the sanctuary (Oteng-Yeboah and Asase, 2002). The study has also shown how different interviewing methods can influence the scope of information obtained about the uses of each species. Interviews based on plants collected by the person being interviewed identified the least number of species, whereas the house-to-house interviews identified the most species. The field interviews were the most effective use of time as they took less time than the house-to-house interviews. Field interviews have also proved very successful in other ethnobotanical studies in Ghana (Oteng-Yeboah, 1999). It is of interest that although the interviews with the herbalists identified only a few species as being anti-malarial most of the species they selected were considered by the community to be active. The herbalists also collected two of the effective species, *Strychnos spinosa* and *Vernonia amygdalina*, that were not reported to be grown in home gardens and not found during the ecological surveys. This suggests that these herbalists had a very good knowledge of the local flora, especially the growing places of some of their important medicinal plants.

Most of the species used to treat malaria in the sanctuary are known to be anti-malarial plants and thus corroborate data from many other sources including Irvine (1961), Ampofo (1983), Ayitey-Smith (1989), Abbiw (1990), PORSPI (1992), Dokosi (1998) and Mshana et al. (2001). The study has also identified and documented the anti-malarial use for the first time in Ghana of eight species namely, *Afraegle paniculata*, *Haematostaphis barteri*, *Indigofera pulchra*, *Monathotaxis* sp., *Ozoroa insignis*, *Strychnos innocua*, *Strychnos spinosa* and *Xeroderris stuhlmannii*. We were not able to find any published literature on the use of these species for the treatment of malaria in Ghana. The high diversity of plants reported to have anti-malaria activity during the house-to-house interviews could be because people were reflecting, not only on what they now use to treat malaria but also on what they remember being used to treat malaria. Thus an element of hearsay can occur when collecting information within a group of people. These data need to be confirmed.

Plant species used in the treatment of malaria in the sanctuary area were derived from a diverse range of plant families and there are no phylogenetic relationships among the 17 families of plants used to treat malaria in the sanctuary (Chase et al., 1993; Takhtajan, 1997). However, some of the families containing anti-malarial species including the Anacardiaceae, Asteraceae, Leguminosae, and Rubiaceae contain other species that are used to treat other illnesses and diseases in Ghana (PORSPI, 1992; Mshana et al., 2001).

The majority of the herbal preparations identified in this study involved boiling the plant material and then drinking the extract. However, none of the people interviewed provided any information about how they might "standardize" treatments and the amounts used were generally vague. Thus the quality could vary greatly among prescriptions.

This lack of standardization and quality control is seen by as one of the main disadvantages of traditional medicine (Evans-Anfom, 1986; Sofowora, 1982). Some species were also used as mixtures, which makes it more complex to standardize as well as investigate and monitor the levels of biologically active compounds. This investigation would need to be done if quality control methods were to be developed.

The fact that the most common parts of the plant species used in the treatment of malaria were leaves and twigs is very encouraging for sustainable harvesting of the plants. Harvesting roots and bark can easily threaten local populations of plants unless a sustainable harvesting strategy has been developed (Cunningham, 2001). If a successful conservation strategy is to be developed for the sanctuary then, priority should be given to supporting the sustainable harvesting of the most effective anti-malarial plants in the sanctuary, especially those with other uses such as *Cassia sieberiana*, *Mitragyna inermis*, *Haematostaphis barteri*, *Pseudocedrla kostchyi* and *Indigofera pulchra*. As more people become aware of the uses of these species they could be among the most exploited in the sanctuary and are thus likely to be the most threatened. Plants earmarked as 'rare' in the present study could be cultivated as part of the home gardening strategy being developed in the sanctuary.

In this study recording the uses and abundance of the anti-malarial species of plants has highlighted the importance fact that some species with medicinal uses are not abundant. The people living in the sanctuary area were not fully aware that some of their medicinal plant species were becoming threatened or extinct. This information can assist identify which species should be given priority when developing sustainable harvesting strategies for species within the communities. To enable people in the sanctuary maximize the use of their flora in their day-to-day activities. It is important that the entire ethnoflora of the sanctuary is documented as this information could assist identify conservation strategies for target species and thus support the health and economy of the community.

Virtually, all people in the Wechiau Community Hippopotamus Sanctuary rely on medicinal plants for the treatment of malaria since the nearest hospital is at Wa, about 42 km away accentuated by poor roads and means of transport. Further research should be done on the comparative anti-malarial activity of the different species to see if the local evaluation of the efficacy of the different species can be scientifically validated.

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