Ethnobotanical inventory and therapeutic applications of plants traded in the Ho Central Market, Ghana

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Research

Abstract

Background: For therapeutic purposes, local markets serve as the main trading center of medicinal plants for both traditional medicine practitioners and the general public. However, there is still limited information about the plant species and their derivatives traded outside larger markets in major cities. This study aimed to take inventory of the plant species traded for medicinal purposes in a traditional market outside a major city and determine their applications through vendors' familiarization.

Methods: An inventory of plant species traded for medicinal purposes in the Ho Central Market was undertaken, coupled with a semi-structured interviews on their applications based on the vendor's familiarization. Quantitative ethnobotanical indices were used to determine the most culturally important species.

Results: A total of 60 plant species from 37 families was documented to be traded in the Ho Central Market. The *Adansonia digitata*, *Thaumatococcus daniellii* and *Zanthoxylum zanthoxyloides* were recorded to have the highest frequency of citations. The highest use report (UR) and cultural importance (CI) values were recorded for *Z. zanthoxyloides*. Body pains, blood tonic (anemia), and abdominal pains were the most prominent conditions that traded plants were used to treat.

Conclusion: The study revealed a total of 60 medicinal plants which is commonly sold in the Ho Central Market and other major markets in the country, which was attributed to idiosyncrasy in cultural knowledge about the application of the plants. The market served as a venue for information exchange and learning, resulting in the high uniformity of vendors' familiarization with plant application and that of traditional medicine practitioners.

Keywords: Local market, Medicinal plants, Trade, Cultural importance, Traditional medicine, Body pains

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Background

Local markets serve as the main trading center for goods and services and are a source of medicinal plants for both traditional medicine practitioners and the general public for therapeutic purposes. These markets serve as a concentration and diffusion center for empirical knowledge about plant resources, which helps maintain local knowledge about medicinal plants (Bye & Linares 1983; Albuquerque *et al.* 2007; Monteiro *et al.* 2010). The local markets provide a snapshot of the plant biodiversity of a region (Albuquerque *et al.* 2007; van Andel *et al.* 2007, 2012; Ouedraogo *et al.* 2020;). Market surveys have become an indispensable aspect of understanding the supply and the demand for medicinal plants and are instrumental in identifying species requiring resource management priorities (Martin 1995; Albuquerque *et al.* 2007; van Andel *et al.* 2012; Bussmann *et al.* 2016, 2018; Ouedraogo *et al.* 2020; Oliveira *et al.* 2021).

In Ghana, ethnobotanical market survey studies have provided insights into the use of botanical resources and plant diversity through trade (Obiri & Addai 2007; Asase & Oppong-Mensah 2009; van Andel *et al.* 2012). However, previous market surveys were conducted in traditionally established larger markets in major cities, creating a paucity of information for smaller cities not known for their large markets. The Volta Region is rich in plant diversity because the vegetation is a mixture of both forest and savanna species but not known for its larger markets, leading to under-documentation regarding the sale of plants for traditional medicine purposes. Currently, no known ethnobotanical market survey has been undertaken in any of the traditional markets in the region.

Market surveys efficiently acquire data on local consumption and conservation status of medicinal plant species (Idu *et al.* 2010; Ouedraogo *et al.* 2020). Markets provide a shortlist of the much more comprehensive range of species used in a country or a locality (van Andel *et al.* 2007). The market also provides insight into indigenous uses of plants that contribute to preserving indigenous knowledge, which is disappearing at an alarming rate (Ouedraogo *et al.* 2020). Studies of traditional markets are necessary for Ghana to gain insights into the plant species traded and their impact on plant populations because of the significant gaps in knowledge on flora trade outside major cities. There is a need to investigate the medicinal plants sold in relatively minor markets to determine the medicinal plant species sold and their relation to local health disorders. Identified medicinal plants may also serve as leads in the research and discovery of medications from natural sources. This study aimed to provide an inventory of plant species traded for medicinal purposes in the Ho Central Market, one of the oldest traditional markets in the Volta Region but without any information on ethnobotanical trade. The study objectives were to (1) document the medicinal plants commercialized in the Ho Central market, (2) determine whether traded plant species are comparable to those of larger markets in major cities, and (3) determine their therapeutic applications based on vendors' familiarization.

Materials and Methods

Study area

The study was conducted in the Ho Municipal area in the Volta Region of Ghana (Figure 1). The study area is located between 6° 20" N and 6° 55" N latitudes 0° 12'E and 0° 53'E longitude and covers an area of approximately 2,361 km^2 (Ghana Statistical Service 2014). It shares boundaries with Ho West District to the North and West, Adaklu and Agotime-Ziope Districts to the South and Republic of Togo to the East. Based on the 2010 Population and Housing Census report, the human population of Ho Municipal is estimated at around 177 281 (Ghana Statistical Service, 2014). Ho city is regarded as the center of commerce in the Volta Region as it serves as the regional capital. There is a deep-rooted belief in the potency of plant materials and the high patronage of traditional medicine in the municipality (Konlan *et al.* 2020). There is no known ethnobotanical inventory of local markets in the study area based on a literature search, making it ideal for conducting this study. In addition, this market serves as a converging point for all the satellite markets in the adjoining towns.

Sampling method and data collection

There are three (3) main markets in Ho city: Ho Central Market, Ahoe Market and Civic Centre Market. A preliminary survey of these three main markets revealed that plants sale only occurs at the Ho Central Market for traditional medicine purposes. The queen of the market was first informed about the nature, scope, and aim of the research and obtain informed consent to research in the market. An informed consent process made all the participants aware of their rights to decide to participate voluntarily or decline after the purpose of the research had been made known to them. Interviews were conducted only after obtaining participants' prior informed consent. This research was conducted following the International Society for Ethnobiology Code of Ethics that provides a framework for

conducting ethnobiological research and related activities (International Society of Ethnobiology 2006). No further ethics approval was required.

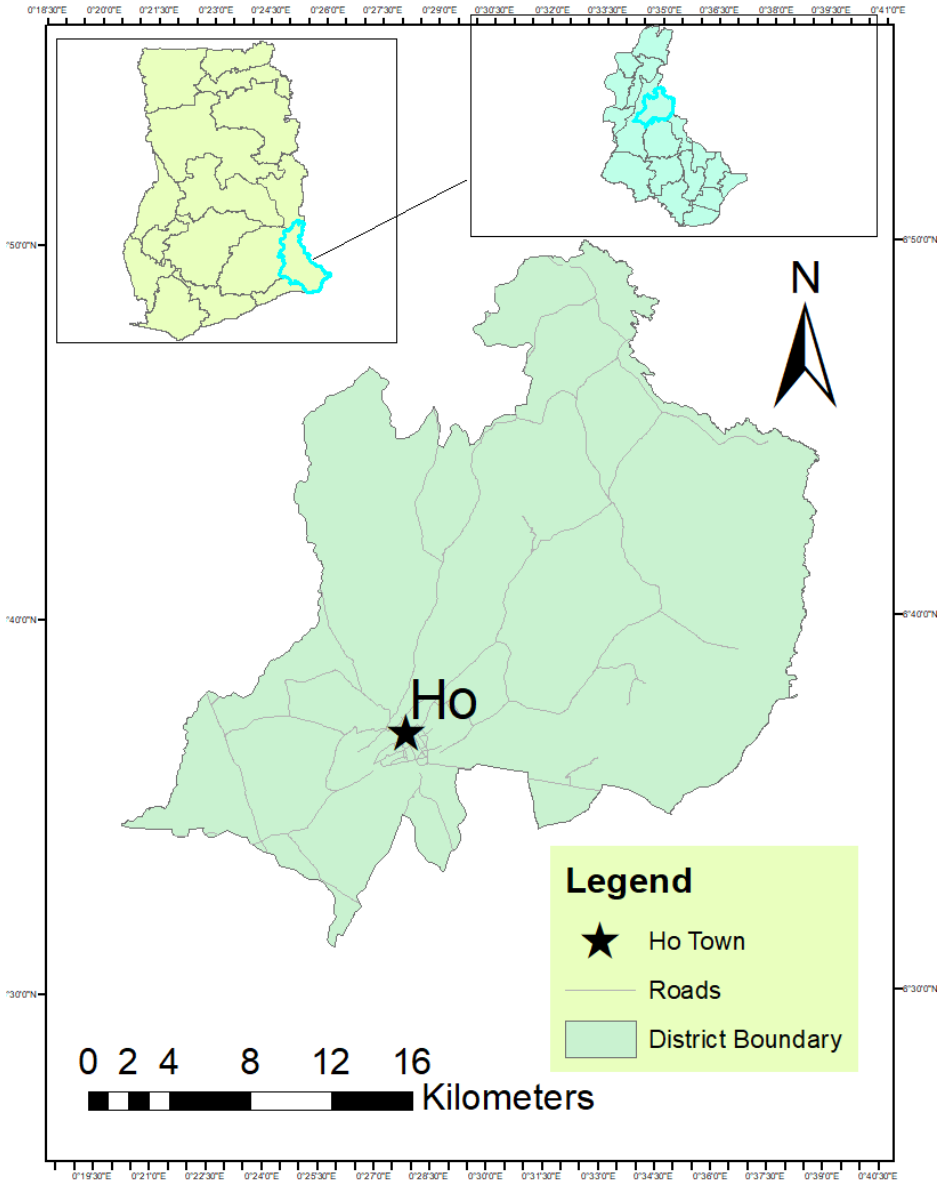

Figure 1. Map of Ghana indicating the Volta Region and Ho Municipal

An inventory was conducted on plants traded for traditional medicinal purposes in the Ho Central Market in November and December 2020. The sampling approach was purposeful, with only vendors selling medicinal products selected because they could provide the information needed for this study. All 22 vendors identified as selling plants and their derivatives for medicinal purposes agreed to partake in this study. Data were gathered using a semi-structured interview guide that was supplemented by an inventory of the plant species displayed. The interview questions were guided by Martin (1995) suggested lines of inquiry for local markets research. The key questions put to the vendors included the plant products offered for sale, their familiarization with the therapeutic applications of plant species and parts sold, condition of the goods (fresh or dried), management, and marketing of the resource (cultivated or wild). Within the data collection period, no changes were observed concerning changes in the inventoried plant species. The interviews were conducted in the Ewe language, the most widely spoken language in the study area for those who could not speak English. Maxwell Kwame Boakye and Alfred Ofori Agyemang, together with the field assistant (Mathias Gidisu), conducted the interviews with all the participants. The field assistant was fluent in the Ewe language and did most of the Ewe translation. Most of the questions were structured to avoid loss of meaning through the translation.

Plant species identification was carried out by matching the local names mentioned by the vendors with that in the available literature (Irvine, 1961; Abbiw, 1990; Mshana *et al.* 2000). The collection of plant materials was used to confirm their identification by comparison with voucher specimens at the Institute of Traditional and Alternative Medicine (ITAM), University of Health and Allied Sciences (UHAS). The names and authority of plant species were confirmed using electronic databases (http://www.worldfloraonline.org and http://www.theplantlist.org).

Data analysis

Ethnobotanical analysis was performed with the ethnobotanyR package in R (Cory, 2020). The ethnobotanyR package was used to calculate common quantitative ethnobotanical indices. The calculated indices included: Use report (UR), Cultural importance (CI), Frequency of citation (FC), Number of uses (NU), Relative frequency of citation (RFC), Relative importance index (RI), and fidelity level (FL) per species.

The UR values per species count the number of informants who mention each use category for the species and the sum of all uses in each use category (Prance *et al.* 1987). The number of uses (NU) per species is the sum of all categories considered useful for a species (Prance *et al.* 1987). The cultural importance (CI) index calculates the cultural importance index for each species in the data set (Tardío & Pardo de Santayana, 2008). The frequency of citation (FC) per species is the sum of informants that cite a use for the species in the dataset (Prance *et al.* 1987). The relative frequency of citation (RFC) determines the significance of every species based on the number of informants who reported using it. The relative importance (RI) index calculates the relative importance for each species in the data set, considering only the use categories (Tardío & Pardo de Santayana, 2008). The fidelity level (FL) per species calculates the percentage of informants who use a plant for the same purpose compared to all plants' uses (Friedman *et al.* 1 986).

A word cloud visual representation of word frequency was used to get instant insight into plant species' most prominent or prevalent applications based on vendors' familiarization using WordIt Out. The sizes of the words are proportional to the frequency with which the vendors mentioned the words. A visualization of flows i.e., weighted connections between plant parts sold and their condition was presented in a Sankey diagram using Power BI.

Results

Composition of commercialized plants and their characteristics

A total of 60 plant species belonging to 37 families were documented to be traded in the Ho Central Market (Table 1). In the total of 37 families of plants, members of the Fabaceae had the highest percentage of plants with 8.3% (n = 5 species), followed by Apocynaceae and Malvaceae with 6.7% (n = 4; each), Cucurbitaceae and Zingiberaceae with 5% (n = 3 species; each), Amaryllidaceae, Annonaceae, Apiaceae, Compositae, Euphorbiaceae, Lamiaceae, Rubiaceae, Rutaceae, and Solanaceae had 3% (n = 2 species; each). While the remaining families contributed only one species, each 1.7% (Table 1).

Based on plant habit, herbaceous species were commonly cited with 45% (n = 26 species) followed by trees with 38.33% (n = 23 species), and shrubs with 16.66% (n = 10 species). With regard to management and marketing of the resource (cultivated or wild) of the plants inventoried, wild forms contributed to 45% (n = 27), cultivated forms to 16.66% (n = 10) and both (wild/cultivated) contributed to 38.33% (n = 23). *Khaya senegalensis* and *Garcinia kola* are classified as vulnerable species under the IUCN Red List categories of species while the remaining were classified either as Least Concern or Data Deficient.

The plant parts such as Fruits, stem bark, roots, leaves, seeds, aerial parts, bulbs, flowers, rhizome, and whole plant were documented to be sold in the Ho Central Market. Fruits were the most common commercialized plant part with 32.31% followed by stem bark (16.92%), roots (13.85%), leaves (9.23%), seeds and aerial parts (7.69%; each), bulbs (4.62%), flowers and rhizome (3.08%; each) and whole plant (1.54%) (Figure 2). With regards to the conditions of plants sold, 80.30% of the parts sold were dried, while 12.12% and 7.58% were fresh and powdered form respectively. The contribution of the plant parts sold, and their state (dried, fresh, powdered) is presented on a flow diagram in Figure 3. The mode of preparation of remedies decoction mode was the most common, with oral administration being the most common means of taking remedies.

Table 1. Plant species traded in the Ho Central Market with their ethnobotanical indices based on vendors' knowledge of their application

Family	Scientific name	Local names	Voucher ID	Habit	Status	Conservation status	URs	FC	NU	CI	RFC	RI
Amaryllidaceae	*Allium cepa* L.	Sabala ga	UHAS/ITAM/2021/BB001	Herb	Cultivated	Not Listed	3	1	3	0.136	0.045	0.238
Amaryllidaceae	*Allium sativum* L.	Ayo	UHAS/ITAM/2021/BB002	Herb	Cultivated	Least Concern	2	1	2	0.091	0.045	0.175
Anacardiaceae	*Mangifera indica* L.	Mango	UHAS/ITAM/2021/SB009	Tree	Wild/ Cultivated	Data Deficient	4	1	4	0.182	0.045	0.300
Annonaceae	*Monodora myristica* (Gaertn.) Dunal	Ayiku; Yikwi	UHAS/ITAM/2021/FR015	Tree	Wild/ Cultivated	Least Concern	6	2	3	0.273	0.091	0.288
Annonaceae	*Xylopia aethiopica* (Dunal) A.Rich.	Etso; Tso	UHAS/ITAM/2021/FR24	Tree	Wild/ Cultivated	Least Concern	12	6	3	0.545	0.273	0.488
Apiaceae	*Cuminum cyminum* L.	Ahaliwoe	UHAS/ITAM/2021/FR010	Herb	Cultivated	Not Listed	4	2	2	0.182	0.091	0.225
Apiaceae	*Pimpinella anisum* L.	Anise	UHAS/ITAM/2021/FR017	Shrub	Wild/ Cultivated	Not Listed	6	2	6	0.273	0.091	0.475
Apocynaceae	*Alstonia boonei* De Wild.	Siaketekre	UHAS/ITAM/2021/SB004	Tree	Wild	Least Concern	1	1	1	0.045	0.045	0.112
Apocynaceae	*Mondia whitei* (Hook.f.) Skeels	Kedeke	UHAS/ITAM/2021/R005	Herb	Wild	Not Listed	4	4	1	0.182	0.182	0.262
Apocynaceae	*Picralima nitida* (Stapf) T. Durand & H. Durand	Quinine ku	UHAS/ITAM/2021/FR016	Tree	Wild	Not Listed	17	4	5	0.773	0.182	0.512

Apocynaceae	*Voacanga africana* Stapf. ex Scott-Elliot	Foba	UHAS/ITAM/2021/FR023	Tree	Wild/ Cultivated	Not Listed	6	2	3	0.273	0.091	0.288
Araliaceae	*Pseudopanax arboreus* (L.f.) K.Koch	Asikuiator	UHAS/ITAM/2021/SB010	Tree	Wild/ Cultivated	Not Listed	2	1	2	0.091	0.045	0.175
Arecaceae	*Cocos nucifera* L.	Agone	UHAS/ITAM/2021/FR008	Tree	Cultivated	Not Listed	1	1	1	0.045	0.045	0.112
Asparagaceae	*Drimia numidica* (Jord. & Fourr.) J.C.Manning & Goldblatt	Doli sabala	UHAS/ITAM/2021/BB003	Shrub	Wild	Not Listed	1	1	1	0.045	0.045	0.112
Asteraceae	*Ageratum conyzoides* (L.) L.	Efoe	UHAS/ITAM/2021/R002	Herb	Wild	Least Concern	3	1	3	0.136	0.045	0.238
Balanophoraceae	*Thonningia sanguinea* Vahl.	Anyigbade	UHAS/ITAM/2021/WP001	Herb	Wild	Not Listed	12	5	4	0.545	0.227	0.500
Bignoniaceae	*Kigelia africana* (Lam.) Beneth.	Nyakpekpe	UHAS/ITAM/2021/FR013	Tree	Wild/ Cultivated	Least Concern	11	3	7	0.500	0.136	0.588
Brassicaceae	*Anastatica hierochuntica* L.	Jericho rose	UHAS/ITAM/2021/AP001	Herb	Wild	Not Listed	2	1	2	0.091	0.045	0.175
Clusiaceae	*Garcinia kola* Heckel	Yikui	UHAS/ITAM/2021/FR012	Tree	Wild/ Cultivated	Vulnerable	2	1	2	0.091	0.045	0.175
Combretaceae	*Pteleopsis suberosa* Engl. & Diels	Gbagaluwa	UHAS/ITAM/2021/SB011	Tree	Wild	Not Listed	12	6	2	0.545	0.273	0.425
Compositae	*Tithonia diversifolia* (Hemsl.) A.Gray	Agbale	UHAS/ITAM/2021/R009	Herb	Wild/ Cultivated	Not Listed	1	1	1	0.045	0.045	0.112
Cucurbitaceae	*Cucumeropsis mannii* Naudin	Guzi	UHAS/ITAM/2021/S004	Climbing herb	Cultivated	Not Listed	1	1	1	0.045	0.045	0.112

Cucurbitaceae	*Lagenaria siceraria* (Molina) Standl.	Ego; Goe	UHAS/ITAM/2021/FR014	Herb	Wild	Not Listed	3	1	3	0.136	0.045	0.238
Cucurbitaceae	*Momordica charantia* L.	Kakle	UHAS/ITAM/2021/AP003	Climbing herb	Wild	Least Concern	5	1	5	0.227	0.045	0.362
Euphorbiaceae	*Euphorbia hirta* L.	Notsigbe	UHAS/ITAM/2021/AP002	Herb	Wild	Not Listed	2	1	2	0.091	0.045	0.175
Euphorbiaceae	*Ricinus communis* L.	Gbale; Dzongbale	UHAS/ITAM/2021/FR020	Herb	Wild	Not Listed	3	2	3	0.136	0.091	0.288
Fabaceae	*Caesalpinia bonduc* (L.) Roxb.	Adiku; Wole ade	UHAS/ITAM/2021/R004	Climbing shrub	Wild	Least Concern	1	1	1	0.045	0.045	0.112
Fabaceae	*Cajanus cajan* (L.) Millsp	Dedekuad; adekude	UHAS/ITAM/2021/SB012	Shrub	Cultivated	Not Listed	4	1	4	0.182	0.045	0.300
Fabaceae	*Dioclea reflexa* Hook. f.	Adi	UHAS/ITAM/2021/FR011	Climbing shrub	Wild	Not Listed	3	2	3	0.136	0.091	0.288
Fabaceae	*Mucuna pruriens* (L.) DC.	Tsapkoe	UHAS/ITAM/2021/S005	Climbing shrub	Wild/ Cultivated	Least Concern	4	2	2	0.182	0.091	0.225
Fabaceae	*Tetrapleura tetraptera* (Schum and Thonn) Taub.	Prekese	UHAS/ITAM/2021/FR022	Tree	Wild/ Cultivated	Least Concern	11	6	5	0.500	0.273	0.613
Gentianaceae	*Anthocleista djalonensis* A. Chev.	Gboloba	UHAS/ITAM/2021/R003	Tree	Wild	Least Concern	1	1	1	0.045	0.045	0.112
Lamiaceae	*Clerodendrum capitatum* (Willd.) Schumach. & Thonn.	Ayeti	UHAS/ITAM/2021/SB006	Shrub	Wild	Least Concern	4	1	4	0.182	0.045	0.300
Lamiaceae	*Ocimum basilicum* L.	Ahame	UHAS/ITAM/2021/AP004	Herb	Wild/ Cultivated	Not Listed	1	1	1	0.045	0.045	0.112

Lauraceae	*Cinnamomum zeylanicum* Blume	Ami veveti	UHAS/ITAM/2021/SB005	Tree	Wild/ Cultivated	Least Concern	9	3	8	0.409	0.136	0.650
Malvaceae	*Adansonia digitata* L.	Adewudati; Adido	UHAS/ITAM/2021/SB003	Tree	Wild	Not Listed	12	10	4	0.545	0.455	0.750
Malvaceae	*Cola nitida* (Vent.) Schott & Endl.	Bisi	UHAS/ITAM/2021/FR009	Tree	Wild	Least Concern	8	4	4	0.364	0.182	0.450
Malvaceae	*Corchorus olitorius* L.	Ademe	UHAS/ITAM/2021/L007	Herb	Cultivated	Not Listed	1	1	1	0.045	0.045	0.112
Malvaceae	*Hibiscus sabdariffa* L.	Evema	UHAS/ITAM/2021/FL003	Shrub	Cultivated	Not Listed	13	7	2	0.591	0.318	0.475
Marantaceae	*Thaumatococcus daniellii* (Benn.) Benth.	Adaa	UHAS/ITAM/2021/L012	Herb	Wild	Not Listed	18	9	4	0.818	0.409	0.700
Meliaceae	*Khaya senegalensis* (Desr.) A.Juss.	Logo	UHAS/ITAM/2021/SB007	Tree	Wild/ Cultivated	Vulnerable	16	6	4	0.727	0.273	0.550
Menispermaceae	*Sphenocentrum jollyanum* Pierre	Kraman kote	UHAS/ITAM/2021/R008	Climbing herb	Wild/ Cultivated	Least Concern	4	1	4	0.182	0.045	0.300
Moringaceae	*Moringa oleifera* Lam.	Babatsi; Yevutsi	UHAS/ITAM/2021/L011	Tree	Wild/ Cultivated	Least Concern	2	1	2	0.091	0.045	0.175
Myrtaceae	*Syzygium aromaticum* (L.) Merr. & L.M.Perry	Kpetonku	UHAS/ITAM/2021/FR021	Tree	Wild/ Cultivated	Not Listed	11	5	6	0.500	0.227	0.625
Phyllanthaceae	*Phyllanthus fraternus* G.L.Webster	Koklobliku; Lume	UHAS/ITAM/2021/AP005	Herb	Wild	Not Listed	9	2	6	0.409	0.091	0.475
Piperaceae	*Piper guineense* Schumach. & Thonn.	Kaleke; Kukuabe	UHAS/ITAM/2021/FR018	Climbing herb	Wild/ Cultivated	Least Concern	8	3	4	0.364	0.136	0.400

Plantaginaceae	*Plantago ovata* Forssk.	Psyllium	UHAS/ITAM/2021/FR019	Herb	Wild/ Cultivated	Not Listed	2	2	1	0.091	0.091	0.162
Poaceae	*Cymbopogon citratus* (DC.) Stapf	Tigbe	UHAS/ITAM/2021/L009	Herb	Cultivated	Not Listed	9	3	3	0.409	0.136	0.338
Polygalaceae	*Securidaca longepedunculata* Fresen.	Kyirituo; egbéwoyé	UHAS/ITAM/2021/SB013	Herb	Wild	Least Concern	6	2	3	0.273	0.091	0.288
Rubiaceae	*Morinda lucida* Benth.	Ake; Dadklan	UHAS/ITAM/2021/R006	Tree	Wild	Least Concern	3	2	2	0.136	0.091	0.225
Rubiaceae	*Nauclea latifolia* Sm.	Nyimo	UHAS/ITAM/2021/R007	Tree	Wild	Least Concern	7	4	3	0.318	0.182	0.388
Rutaceae	*Citrus aurantiifolia* (Christm.) Swingle	Mumoe; Donuti	UHAS/ITAM/2021/FR007	Tree	Wild/ Cultivated	Not Listed	4	2	3	0.182	0.091	0.288
Rutaceae	*Zanthoxylum zanthoxyloides* L.	Exe	UHAS/ITAM/2021/R010	Tree	Wild	Least Concern	23	9	7	1.045	0.409	0.887
Sapotaceae	*Butyrospermum parkii* (G.Don) Kotschy	Yɔ	UHAS/ITAM/2021/FR005	Tree	Wild	Not Listed	2	1	2	0.091	0.045	0.175
Solanaceae	*Capsicum frutescens* L.	Atadi	UHAS/ITAM/2021/FR006	Shrub	Wild/ Cultivated	Least Concern	7	6	2	0.318	0.273	0.425
Solanaceae	*Solanum macrocarpon* L.	Gboma	UHAS/ITAM/2021/L008	Herb	Wild/ Cultivated	Not Listed	2	1	2	0.091	0.045	0.175
Verbenaceae	*Lippia multiflora* Moldenke	Avudati	UHAS/ITAM/2021/L010	Shrub	Wild	Not Listed	3	2	2	0.136	0.091	0.225
Zingiberaceae	*Aframomum melegueta* K. Schum.	Awusa; Atakui	UHAS/ITAM/2021/S003	Herb	Wild	Data Deficient	12	5	4	0.545	0.227	0.500

Zingiberaceae	*Curcuma longa* L.	Tumeric	UHAS/ITAM/2021/RH001	Herb	Cultivated	Data Deficient	1	1	1	0.045	0.045	0.112
Zingiberaceae	*Zingiber officinale* Roscoe.	Agumetaku	UHAS/ITAM/2021/RH002	Herb	Wild/ Cultivated	Data Deficient	5	3	4	0.227	0.136	0.400

Use report (UR), Cultural importance (CI), Frequency of citation (FC), Number of uses (NU), Relative frequency of citation (RFC), Relative importance index (RI)

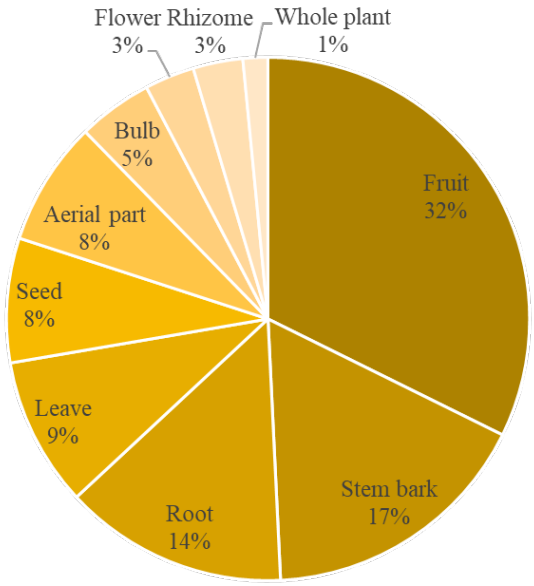

Figure 2. Plant parts sold in the Ho central market as percentage of the total number of species (n = 60)

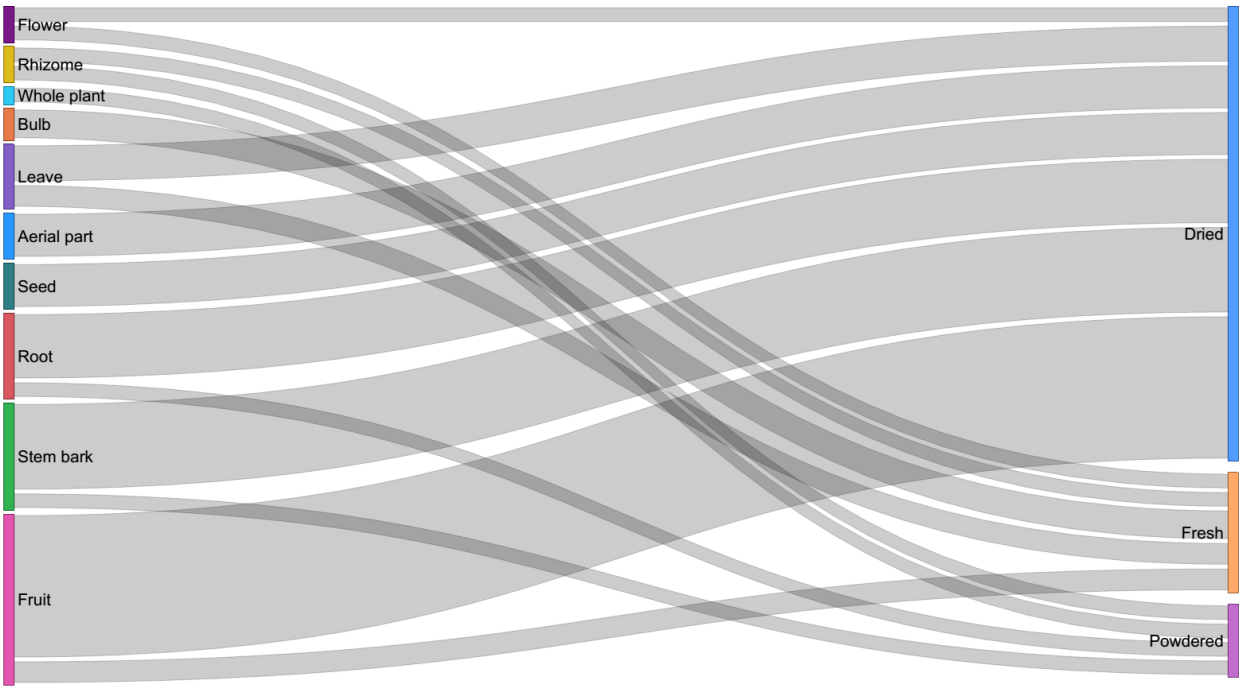

Figure 3. The flow connections between plant parts sold and their condition

Quantitative ethnobotanical indices for commercialized plants

The highest FC value (n = 10) was recorded for *Adansonia digitata*, followed by *Thaumatococcus daniellii* and *Zanthoxylum zanthoxyloides* (n = 9; each) and *Hibiscus sabdariffa* (n = 7), thus were sold by 10, 9, and 7 out of the 22 vendors respectively. The FC value was the same for *K. senegalensis*, *Xylopia aethiopica*, *Pteleopsis suberosa*, *Tetrapleura tetraptera* and *Capsicum frutescens* (n = 6), while *Thonningia sanguinea, Aframomum melegueta*, and *Syzygium aromaticum* had FC (n = 5).

With regard to use reports (UR), *Z. zanthoxyloides* had the highest UR value (n = 23) that was followed by *T. daniellii* (n = 18), *Picralima nitida* (n = 17), *K. senegalensis* (n = 16), and *H. sabdariffa* (n = 13). The *X. aethiopica*, *T. sanguinea*, *P. suberosa*, *A. digitata* and *A. melegueta* had the same UR value (n = 12; each) while *Kigelia africana*, *T. tetraptera,* and *S. aromaticum* had the same UR value (n = 11; each). The cultural importance (CI) of the species followed the

same trend as the UR value with *Z. zanthoxyloides* having the highest CI value (1.045) followed by *T. daniellii* (0.818), *P. nitida* (0.773), *K. senegalensis* (0.727) and *H. sabdariffa* (0.591). The number of uses (NU) for each species for the different categories of application was highest for *C. zeylanicum* (n = 8), *K. africana* and *Z. zanthoxyloides* (n = 7; each), *S. aromaticum*, *P. fraternus* and *P. anisum* (n = 6; each).

With regards to the relative frequency citation (RFC) *A. digitata* had the highest RFC value (0.455), while *T. daniellii* and *Z. zanthoxyloides* had the same RFC (0.409; each) and *H. sabdariffa* (0.318). Unlike the RFC, the relative importance index (RI) was recorded the highest for *Z. zanthoxyloides* (0.887). *A. digitata* recorded the second-highest RI value (0.75), followed by *T. daniellii* (0.700), *C. zeylanicum* (0.65), *S. aromaticum* (0.625), and *T. tetraptera* (0.613).

Plant applications

A total of 51 applications were recorded for the 60 plant species. The most salient application for the plants based on the use report of vendors familiarization were for body pains (n = 51), blood tonic (n = 29), abdominal pains (n = 22), immune booster (n = 20), sexual weakness, piles, and malaria (n = 19; each), stomach ulcer (n = 13) and as a preservative for traditional medicine (n = 12) (Figure 4). The least mentioned ailments include sperm production, prostate disease, kidney disease, and measles (n = 1; each).

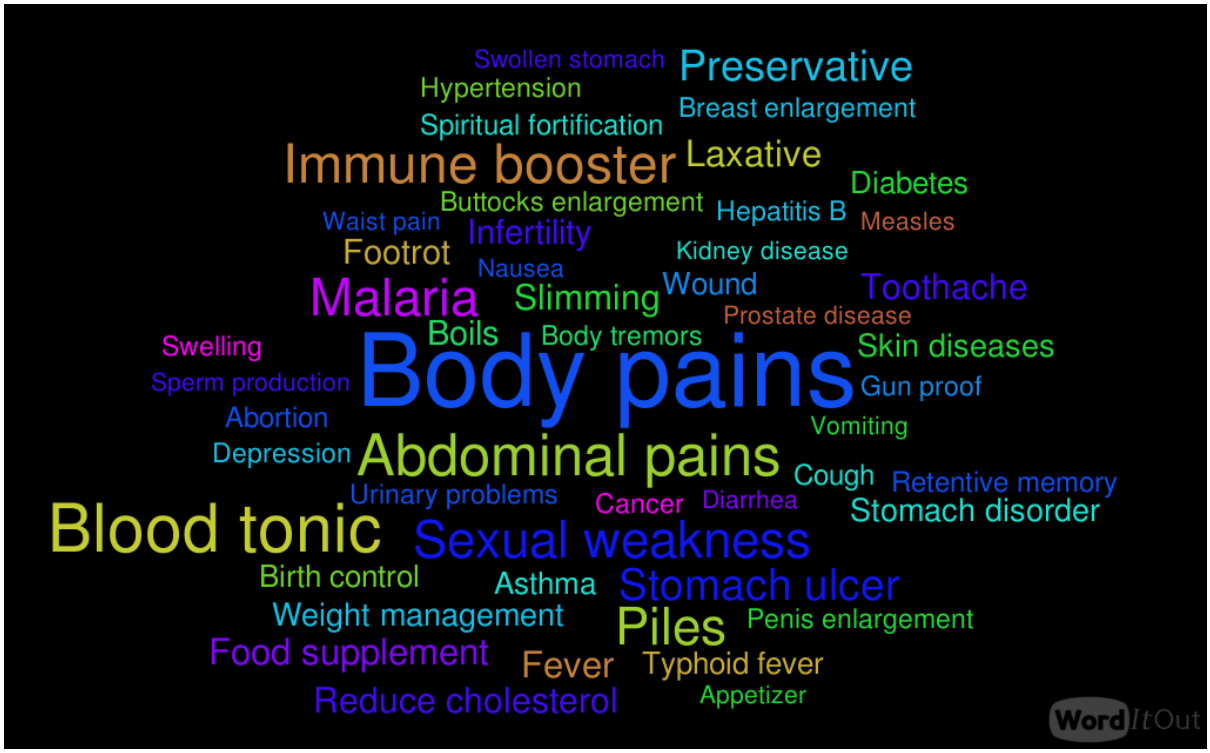

Figure 4. Word cloud of the applications mentioned by vendors for the medicinal plants traded in the Ho Central Market. Maximum mentions are 51 for body pains.

The species used in treating particular ailments is presented in Table 2. The highest number of plant species (n = 22) were used to treat body pains. Based on fidelity level (FL), the most important species for treating body pain were *L. siceraria*, *A. melegueta*, *P. guineense*, *C. frutescens*, *C. cajan*, *P. arboreus*, *A. conyzoides*, *P. suberosa*, *C. capitatum*, *X. aethiopica* and *S. aromaticum*. For the treatment of anemia (blood tonic), the most important species were *G. kola*, *H. sabdariffa*, *A. hierochuntica*, *T. daniellii* based on fidelity level (Table 2).

Table 2. Medicinal applications, formulation, route of administration and fidelity level (FL) of plants traded in the Ho Central Market

Condition	Scientific name	Plant part used	Mode of preparation	Mode of administration	FL (%)
Body pains	*Lagenaria siceraria* (Molina) Standl.	Fruit	Decoction	Oral	100.00
	Aframomum melegueta K. Schum.	Seed	Decoction	Oral	100.00
	Piper guineense Schumach. & Thonn.	Fruit	Decoction/tincture	Oral	100.00
	Capsicum frutescens L.	Fruit	Decoction	Oral	100.00
	Cajanus cajan (L.) Millsp	Stem bark	Decoction	Oral	100.00
	Pseudopanax arboreus (L.f.) K.Koch	Stem bark	Decoction	Oral	100.00
	Ageratum conyzoides (L.) L.	Root	Decoction	Oral	100.00
	Pteleopsis suberosa Engl. & Diels	Stem bark	Decoction	Oral	100.00
	Clerodendrum capitatum (Willd.) Schumach. & Thonn.	Stem bark	Decoction	Oral	100.00
	Xylopia aethiopica (Dunal) A.Rich.	Fruit	Decoction	Oral	100.00
	Syzygium aromaticum (L.) Merr. & L.M.Perry	Fruit	Decoction	Oral	80.00
	Nauclea latifolia Sm.	Root	Decoction	Oral	75.00
	Khaya senegalensis (Desr.) A.Juss.	Stem bark	Tincture	Oral	66.67
	Lippia multiflora Moldenke	Leave	Decoction	Oral	50.00
	Morinda lucida Benth.	Root	Decoction	Oral	50.00
	Kigelia africana (Lam.) Beneth.	Stem bark	Tincture	Oral	33.33
	Cinnamomum zeylanicum Blume	Stem bark	Powder	Oral	33.33
	Zingiber officinale Roscoe	Root	Decoction	Oral	33.33
	Tetrapleura tetraptera (Schum and Thonn) Taub.	Fruit	Powder	Oral	16.67
	Thaumatococcus daniellii (Benn.) Benth.	Leave	Decoction	Oral	11.11
	Zanthoxylum zanthoxyloides L.	Root	Decoction	Oral	11.11
	Adansonia digitata L.	Stem bark	Decoction	Oral	10.00
Blood tonic	*Garcinia kola* Heckel	Fruit	Chewing	Oral	100.00
	Hibiscus sabdariffa L.	Flower	Decoction	Oral	100.00
	Anastatica hierochuntica L.	Aerial part	Decoction	Oral	100.00
	Thaumatococcus daniellii (Benn.) Benth.	Leave	Decoction	Oral	100.00
	Adansonia digitata L.	Stem bark	Decoction	Oral	90.00
	Cinnamomum zeylanicum Blume	Stem bark	Decoction	Oral	33.33
	Khaya senegalensis (Desr.) A.Juss.	Stem bark	Tincture	Oral	16.67
Immune booster	*Moringa oleifera* Lam.	Leave	Decoction	Oral	100.00
	Cymbopogon citratus (DC.) Stapf	Leave	Decoction	Oral	100.00
	Hibiscus sabdariffa L.	Flower	Decoction	Oral	85.71
	Thaumatococcus daniellii (Benn.) Benth.	Leave	Decoction	Oral	77.78
	Tetrapleura tetraptera (Schum and Thonn) Taub.	Fruit	Powder	Oral	33.33
	Cinnamomum zeylanicum Blume	Stem bark	Decoction	Oral	33.33
Sexual weakness	*Sphenocentrum jollyanum* Pierre	Root	Chewing/Tincture	Oral	100.00
	Ageratum conyzoides (L.) L.	Root	Decoction	Oral	100.00

	Garcinia kola Heckel	Fruit	Chewing	Oral	100.00
	Caesalpinia bonduc (L.) Roxb.	Root	Tincture	Oral	100.00
	Thonningia sanguinea Vahl	Root	Decoction	Oral	100.00
	Mondia whitei (Hook.f.) Skeels	Root	Chewing	Oral	100.00
	Monodora myristica (Gaertn.) Dunal	Fruit	Decoction	Oral	100.00
	Tithonia diversifolia (Hemsl.) A.Gray	Root	Decoction	Oral	100.00
	Ricinus communis L.	Fruit	Decoction	Oral	50.00
	Kigelia africana (Lam.) Beneth.	Stem bark	Tincture	Oral	33.33
	Thaumatococcus daniellii (Benn.) Benth.	Leave	Decoction	Oral	11.11
Piles	*Thonningia sanguinea* Vahl	Whole plant	Decoction	Oral	100.00
	Khaya senegalensis (Desr.) A.Juss.	Stem bark	Tincture	Oral	83.33
	Xylopia aethiopica (Dunal) A.Rich.	Fruit	Decoction	Oral	83.33
	Piper guineense Schumach. & Thonn.	Fruit	Decoction	Oral	66.67
	Cinnamomum zeylanicum Blume	Stem bark	Decoction	Oral	33.33
	Zanthoxylum *zanthoxyloides* L.	Root	Decoction	Oral	11.11
Malaria	*Picralima nitida* (Stapf) T. Durand & H. Durand	Seed	Infusion	Oral	100.00
	Momordica charantia L.	Aerial parts	Decoction	Oral	100.00
	Lippia multiflora Moldenke	Leave	Decoction	Oral	100.00
	Khaya senegalensis (Desr.) A.Juss.	Stem bark	Decoction	Oral	100.00
	Alstonia boonei De Wild.	Stem bark	Decoction	Oral	100.00
	Cymbopogon citratus (DC.) Stapf	Flower	Decoction	Oral	100.00
	Phyllanthus fraternus G.L.Webster	Aerial part	Decoction	Oral	50.00
	Zanthoxylum zanthoxyloides L.	Root	Decoction	Oral	11.11
Stomach ulcer	*Picralima nitida* (Stapf) T. Durand & H. Durand	Seed	Decoction	Oral	100.00
	Cajanus cajan (L.) Millsp	Stem bark	Decoction	Oral	100.00
	Pteleopsis suberosa Engl. & Diels	Stem bark	Decoction	Oral	100.00
	Clerodendrum capitatum (Willd.) Schumach. & Thonn.	Stem bark	Decoction	Oral	100.00
	Pimpinella anisum L.	Fruit	Decoction	Oral	50.00
Preservative	*Aframomum melegueta* K. Schum.	Seed	Decoction		100.00
	Monodora myristica (Gaertn.) Dunal	Fruit	Tincture		100.00
	Syzygium aromaticum (L.) Merr. & L.M.Perry	Fruit	Decoction		60.00
	Citrus aurantiifolia (Christm.) Swingle	Fruit	Decoction		50.00
	Xylopia aethiopica (Dunal) A.Rich.	Fruit	Decoction		16.67
Abdominal pains	*Zanthoxylum zanthoxyloides* L.	Root	Decoction	Oral	100.00
	Phyllanthus fraternus G.L.Webster	Aerial part	Decoction	Oral	100.00
	Monodora myristica (Gaertn.) Dunal	Fruit	Tincture	Oral	100.00
	Mangifera indica L.	Stem bark	Decoction	Oral	100.00
	Picralima nitida (Stapf) T. Durand & H. Durand	Seed	Decoction	Oral	100.00
	Pimpinella anisum L.	Fruit	Infusion	Oral	50.00
	Nauclea latifolia Sm.	Root	Decoction	Oral	50.00

	Piper guineense Schumach. & Thonn.	Fruit	Decoction	Oral	33.33
	Zingiber officinale Roscoe	Root	Tincture	Oral	33.33
Fever	*Solanum macrocarpon* L.	Leave	Decoction	Oral	100.00
	Momordica charantia L.	Aerial parts	Decoction	Oral	100.00
	Phyllanthus fraternus G.L.Webster	Aerial part	Decoction	Oral	100.00
	Cymbopogon citratus (DC.) Stapf	Flower	Decoction	Oral	100.00
	Mangifera indica L.	Stem bark	Chewing	Oral	100.00
	Zanthoxylum *zanthoxyloides* L.	Root	Decoction	Oral	11.11
Slimming	*Allium sativum* L.	Bulb	Fresh	Oral	100.00
	Curcuma longa L.	Rhizome	Powder	Oral	100.00
	Moringa oleifera Lam.	Leave	Decoction	Oral	100.00
	Cinnamomum zeylanicum Blume	Stem bark	Powder	Oral	66.67
	Citrus aurantiifolia (Christm.) Swingle	Fruit	Juice	Oral	50.00
	Tetrapleura tetraptera (Schu & Thonn) Taub.	Fruit	Decoction	Oral	33.33
Laxative	*Picralima nitida* (Stapf) T. Durand & H. Durand	Seed	Decoction	Oral	100.00
	Plantago ovata Forssk.	Fruit	Infusion	Oral	100.00
	Cucumeropsis mannii Naudin	Seed	Decoction	Oral	100.00
	Zingiber officinale Roscoe	Root	Tincture	Oral	33.33
	Capsicum frutescens L.	Fruit	Decoction	Oral	16.67
	Zanthoxylum zanthoxyloides L.	Root	Decoction	Oral	11.11
Food supplement	*Corchorus olitorius* L.	Leave	Decoction	Oral	100.00
	Solanum macrocarpon L.	Leave	Decoction	Oral	100.00
	Mucuna pruriens (L.) DC.	Seed	Decoction	Oral	100.00
	Cuminum cyminum L.	Fruit	Add to honey	Oral	100.00
	Adansonia digitata L.	Stem bark	Decoction	Oral	10.00
Toothache	*Zanthoxylum zanthoxyloides* L.	Root	Decoction	Oral	88.89
Reduce cholesterol	*Allium cepa* L.	Bulb	Chewing	Oral	100.00
	Citrus aurantiifolia (Christm.) Swingle	Fruit	Juice	Oral	100.00
	Allium sativum L.	Bulb	Decoction	Oral	100.00
	Tetrapleura tetraptera (Schum and Thonn) Taub.	Fruit	Decoction	Oral	66.67
Foot rot	*Cajanus cajan* (L.) Millsp	Stem bark	Decoction	Topical	100.00
	Clerodendrum capitatum (Willd.) Schumach. & Thonn.	Stem bark	Decoction	Oral	100.00
	Cola nitida (Vent.) Schott & Endl.	Fruit	Decoction	Oral	50.00
	Pimpinella anisum L.	Fruit	Decoction	Oral	50.00
	Syzygium aromaticum (L.) Merr. & L.M.Perry	Fruit	Decoction	Oral	20.00
Infertility	*Ocimum basilicum* L.	Aerial part	Infusion	Oral	100.00
	Cocos nucifera L.	Fruit	Drink/Chewing	Oral	100.00
	Anthocleista djalonensis A. Chev.	Root	Decoction	Oral	100.00
	Nauclea latifolia Sm.	Root	Decoction	Oral	50.00
	Kigelia africana (Lam.) Beneth.	Stem bark	Decoction	Oral	33.33

Boils	*Allium cepa* L.	Bulb	Paste	Topical	100.00
	Voacanga africana Stapf. ex Scott-Elliot	Fruit	Decoction	Oral	100.00
	Cinnamomum zeylanicum Blume	Stem bark	Decoction	Oral	33.33
	Cola nitida (Vent.) Schott & Endl.	Fruit	Decoction	Oral	25.00
	Syzygium aromaticum (L.) Merr. & L.M.Perry	Fruit	Squeeze	Lick/Topical	20.00
Skin diseases	*Cajanus cajan* (L.) Millsp	Stem bark	Decoction	Oral	100.00
	Voacanga africana Stapf. ex Scott-Elliot	Fruit	Decoction	Oral	100.00
	Butyrospermum parkii (G.Don) Kotschy	Fruit	Paste	Topical	100.00
	Clerodendrum capitatum (Willd.) Schumach. & Thonn.	Stem bark	Decoction	Oral	100.00
Wound	*Mangifera indica* L.	Stem bark	Decoction	Oral	100.00
	Voacanga africana Stapf. ex Scott-Elliot	Fruit	Decoction	Oral	100.00
	Butyrospermum parkii (G.Don) Kotschy	Fruit	Paste	Topical	100.00
Typhoid fever	*Phyllanthus fraternus* G.L.Webster	Aerial part	Decoction	Oral	100.00
	Morinda lucida Benth.	Root	Tincture	Oral	100.00
Stomach disorder	*Pseudopanax arboreus* (L.f.) K.Koch	Stem bark	Decoction	Oral	100.00
	Piper guineense Schumach. & Thonn.	Fruit	Decoction	Oral	66.67
	Syzygium aromaticum (L.) Merr. & L.M.Perry	Fruit	Decoction	Oral	20.00
Asthma	*Securidaca longepedunculata* Fresen.	Stem bark	Decoction + honey	Oral	100.00
	Euphorbia hirta L.	Aerial part	Decoction	Oral	100.00
	Dioclea reflexa (Hook.f) C. Wright	Seed	Decoction	Oral	50.00
Diabetes	*Allium cepa* L.	Bulb	Chewing	Oral	100.00
	Momordica charantia L.	Aerial parts	Decoction	Oral	100.00
	Pimpinella anisum L.	Fruit	Decoction	Oral	50.00
	Adansonia digitata L.	Fruit	Mash	Oral	10.00
Weight management	*Lagenaria siceraria* (Molina) Standl.	Fruit	Decoction	Oral	100.00
	Cola nitida (Vent.) Schott & Endl.	Fruit	Chewing	Oral	100.00
Birth control	*Sphenocentrum jollyanum* Pierre	Root	Tincture	Oral	100.00
	Ricinus communis L.	Fruit	Decoction	Oral	50.00
	Aframomum melegueta K. Schum.	Seed	Tincture	Oral	20.00
	Thonningia sanguinea Vahl	Root	Tincture	Oral	20.00
Retentive memory	*Euphorbia hirta* L.	Aerial part	Decoction	Oral	100.00
	Cuminum cyminum L.	Fruit	Decoction	Oral	100.00
Cough	*Mangifera indica* L.	Stem bark	Decoction	Oral	100.00
	Pimpinella anisum L.	Fruit	Infusion	Oral	50.00
	Cola nitida (Vent.) Schott & Endl.	Fruit	Decoction	Oral	25.00
Appetizer	*Zingiber officinale* Roscoe	Rhizome	Decoction	Oral	66.67
	Picralima nitida (Stapf) T.Durand & H.Durand	Seed	Decoction	Oral	25.00
Abortion	*Sphenocentrum jollyanum* Pierre	Root	Decoction	Oral	100.00
	Aframomum melegueta K. Schum.	Seed	Tincture	Oral	20.00
	Thonningia sanguinea Vahl	Root	Tincture	Oral	20.00

Spiritual fortification	*Drimia numidica* (Jord. & Fourr.) J.C.Manning & Goldblatt	Bulb	Infusion	Bathing	100.00
	Ricinus communis L.	Fruit	Decoction	Oral	50.00
	Phyllanthus fraternus G.L.Webster	Aerial part	Decoction	Oral	50.00
Urinary problems	*Zanthoxylum zanthoxyloides* L.	Root	Decoction	Oral	22.22
Hypertension	*Tetrapleura tetraptera* (Schum and Thonn) Taub.	Fruit	Decoction	Oral	33.33
Body tremors	*Mucuna pruriens* (L.) DC.	Seed	Decoction	Oral	100.00
Penis enlargement	*Kigelia africana* (Lam.) Beneth.	Fruit	Decoction	Oral	66.67
Breast enlargement	*Kigelia africana* (Lam.) Beneth.	Fruit	Powder + Shea butter	Topical	66.67
Buttocks enlargement	*Kigelia africana* (Lam.) Beneth.	Fruit	Powder + Shea butter	Topical	66.67
Cancer	*Kigelia africana* (Lam.) Beneth.	Fruit	Decoction	Oral	66.67
Swelling	*Securidaca longepedunculata* Fresen.	Stem bark	Powder + Shea butter	Topical	100.00
Gun proof	*Securidaca longepedunculata* Fresen.	Stem bark	Decoction	Oral	100.00
Hepatitis B	*Momordica charantia* L.	Aerial part	Decoction	Oral	100.00
	Phyllanthus fraternus G.L.Webster	Aerial part	Decoction	Oral	50.00
Depression	*Lagenaria siceraria* (Molina) Standl.	Fruit	Decoction	Oral	100.00
	Pimpinella anisum L.	Fruit	Decoction	Oral	50.00
Nausea	*Cinnamomum zeylanicum* Blume	Stem bark	Decoction	Oral	33.33
Vomiting	*Cinnamomum zeylanicum* Blume	Stem bark	Decoction	Oral	33.33
Diarrhea	*Syzygium aromaticum* (L.) Merr. & L.M.Perry	Fruit	Decoction	Oral	20.00
Waist pain	*Sphenocentrum jollyanum* Pierre	Root	Tincture	Oral	100.00
Measles	*Momordica charantia* L.	Aerial parts	Decoction	Oral	100.00
Swollen stomach	*Anastatica hierochuntica* L.	Aerial part	Decoction	Oral	100.00
Sperm production	*Ageratum conyzoides* (L.) L.	Root	Decoction	Oral	100.00
Prostate disease	*Dioclea reflexa* (Hook.f) C. Wright	Fruit	Powder	Oral	50.00
Kidney disease	*Dioclea reflexa* (Hook.f) C. Wright	Fruit	Powder	Oral	50.00

Discussion

The use of Fabaceae, Apocynaceae, and Malvaceae families in herbal medicines is documented in Ghana (Asase & Oppong-Mensah 2009; Boadu & Asase 2017). The dominance of these three plant families in this study is consistent with other market surveys in the country (Asase & Oppong-Mensah 2009; van Andel *et al.* 2012). According to Boadu and Asase (2017), members of these plant families are widely known to contain secondary metabolites such as tannins, phenolics, and alkaloids responsible for their bioactivity. The general knowledge about their bioactivity may account for their dominance in the Ghanaian herbal pharmacopoeia. The dried condition of most plant species traded is consistent with findings from other herbal market surveys in Ghana (Asase & Oppong-Mensah 2009; Van Andel *et al.* 2012). The dried plant materials are easy transported and better protected from microorganism infestations as water is the main requirement in microbial growth and thus the primary method used to preserve the plant materials (Asase & Oppong-Mensah 2009).

The plant species commonly traded in this study differed from market surveys in other places in Ghana. Asase and Oppong-Mensah (2009) found a clear difference in plant species sold for the treatment of malaria to be dissimilar for markets in different political regions in Ghana. Van Andel *et al.* (2012) also found variation in floristic diversity in different herbal markets across Ghana. According to Thomas *et al.* (2009) the distribution of knowledge about traditional remedies follows a pattern whereby most knowledge is idiosyncratic while few remedies are known to almost everyone. Idiosyncrasy may account for the variation in medicinal plants sold in different markets. The dynamic nature and non-codified traditional knowledge systems result in variation even for the most prevalent species (Mary *et al.* 2011). Albuquerque *et al.* (2007) pointed out that medicinal products traded in markets represent local cultural knowledge and biological diversity. Most species documented in this study are listed in other market surveys. Cultural knowledge about the medicinal application of *A. digitata*, *Z. zanthoxyloides*, *T. daniellii*, *P. nitida*, *K. senegalensis* and *H. sabdariffa* was recorded as idiosyncratic, leading to their high frequency of citation (FC) in this study. Thus, their increased use reports reflect their versatility in the local repertoire of valuable medicinal plant species.

Markets serve as a venue to diffuse empirical knowledge about plants (Bye & Linares 1983; Albuquerque *et al.* 2007; Monteiro *et al.* 2010). Information exchange between vendors, suppliers, and customers usually results in a high level of agreement on the selection of plants and their parts to treat a particular ailment (Albuquerque *et al.* 2007). The market as an open knowledge system and exchange of information accounted for the high uniformity between the application of the plants mentioned by the vendors and their application by traditional medicine practitioners in Ghana. The use of *P. guineense* and *Z. zanthoxyloides* for the treatment of body pains, *M. charantia* for malaria and diabetes, *X. aethiopica* and *P. guineense* for piles, *A. boonei*, *C. citratus* and *Z. zanthoxyloides* for malaria, *K. senegalensis* for malaria and anemia, *M. indica* for cough, *V. Africana* for wound treatment as well as their mode of preparation and administration are consistent with previous studies (Asase & Oppong-Mensah 2009; van Andel *et al.* 2012; Boadu & Asase 2017; Dogor *et al.* 2018; Appiah *et al.* 2019). The traditional medicinal applications of the most culturally important plant species in this study *Z. zanthoxyloides,* was consistent with their application in other countries (Okagu *et al.* 2021). The findings of the present study is in line with that of Tinitana *et al.* (2016) and Ouedraogo *et al.* (2020), which also found a high level of knowledge about the application of medicinal plants among vendors in Ecuador and Burkina Faso, respectively.

Markets typically provide insights into health and illness in society as the trade in medicinal resources reflects the health needs of the local community (Van Andel *et al.* 2012; Quiroz *et al.* 2014; Towns *et al.* 2014; Tinitana *et al.* 2016; Williams *et al.* 2000). Culturally important plant species are typically used for a more common ailment (Heinrich *et al.* 2009). This study revealed that the most culturally significant plants were used to treat the most prevalent diseases in the study area. The most regular prevailing diseases related to pains, hypertension, anemia, malaria, diabetes, asthma, malnutrition and diarrheal are among the top causes of outpatient attendance and deaths in Ghana (University of Ghana 2018; Centre for Disease Control and Prevention-CDC 2019). Accordingly, these indications were amongst the most cited by the vendors and for which the most culturally important species were applied. The most culturally important medicinal plant species are usually linked to local health issues (Bye & Linares 1983, Cunningham 2001). This study revealed high fidelity levels for the most culturally important species and the most prevalent ailments.

Conclusions

The findings from this study have revealed that the local market value of 60 plant species were documented. The local market study is an essential source of plant resources for the practice of traditional medicine. The market is a venue for the diffusion of empirical knowledge about plants from different regions and origins for traditional

medicinal purposes that help maintain local knowledge about medicinal plants. An idiosyncrasy of knowledge due to culture influenced the plant species traded and their use in a community that results in the variation in trade and use for traditional medicinal practice. The market provides an overview of the most prevalent ailments in the community as people become knowledgeable about the culturally bound syndromes in communities.

Declarations

Ethics approval and consent to participate. All the participants provided prior informed consent before the interviews.

Consent for publication: Not applicable.

Availability of data and materials: Plant materials were prepared and deposited in the herbarium unit of the Institute of Traditional and Alternative Medicine (ITAM), University of Health and Allied Sciences (UHAS).

Competing interests: The authors declared no conflicting interests.

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Authors' contributions: MKB, AOA, BKT, EDW, MFB and MTB conceived the research idea. MKB and AOA did the data collection. MKB, AOA, EDW and BKT analyzed and interpreted the data. MKB and AOA drafted the initial manuscript, and EDW and MTB revised and improved the manuscript. All the authors read, reviewed, and approved the final version of the manuscript.

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