Fertility and fontanels : women's knowledge of medicinal plants for reproductive health and childcare in western Africa

Towns, A.M.

Fertility and Fontanels: Women's knowledge of medicinal plants for reproductive health and childcare in western Africa

Alexandra Maria Towns

Naturalis Biodiversity Center, Sector Botany
Leiden University
2014

Towns, A.M.
Fertility and Fontanels: Women's knowledge of medicinal plants for reproductive health and childcare in western Africa
ISBN: 978-90-9028493-4
NUR: 941

Graphic design & layout: Alexandra M. Towns
Cover photograph: Beninese woman by Sofie Ruysschaert
Back cover photograph: Gabonese child by Alexandra M. Towns
Printing: CPI-Koninklijke Wöhrmann
This book in printed on FSC certified paper

Chapter 2: Published in Journal of Ethnobiology and Ethnomedicine 10:42 (2014). Towns, A.M., Ruysschaert S., van Vliet E., and van Andel T., Evidence in support of the role of disturbance vegetation for women's health and childcare in Western Africa.

Chapter 3: Published in BMC Complementary and Alternative Medicine 14: 113 (2014). Towns, A.M. and van Andel, T., Comparing local perspectives on women's health with statistics on maternal mortality: an ethnobotanical study in Bénin and Gabon.

Chapter 4: Published in PLoS ONE 9(8): e105972 (2014). Towns, A.M., Eyi, S.M. and van Andel, T., Traditional medicine and child care in Western Africa: mothers' knowledge, folk illnesses, and patterns of healthcare-seeking behavior.

Chapter 5: Published in Journal of Ethnopharmacology 155: 1184-1193 (2014). Towns, A.M., Quiroz, D., Guinee, G., de Boer, H., and van Andel T., Volume, value and floristic diversity of Gabon's medicinal plant markets.

Fertility and Fontanels: Women's knowledge of medicinal plants for reproductive health and childcare in western Africa

PROEFSCHRIFT

ter verkrijging van
de graad van Doctor aan de Universiteit Leiden,
op gezag van Rector Magnificus prof. mr. C.J.J.M. Stolker
volgens besluit van het College voor Promoties
te verdedigen op dinsdag 30 september 2014
klokke 13:45 uur

door

Alexandra Maria Towns
Geboren te Watertown, New York, United States of America
in 1983

Promotiecommissie

Promotor: Prof. dr. E.F. Smets

Co-promotor: Dr. T.R. van Andel

Overige leden:

Prof. dr. J.C. Biesmeijer (Naturalis Biodiversity Center & Universiteit van Amsterdam)
Dr. H.J. de Boer (Naturalis Biodiversity Center & Uppsala University)
Prof. dr. A.J. Dietz (Universiteit Leiden & Universiteit van Amsterdam)
Prof. dr. R. Reis (Universiteit Leiden [LUMC] & Universiteit van Amsterdam)
Prof. dr. M.S.M. Sosef (Botanic Garden Meise & Wageningen Universiteit)
Prof. dr. C.J. ten Cate
Dr. I. Vandebroek (New York Botanical Garden)

This PhD was financially supported by the Netherlands Organization for Scientific Research (NWO) ALW-Vidi grant nr. 864.09.007.

Table of Contents

Chapter One

Introduction

General Introduction

Women's knowledge of medicinal plants has largely been understudied in the field of ethnobotany (Pfeiffer and Butz 2005; Howard 2003). In many societies, men have greater access to public spaces, resources, and recognition than women from the same population (Iyam 1996), resulting in an over-representation of men's knowledge by ethnobiologists (Phillips et al. 1994). In *Contribution aux études ethnobotaniques et floristiques en République Populaire du Bénin* (Adjanohoun et al. 1989), for example, only 13 participants out of the 800 informants interviewed for the study were women. The lack of female expertise in ethnobotanical studies can also be attributed to the more intentional exclusion of female knowledge by men due to taboos and cultural norms surrounding sexuality and reproduction (Newman 1985; McClain 1989; Schiebinger 2004). In addition to this gender bias, most ethnobotanical work has focused on the expert knowledge of traditional healers (van der Geest 1997; Vandebroek 2013), overlooking the domestic knowledge of women in their childbearing years (McDade et al. 2007) as well as those women who have entered the "third age" or post-fertile period of life. Both generations of women are major players in the health and well-being of women and children in their communities (Voeks 2007; Miller 2011; Tanner et al. 2011). Recent literature has highlighted the contribution of women of the third age to childcare in Africa (Bezner Kerr et al. 2008), and more generally to human survival as a whole (Hawkes 2004).

The continued under-representation of female botanical expertise in scientific studies has not only systematically excluded half of the world's population, it also limits the understanding of variation in cultural knowledge systems and practices (Camou-Guerrero et al. 2007). This is a particular concern for women's knowledge in reproductive health and childcare, since gynecological morbidity and infant mortality are among the most severe health problems in developing countries (Horton 2010). Doctors and anthropologists have expressed their concerns about the frequent use of herbs as menstrual inducers, child enemas and vaginal drying agents (Low et al. 2011; Bland et al. 2004), but much of the available literature on the culture surrounding women's health practices (Martin Hilber et al. 2012) and the care of young children (Gottlieb 2004) provides little information on the plants or public health implications associated with these practices.

An interdisciplinary approach is needed in order to unravel the relationship between women and medicinal plants, combining the fields of ecology, botany, medical anthropology, international public health, and economics. Drawing upon literature in each of these disciplines, this study focused on capturing women's medicinal plant knowledge and plant use practices for reproductive health and childcare in Bénin, West Africa and Gabon, Central Africa. This introduction includes a general background of the study and field sites, a brief synopsis of major themes addressed in the research, an overview of research aims and hypotheses, and a general outline of the thesis.

Background and field sites

This study is part of a larger five-year research project comparing plant use patterns between descendants of the trans-African slave trade in Suriname with ancestral groups in Western Africa (van Andel 2009). The five-year project is composed of a team of researchers, including principle investigator Dr. Tinde van Andel (Leiden University), PhD student Diana Quiroz (Wageningen University), research associate Sofie Ruysschaert (Ghent University, Belgium), research associate Sandra Eyi (Centre National de la Recherche Scientifique et Technologique, Gabon), MSc student Lieke Guinee (Utrecht University), MSc student Esther van Vliet (Utrecht University), BSc student Lucrece Atindehou (Université

d'Abomey-Calavi, Bénin), and BSc student Raoudath Bouraima (Université d'Abomey-Calavi, Bénin). All research was conducted according to the Code of Ethics of the International Society of Ethnobiology (International Society of Ethnobiology 2006). We worked with the existing scientific network established by Wageningen University, especially the close collaboration with professors at the herbarium at Université d'Abomey-Calavi in Bénin and research staff at l'Institut de Pharmacopée et de Médecine Traditionnelles (IPHAMETRA), le Centre National de la Recherche Scientifique et Technologique (CENAREST), and the Agence Nationale des Parcs Nationaux (ANPN) in Gabon.

In particular, this study focuses on women from the Fon and Yoruba-speaking ethnic groups of Bénin and the Bantu-speaking ethnic groups of Gabon. Although Bénin and Gabon vary tremendously in terms of population, level of economic development, and ecological diversity, both countries have well-established systems of plant-based medicine, creating a botanically, culturally, and socially relevant backdrop to carry out an ethnobotanical study. We worked with a range of women from age 20 through age 90, with an average age of 55 years old. We conducted a total of 172 questionnaires throughout the duration of this study. In Bénin, we carried out 85 questionnaires with women, further divided into 43 for childcare and 42 for women's health. In total 68 individual Beninese women participated, so 20% of women participated both in the women's health and childcare questionnaires. In Gabon, we carried out 78 questionnaires with women, divided into 40 for women's health and 38 for childcare. In total 54 Beninese women participated, so 30% of women participated both in the women's health and childcare questionnaires. These 163 questionnaires were used to address the research questions outlined in Chapters 2, 3 and 4 of this thesis. An additional 9 questionnaires (7 in Bénin and 2 in Gabon) were conducted with men who were identified by their communities as being knowledgeable on women's health and/or childcare. However, data from the questionnaires conducted with men (4 from Bénin and 1 from Gabon) were used only in the women's health analysis described in Chapter 3 and were not a part of the analysis of other chapters.

The first round of fieldwork took place in Bénin from April through October 2011. We worked with women in the eight Beninese departments of Collines, Zou, Plateau, Kouffo, Mono, Atlantique, Littoral, and Ouémè (Fig.1). Bénin is located in the Dahomey gap of West Africa, a savannah corridor between the Lower and Upper Guinea forests. The Beninese landscape is 50% savannah with high levels of deforestation (Jha and Bawa 2006; FAO 2010a). The remaining forested areas are concentrated in the south of the country, where 20% of the total flora and 64% of its threatened species are located (Neuenschwander, Sinsin, and Goergen 2011). Bénin has a population of just over 10 million people represented mainly by Fon, Adja, and Yoruba ethnic groups (CIA 2013a). According to the United Nations Development Program Human Development Index (UNDP 2013a), Bénin is considered a country of "low human development" on the basis of life expectancy, education, and income. Bénin has an infant mortality ratio of 57 deaths per 1,000 live births and a maternal mortality ratio of 350 deaths per 100,000 live births (CIA 2013a).

We worked in Gabon for the second half of the fieldwork from June through December 2012, in the provinces of Estuaire, Woleu-Ntem, Haut-Ogooué, Ngounié, Moyen-Ogooué, and Ogooué-Ivindo (Fig. 2). Gabon is located in Western Central Africa, between the Republic of the Congo and Equatorial Guinea, and has a population of over 1.6 million people, mainly of Fang, Bapounou, Nzebi, and Obamba ethnic groups (CIA 2013b). The UNDP considers Gabon to be a country of "medium human development"(UNDP 2013b), with per capita incomes four times those of other sub-Saharan African countries (CIA 2013b). Gabon's infant mortality ratio is 47 deaths per 1,000 live births with a maternal mortality ratio of 230 deaths per 100,000 live births (CIA 2013b). In stark contrast to Bénin, Gabon is covered by up to 80% forest (Sosef et al. 2006). Although 65% of the forest is considered primary, Gabon is currently losing primary forest at the highest rate in Africa (FAO 2010b).

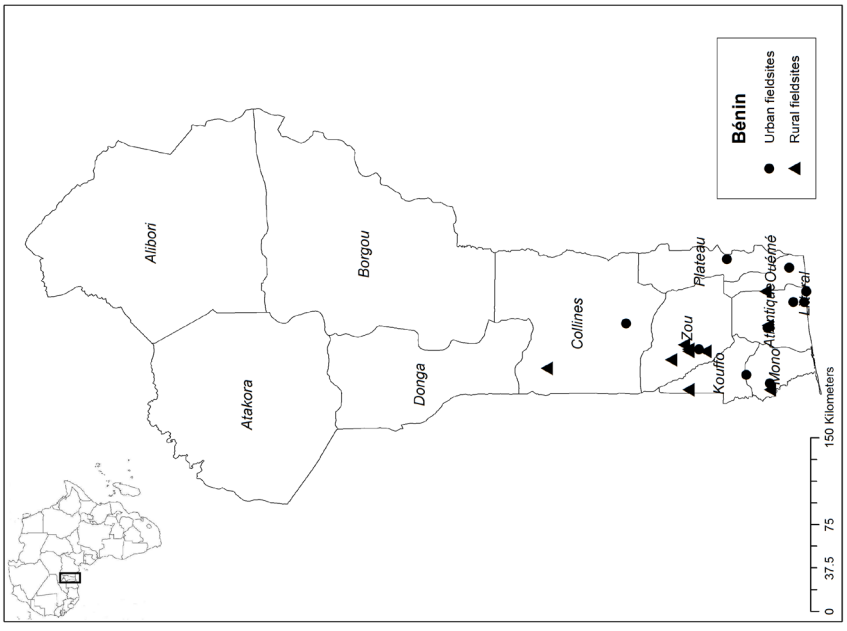


Fig. 1: Bénin field sites 2011

Fig. 2: Gabon field sites 2012

Ecology, natural resource management, and conservation

In several countries across Africa, conservation research has focused on the sustainability of medicinal plant harvesting (Gaoue et al. 2013; Stewart 2003), particularly the commercial extraction of plants (Hamilton 2004). Given the frequent use of plants (Anyinam 1995) from mainly wild populations (Schippmann, Leaman, and Cunningham 2002), overharvesting of these resources is a common concern (Cunningham 1993; Dold and Cocks 2002). Research in Madagascar (Lyon and Hardesty 2012) and Ivory Coast (Malan and Neuba 2011), however, have shown that women use mainly human-altered vegetation, which would have far greater regeneration ability and less vulnerable species than relying on old growth vegetation (Brown and Lugo 1990). Yet few studies are available in West and Central Africa, particularly those that assess variations in harvest patterns across different ecological zones and among community members. Identifying these differences, especially between the sexes and those who harvest for personal versus commercial use, can help prioritize species for conservation and design appropriate natural resource management programs.

International health, local perspectives, and treatment-seeking behavior

Gynecological morbidity is among the most severe health issues in Africa, mainly caused by hemorrhage, sepsis, and hypertensive disorders (Khan et al. 2006). In spite of widespread international and national commitment to achieving improved reproductive health (Bhutta et al. 2010), little information is available on the local management of reproductive healthcare, including the use of medicinal plants (Abdillahi and Staden 2013; Njamen and Mvondo 2013). This scenario is a startling contrast to the daily lives of Africans, as traditional medicine is the main form of healthcare for the majority of African populations (Anyinam 1995). What is needed is an understanding of how women experience and manage their own health, particularly through the use of herbal medicines.

In the case of children's health initiatives, many programs are designed and measured by biomedical responses to treating and preventing the statistical causes of infant mortality- diarrhea, malaria, and respiratory problems (Bryce et al. 2005). Research has largely focused on mothers' abilities to access biomedical remedies to these illnesses (Rutherford 2010), overlooking the full range of treatment options in pluralistic healthcare systems.Little information is known specifically on mothers' knowledge of plants or how mothers make treatment decisions (Colvin et al. 2013; Beiersmann and Sanou 2007). In order to have a comprehensive understanding of mothers' decision-making behavior, it is essential to identify local perspectives and treatments of children's health ailments, including special consideration for folk illnesses.

The informal economy and plant trade

The trade of medicinal plants is a part of the informal economy in many African countries. The commercialization of herbal medicines generates income for plant vendors, many of whom are women (Dold and Cocks 2002; Jusu and Sanchez 2013; Quiroz et al. 2014), and contributes to the availability of healthcare for urban populations who commonly use plant-based medicines. Medicinal plant markets have recently been studied in West, South, and East Africa, yet little quantitative data is available on the medicinal plant trade in Central Africa. Studying the medicinal plant market can contribute to improved decision-making in sustainable land management and livelihoods, as well as identify commercially important species and salient health concerns of the community (van Andel et al. 2012).

Research aims and outline of the thesis

As evidenced by the diverse themes described above, ethnobotanical research is by nature interdisciplinary. For this thesis, the common thread across the chapters is an exploration of the relationship that women have with plants. The research aims and hypotheses described below aim to disentangle this multidimensional relationship.

In **Chapter 2**, I investigated the conservation concern of overharvesting of medicinal plants by assessing which types of vegetation women utilize for medicinal plants. I expected all women to harvest predominantly from secondary forest and disturbance vegetation on the basis of women's specific knowledge of plants from human-altered vegetation in other parts of Africa. I also expected rural women to use more vulnerable and primary forest species than urban and market women due to the proximity of rural communities to primary forest vegetation. Together with the research team, I carried out 85 questionnaires in Bénin and 78 questionnaires in Gabon, and collected approximately 1500 corresponding botanical vouchers. Using a Detrended Correspondence Analysis (DCA) in PC-ORD (McCune and Mefford 2006) and Kruskall-Wallis tests, I determined the most commonly utilized vegetation types by women in each country and further assessed harvesting variation between urban, market, and rural women.

In **Chapter 3**, I examined how closely Beninese and Gabonese women's health perspectives, medicinal plant knowledge, and plant use practices reflect the statistical causes of maternal mortality identified by international health organizations. I expected the local perspectives, knowledge, and practices to closely parallel the international statistics. Using data gathered in the field from 87 questionnaires and over 800 botanical vouchers, I sought to determine women's most salient health concerns through free-listing analysis, citation frequency and species counts. I also interviewed 18 biomedical healthcare providers in national hospitals and local clinics in order to capture the local biomedical healthcare perspective on women's health and medicinal plant use.

In **Chapter 4**, I aimed to identify which infant illnesses Beninese and Gabonese mothers knew to treat with medicinal plants and for which illnesses they sought biomedical care or traditional healers. Through ethnobotanical questionnaires with 43 Beninese and 38 Gabonese mothers and the corresponding collection of over 800 botanical specimens, I calculated the number of species cited per illness and the proportion of participants knowledgeable on at least one herbal remedy per illness. In addition, I used qualitative data to describe folk illnesses and preferences for each of the three healthcare options.

In **Chapter 5**, I aimed to fill the gap in knowledge on the trade in herbal medicine in Central Africa by identifying the species, volume, and value of medicinal plant products sold on the major domestic markets in Gabon. Given Gabon's low population density and higher standards of living than other African countries, I hypothesized that the Gabonese medicinal plant markets would be smaller in volume and floristic diversity than those in West Africa, Tanzania and South Africa. The research team and I conducted a systematic quantitative survey of 21 market stalls at 14 major markets regional cities across the country. From this data, I extrapolated our results to the entire Gabon market. Our market survey enabled a comparison with other medicinal plant markets across sub-Saharan Africa.

Chapter Two

Evidence in support of the role of disturbance vegetation for women's health and childcare in Western Africa

Alexandra M. Towns, Sofie Ruysschaert, Esther van Vliet, and Tinde van Andel

Published in *Journal of Ethnobiology and Ethnomedicine* 10:42, 2014

Abstract

Background
In savannah-dominated Bénin, West Africa, and forest-dominated Gabon, Central Africa, plants are a major source of healthcare for women and children. Due to this high demand and the reliance on wild populations as sources for medicinal plants, overharvesting of African medicinal plants is a common concern. Few studies in Western Africa, however, have assessed variations in harvest patterns across different ecological zones and within local communities.

Methods
We investigated which vegetation types women accessed to harvest medicinal plants by conducting 163 questionnaires with market vendors and women from urban and rural communities. We made botanical vouchers of cited species and collected information on their vegetation type and cultivation status.

Results
Secondary vegetation was a crucial asset; over 80% of the 335 Beninese and 272 Gabonese plant species came from disturbance vegetation and home gardens. In Bénin, access to trade channels allowed female market vendors to use more vulnerable species than rural and urban women who harvested for personal use. In Gabon, no relationship was found between vulnerable plant use and informant type.

Conclusions
This study highlights the underemphasized point that secondary vegetation is an asset for women and children's health in both savanna-dominated and forest-dominated landscapes. The use of disturbance vegetation demonstrates women's resilience in meeting healthcare needs in the limited amount of space that is available to them. Species of conservation concern included forest species and savanna trees sold at markets in Bénin, especially *Xylopia aethiopica*, *Khaya senegalensis*, and *Monodora myristica*, and the timber trees with medicinal values in Gabon, such as *Baillonella toxisperma*.

Keywords
Bénin; Gabon; Conservation; Disturbance vegetation; Medicinal plants; Non timber forest products; Sustainable extraction; Emic practices; Resilience; Socio-ecological systems

Background

Traditional medicine is the primary source of healthcare in Sub-Saharan Africa (WHO 2008). Herbal medicine in particular has a substantial role in sustaining the health of populations in both rural (Kamatenesi-Mugisha and Oryem-Origa 2007; Pouliot 2011) and urban (Cocks and Dold 2006; Osamor and Owumi 2010) communities in Africa. The trade of medicinal plants contributes to the informal economy in many African countries; estimates of the annual values range from US$ 64,000 in Sierra Leone to US$ 7.8 million in Ghana (Jusu and Sanchez 2013; van Andel, Myren, and van Onselen 2012). The profitability of the trade, combined with the frequent usage of medicinal plants and the reliance on wild populations (Schippmann, Leaman, and Cunningham 2002; Ticktin 2004), has generated concern from conservationists that frequently utilized species are being harvested at an unsustainable rate (Cunningham 1993; Williams, Balkwill, and Witkowski 2000). Estimations of the number of globally threatened medicinal plants range from 4,160 to 10,000 (Hamilton 2004). This concern is even more critical in areas of high conservation priority, such as the biologically diverse Congolian coastal forests of West and Central Africa (Olson and Dinerstein 1998), and is reflected in recent studies exploring the over-exploitation of medicinal plants in Bénin (Gaoue and Ticktin 2007) and Cameroon (Stewart 2009).

However, little information is known on the ecology of many African medicinal plants (McGeoch, Gordon, and Schmitt 2008). If plants are harvested from primary forest vegetation or have a rare or endemic status, over-harvesting can be a particularly serious threat (Dold and Cocks 2002). The collection of plants from disturbed vegetation, however, would have far less impact on the environment, since species in human-altered landscapes are generally fast-growing, have short life spans, and have a wide distribution (Brown and Lugo 1990). Although plant harvesting may kill plant individuals, the great majority of disturbance species is abundant and has the ability to regenerate easily (van Andel and Havinga 2008). Although medicinal plant cultivation may not be entirely sustainable on the ecological level (Schippmann, Leaman, and Cunningham 2002), cultivated species have a low risk of extinction due to their management by people.

Identifying differences in harvesting patterns is also important to consider when assessing the environmental impacts of herbal medicine extraction (Hamilton 2004). There is little research, however, from West and Central Africa that assesses variations in plant use patterns within one country (Terashima and Ichikawa 2003) or across ecological conditions (Gaoue and Ticktin 2007). Plant use patterns can vary between different members of a community (Camou-Guerrero et al. 2007), especially between men and women (Rocheleau and Edmunds 1997). Studies in Madagascar and Ivory Coast found that women had more knowledge of plants from village surroundings and buffer zones than from the forest (Lyon and Hardesty 2012; Malan and Neuba 2011). There is also a distinction between plant harvesting for commercial and subsistence use; the commercialization of medicinal plants has been documented as a greater threat to plant biodiversity (Hamilton 2004), especially given the demand by growing African urban populations (Cunningham 1993). Pinpointing which vegetation types are utilized by different members of a community is an important foundation for identifying conservation priorities, designing environmental management programs, and understanding how local populations manage their health. There may be considerable variation in the vegetation types that are utilized by different community members, with substantially different impacts on the environment.

In order to bridge the gaps in understanding African medicinal plant ecology and women's plant use patterns, we worked in two ecologically-diverse countries in Western Africa: savanna-dominated Bénin and forest-dominated Gabon. We focused on the following research questions: *Which vegetation types are major sources of herbal medicine for women and children in Bénin and Gabon? What are the differences in plant use patterns between herbal medicine vendors and urban and rural women who harvest for personal*

use? We defined the domain of women's knowledge as plants that are used for women's health and childcare. We expected all women to harvest predominantly from secondary forest and disturbance vegetation on the basis of women's specific knowledge of plants from human-altered vegetation in other parts of Africa (Lyon and Hardesty 2012; Malan and Neuba 2011). We expected rural women to use more vulnerable and primary forest species than urban and market women due to the proximity of rural communities to primary forest vegetation.

Methodology

Research Sites

Bénin is located in the West African Dahomey gap, a savannah corridor between the Lower and Upper Guinea forests. The Beninese landscape is 50% savannah and 2.5% gallery forest (FAO 2010a). It has recorded levels of high deforestation (Jha and Bawa 2006), with the remaining mosaic forest clusters and forested savannah scattered across the south of the country, housing 20% of the country's flora and 64% of its threatened species (Neuenschwander, Sinsin, and Goergen 2011). From April to October 2011, we carried out research in the eight southern-most departments of Bénin: Collines, Zou, Plateau, Kouffo, Mono, Atlantique, Littoral, and Oueme. We chose these departments on the basis of the high concentration of people, especially the ethnic majorities Fon and Yoruba, and the large number of medicinal plant markets in this region (Quiroz et al. 2014). We worked with mainly Fon and Yoruba ethnic groups in rural, urban, and marketplace settings within these eight departments.

Gabon borders the Atlantic Ocean at the Equator, between Republic of the Congo and Equatorial Guinea. It is estimated that over 80% of Gabon is covered with forest (Sosef et al. 2006), with up to 65% of the forest considered primary (FAO 2010c). It currently has the highest loss of primary forest in Africa (FAO 2010c). The remaining land area is comprised of swamps, mangroves, and savannas (Lahm 2001). Research in Gabon was completed between June and December 2012, spanning the six provinces of Estuaire, Wolem-Ntem, Haut-Ogooue, Ngounie, Moyen Ogooue, and Ogooué-Ivindo. We worked in rural, urban and market settings with Bantu-speaking ethnic groups.

Data collection

The research team worked within the Code of Ethics of the International Society of Ethnobiology (International Society of Ethnobiology 2006), followed all protocols with partner institutions, and obtained formal invitations, research permits, and plant export permits. We carefully explained the nature of our research and obtained prior informed consent from all participants. We initiated our data collection at the marketplace, speaking informally with herbal medicine saleswomen and purchasing plants in order to familiarize ourselves with local healthcare priorities and commonly utilized medicinal plant species. We then utilized snow-ball sampling to identify additional women from the markets and women from urban and rural communities with whom we conducted our ethnobotanical questionnaires. Based on standard ethnobotanical methods (Alexiades and Sheldon 1996), the questionnaires included free-listing exercises on common maternal and infant health ailments and structured questions on herbal recipes to treat specific illnesses.

In Bénin, we conducted a total of 85 ethnobotanical questionnaires, 42 on women's health and 43 on childcare. The 85 questionnaires were carried out with 48 market vendors, 27 women from rural communities, and 10 women from urban communities. We worked with the following ethnic groups: Fon and related (66%), Yoruba and related (15%), Adja and related (6%) and mixed ethnicities (13%). In Gabon, we conducted a total of 78 ethnobotanical questionnaires, 40 on women's health and 38 on childcare, distributed as follows: 56 with women from rural communities, 12 market vendors, and 10

women from urban communities. We worked with the following ethnic groups: Fang (43%), Mitsogo (15%), Babungu (15%), Obamba (8%), Ossimba (4%), Bapounou (4%), and other (11%). We defined urban settings as those communities with a population larger than 35,000 people, including the Beninese cities of Abomey, Abomey-Calavi, Cotonou, Dassa, Lokossa, Pobe, and Porto-Novo and the Gabonese cities of Libreville, Franceville, and Oyem. Rural communities in which we worked included the villages surrounding these areas, with populations no larger than 6000 people. Interpreters were hired to translate local languages into French. The questionnaires in market settings took place in market stalls during regular business hours. In rural and urban locations, the questionnaires took place in the homes or businesses of the informant. All informants were given monetary compensation equivalent to local norms for their participation in the research.

Immediately after the completion of each questionnaire, informants led the research team on plant collection walks, resulting in the collection of over 1500 botanical specimens. We collected plant specimens for all cited local plant names following standard botanical methods. After successfully pairing the local name of a plant to a corresponding collection for later identification, we only made additional collections of repeated species when in doubt (Martin 2004). We purchased plants cited by saleswomen directly on the market, and later accompanied the women into the field to match market specimens with their corresponding species in the wild. Duplicates of collected specimens were deposited at the Herbier National du Bénin (BEN) and the Herbier National du Gabon (LBV). A full set of specimens was deposited at the Wageningen branch of the National Herbarium of the Netherlands, now part of Naturalis Biodiversity Center (L).

Data analysis

We entered data acquired through the questionnaires into a database, which included scientific names, local names, plant part, preparation, recipe, and informant type. Identical local names within the same language were matched with the same corresponding scientific name of identified collections. We matched 98% of the Beninese database and 93% of the Gabonese database with scientific nomenclature. The remaining unidentified plants from each country were excluded from further analyses. The research data were then classified into vegetation type by means of our own observations in the field and botanical literature (Akoègninou and Burg 2006; Hawthorne and Jongkind 2006; Missouri Botanical Garden 2013; Plant Resources of Tropical Africa 2013; Raponda-Walker and Sillans 1961). We divided the plants into five vegetation types: primary forest, disturbance vegetation- including secondary forest and shrubland around villages, savanna, mangroves/wetlands, and cultivated- including both wild plants taken from their natural surroundings and planted in home gardens and true domesticated species such as *Zea mays*. We also recorded the conservation status of each species on the International Union for Conservation of Nature (IUCN) Red List (IUCN Red List of Threatened Species 2013), Red List for Bénin (Neuenschwander, Sinsin, and Goergen 2011) and the Convention on International Trade of Endangered Species (CITES) list (CITES 2013).

We conducted cluster analyses for each country to assess the similarity of informants' responses. All plant species cited by informants were entered into presence–absence data matrices for each country. We performed a Detrended Correspondence Analysis (DCA) in PC-ORD v 5.33, which identified the two main axes that caused the distribution of our informants and cited species (McCune and Mefford 2006). We plotted the 1st and 2nd axes in two-dimensional graphs to visualize the variation and overlap in plant species used by different informant types, making one comparison between women's health and childcare informants and a second comparison between rural, urban, and market informants. Using Statistica version 8.0, we performed Kruskall-Wallis tests to assess whether women used plants mainly from secondary vegetation, and whether rural women used more vulnerable species than urban or market women. Vulnerable species were defined as primary forest species and those species that were included on the Bénin Red List, CITES, and/or IUCN Red list.

Results

Most commonly cited species and vegetation types

In Bénin we recorded a total of 335 medicinal plant species from 87 families used for women and children. The plants were found in the following vegetation types: 57% disturbance vegetation, 30% cultivated, 19% savannah, 7% primary forest, and 6% wetlands and mangroves. The percentages totaled higher than 100% because some plants occurred in multiple vegetation types. Forty-nine (26%) of the 188 species originating from secondary vegetation were considered weeds in literature (Akoègninou and Burg 2006; Plant Resources of Tropical Africa 2013; Holm 1997). Combining wild species found in disturbance vegetation and cultivated plants, 87% of species used for women's health and childcare were harvested from human-disturbed habitats. At most 32% of mentioned species were found also in undisturbed vegetation (savanna, primary forest and wetlands). However, those plants that occurred both in primary forest and disturbance vegetation, such as *Baphia nitida*, were most likely not harvested from the forest (too far away), thus only 12 species (4%) were exclusively harvested from undisturbed forest because they did not occur elsewhere. The most commonly cited Beninese species were largely cultivated or harvested from secondary vegetation (Table 1).

Table 1 Most frequently cited plant species in Bénin from 43 childcare (CC) questionnaires and 42 women's health (WH) questionnaires

Species	Vegetation type	Conservation status	CC freq. [%][c]	WH freq. [%][c]
Ocimum gratissimum L.	disturbance, cultivated		72	62
Sarcocephalus latifolius (Sm.) E.A. Bruce	savanna		33	69
Securidaca longipedunculata Fresen.	savanna		44	57
Momordica charantia L.	disturbance		60	21
Citrus aurantifolia (Christm.) Swingle	cultivated		44	36
Xylopia aethiopica (Dunal) A.Rich.	disturbance	VU[b]	56	19
Ocimum sp.	cultivated		26	40
Khaya senegalensis (Desv.) A.Juss.	savanna, cultivated	VU[a], EN[b]	30	36
Dichapetalum madagascariense Poir.	disturbance		28	29
Schwenckia americana L.	disturbance		26	29
Uvaria chamae P.Beauv.	disturbance		16	36
Heterotis rotundifolia (Sm.) Jacq.-Fél.	disturbance		28	24
Senna siamea (Lam.) H.S.Irwin & Barneby	disturbance, cultivated		35	17
Monodora myristica (Gaertn.) Dunal	disturbance	EN[b]	35	17
Caesalpinia bonduc (L.) Roxb.	disturbance, cultivated	EW[b]	21	29
Allium sativum L.	cultivated		30	19
Carica papaya L.	cultivated		26	21
Argemone mexicana L.	disturbance		35	12
Psidium guajava L.	cultivated		44	2

[a] IUCN.
[b] Bénin Red List (Neuenschwander, Sinsin, and Goergen 2011).
[c] The number of informants who mentioned each species at least once per questionnaire divided by the total number of informants.
VU = vulnerable; EN = endangered; EW = extinct in wild.

In Gabon we recorded a total of 272 medicinal plant species from 84 families used for women's and children's health. Of these species, 79% came from secondary forest or disturbed vegetation, 20% from cultivated sources, 17% from primary forest, 3% from savannah, and 2% from wetlands and mangroves. Thirty-four (16%) of the 215 secondary vegetation species were considered weeds in literature (Akoègninou and Burg 2006; Plant Resources of Tropical Africa 2013; Holm 1997). At most 22% of the species were found in undisturbed vegetation, with 13 species (5%) exclusively harvested from primary forest. While many of the most commonly cited Gabonese species originated from secondary vegetation or cultivation (Table 2), more commonly cited Gabonese species came from primary vegetation than Beninese species.

Species with priority conservation status

Beninese species which were commonly cited and also figured on conservation lists as species of concern included: *Xylopia aethiopica*, *Khaya senegalensis*, *Monodora myristica*, and

Caesalpinia bonduc. We observed, however, that *C. bonduc* seeds and leaves and *K. senegalensis* bark were often harvested from cultivated sources. *X. aethiopica* and *M. myristica* were cited almost exclusively by market informants. The only CITES species mentioned in our study, *Aloe marcocarpa*, was mentioned one time by a market informant. In Gabon, one of the most frequently cited species, the highly valued timber tree *Baillonella toxisperma*, is considered vulnerable by the IUCN (Table 2). No Gabonese species from our study figured on the CITES list.

Table 2 Most frequently cited plant species in Gabon from 38 childcare (CC) questionnaires and 40 women's health (WH) questionnaires

Species	Vegetation type	Conservation status	CC freq. [%]*	WH freq. [%]*
Citrus aurantifolia (Christm.) Swingle	cultivated		74	10
Capsicum annuum L.	cultivated		39	30
Manihot esculenta Crantz	cultivated		45	23
Pterocarpus soyauxii Taub.	primary		34	28
Elaeis guineensis Jacq.	disturbance, cultivated		37	23
Musa sp.	cultivated		37	20
Annickia affinis (Exell) Versteegh & Sosef	primary, disturbance		37	18
Costus sp.	disturbance		37	18
Alchornea cordifolia (Schumach. & Thonn.) Müll.Arg.	disturbance		8	40
Harungana madagascariensis Lam. ex Poir.	disturbance		34	8
Psidium guajava L.	cultivated		37	5
Aframomum sp.	disturbance		29	10
Cola sp.	disturbance		32	8
Cucumeropsis mannii Naudin	disturbance, cultivated		18	20
Pentaclethra macrophylla Benth.	primary, disturbance		18	20
Ocimum gratissimum L.	disturbance, cultivated		13	18
Baillonella toxisperma Pierre	primary	VU	13	18
Alstonia cf. *boonei* De Wild.	primary, disturbance		29	0
Sida acuta Burm.f.	disturbance		3	25
Vernonia amygdalina Delile	disturbance, cultivated		24	3
Aframomum melegueta K.Schum	disturbance, cultivated		21	5
Mangifera indica L.	cultivated		16	10
Senna alata (L.) Roxb.	disturbance		16	10
Alstonia congensis Engl.	wetlands		0	25

* Number of informants who mentioned each species at least once per questionnaire, divided by the total number of informants.
VU = vulnerable.

Differences in plant use among rural, urban and market women

In Bénin, there was a slight overlap in species cited for women's health and childcare (Fig.1a), with a somewhat larger variation in plants cited for childcare than for women's health. In Gabon, species between the two health categories also overlapped (Fig. 1b), but a larger variation in plants was cited for women's health than for childcare. When both health categories were combined and plants used among different informant groups were compared, rural and urban women from Bénin largely cited the same plants, while market women cited a wider variety of species with less agreement (Fig. 1c). Urban Gabonese women cited a subset of the wide variety of species cited by rural women (Fig. 1d). Market women in Gabon cited largely the same species as rural women, with some variation. Our results suggest that market women in Bénin and rural women in Gabon use the greatest diversity of plant species.

All women, regardless of informant type and country, used more species from disturbance vegetation than from any other vegetation type ($p < 0.001$). Beninese market women used more vulnerable species than rural or urban women ($p = 0.0288$). Rural and urban women used about the same amount of vulnerable species. When we further divided the market informants into vendors from the large metropolitan markets of Cotonou and Porto Novo ($n = 22$), and merchants from all other regional markets ($n = 26$), we found that metropolitan market women used more primary forest species than all other informants ($p = 0.0016$), while regional market vendors' plant citations resembled rural and urban informants. Rural Gabonese women did not use significantly different numbers of vulnerable plant species than urban or market women ($p = 0.7450$).

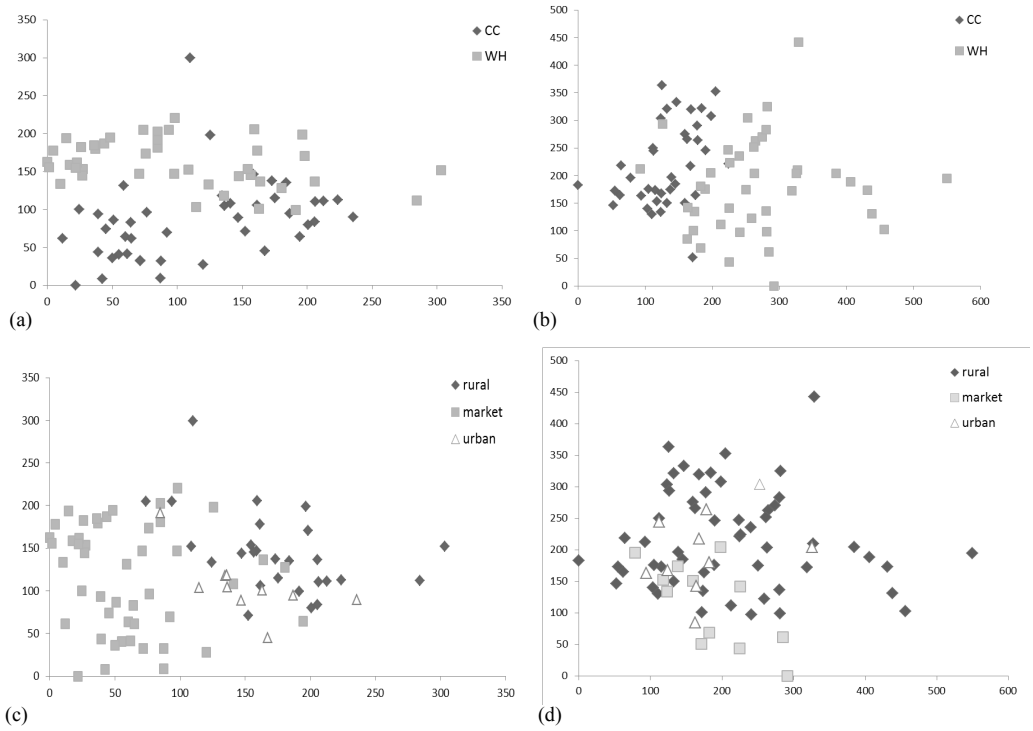


Fig.1 DCA scatterplot comparing women's health informants and childcare informants on species level for (a) Bénin (N = 85) and (b) Gabon (N = 78) and plant use patterns among market, urban, and rural informants for (c) Bénin and (d) Gabon.

Discussion

Space matters: the spatial dimension of medical plant harvesting

Our research highlights the importance of secondary vegetation in two ecologically diverse countries. Bénin is covered for more than 50% by savannah, yet only 19% of medicinal plants for women and children come from savannah vegetation. Gabon is covered with 65% primary forest, yet only 17% of women's and children's pharmacopeias is harvested from primary forest. While it is not surprising that Gabonese women were more likely to incorporate primary forest species in their pharmacopeia than women from Bénin given the high percentage of primary vegetation available to them, both groups of women cited secondary vegetation most frequently. Although savannah and forest species were available, women in both countries predominantly used plants that were most closely surrounding them - species from disturbance vegetation and home gardens. Research from other tropical regions of the world, although not always specific to women's plant use, emphasizes the role of disturbance vegetation in traditional pharmacopeias (Caniago and Stephen, 1998; Frei, Sticher, and Heinrich, 2000; Stepp and Moerman, 2001; Evert Thomas, Vandebroek, Sanca, and Van Damme, 2009; Voeks, 1996, 2004).

Our results support both the plant apparency theory (Feeny 1976) and the resource availability theory (Coley, Bryant, and Chapin 1985), originally used in herbivory studies to explain herbivores' use of different species within an environment. These theories have been applied to human plant use patterns,

to explain the selection by people of those plants that are most available to them (de Albuquerque and de Lucena 2005; de Lucena et al. 2012; Phillips and Gentry 1993). While these theories are widely applied to explain the use of individual species or Non-Timber Forest Products (NTFPs) (Lawrence, Phillips, and Ismodes 2005), our results support their application to a broader vegetation community (Thomas et al., 2009), suggesting the most apparent and accessible plant communities are most likely to be used by human populations. The use of disturbance vegetation may also be explained by the chemical components needed by plants in disturbance areas to survive. The higher quantity of chemical properties in herbs and plants with short-life cycles are not needed by forest trees, which have evolved structural defense systems (Stepp and Moerman, 2001; Thomas et al., 2009; Voeks, 1996, 2004).

Gender matters: women's medicinal plant harvesting

The frequent citation of secondary vegetation and home gardens as sources of medicinal plants may be influenced by differences in gender. Men and women have different social and work-based roles (Pfeiffer and Butz 2005) with distinct domains of knowledge. Men frequently work outside the village, while women's activities tend to revolve in and around the home. These dissimilar activities result in the occupation of different spaces, and thus, different access to natural resources and vegetation types (Voeks, 2007). Given women's high domestic workload, they likely do not have the time or means to travel to the rainforest to harvest medicinal plants. Plants that take several days to find and collect are not very beneficial to treat neither oneself nor one's sick children. These circumstances should be considered when designing and managing conservation programs. Women's perspectives and the vegetation types that are most useful to them need to be included in the decision-making processes in order to ensure the equal distribution of benefits of forest management initiatives (Camou-Guerrero et al. 2007; Rocheleau and Edmunds 1997).

Although definitive claims on the sustainability of plant extraction would need to include population assessments, impact studies and measurements on the rate of extraction versus the rate of natural regeneration (Ticktin 2004; McGeoch, Gordon, and Schmitt 2008), generally speaking, when cultivated plants and species from human-altered vegetation types dominate a pharmacopeia and primary forest species are hardly used, plant extraction can generally be considered a non-destructive use of resources (van Andel and Havinga 2008). This does not mean, however, that all medicinal plant extraction in these countries follows a similar pattern. While women tend to use species associated with habitats of high human influence, men's use of plants extends to all parts of the forest, including old-growth forested habitats (Voeks 2004; Pfeiffer and Butz 2005). There are indications that plants commonly used and known by men, such as aphrodisiacs or ritual plants, often come from primary forest (Lyon and Hardesty 2012; van Andel et al. 2012). More research is needed on male-dominated plant knowledge domains in order to assess men's medicinal plant harvesting patterns and their impact on natural resources. In addition, variations of plant use patterns by women from different ethnic groups should be analyzed in future research.

Commercialization matters: species for concern

The majority of species used and sold by market vendors in both countries came from human-altered habitats. Among all market vendors in Bénin, women who worked in large metropolitan markets, far removed from the primary forest, were the most likely to cite vulnerable species due to their access to the forest through trade. This access is made possible by the exploitation of wild plants of a larger area, including importing plants from other countries (Mati and de Boer 2011; Williams, Witkowski, and Balkwill 2009), and as a consequence, a higher variety of plant species including a higher chance of vulnerable species. In a forested country like Gabon, primary forest products were still widely available, including those who did not have access to trade networks. Including special consideration for the role of the market on the sustainability of medicinal plant extraction is essential to improved decision-making in land management and livelihoods (Belcher and Schreckenberg 2007).

Although the women in our study relied heavily on disturbance vegetation and cultivated species, we did find some exceptions in both countries. The frequently cited Beninese species *Xylopia aethiopica*, *Khaya senegalensis*, *Monodora myristica*, and *Caesalpinia bonduc* were identified as priority conservation species in market surveys in Bénin (Quiroz et al. 2014) and Ghana (van Andel, Myren, and van Onselen 2012), although some of these products may come from cultivated sources. Although *C. bonduc* is considered extinct in the wild according to the Bénin Red List (Neuenschwander, Sinsin, and Goergen 2011), we encountered it both cultivated in house yards and in disturbance areas, suggesting that some wild populations may still exist, although they may be intensively managed by local people. Recent research from Bénin has highlighted the overharvesting of *K. senegalensis* (Gaoue et al. 2013). Although *Baillonella toxisperma* is the only frequently cited Gabonese species from our research on the IUCN red list, other primary forest species such as *Pterocarpus soyauxii* and *Annickia affinis* should also be further investigated for overharvesting issues (Guinee 2013). Both *B. toxisperma* and *P. soyauxii* are valuable timber species exported from Central Africa (Dijk and Wiersum 1999).

Linkage between local resource management and healthcare

Our results give insight into Beninese and Gabonese women's emic practices of natural resource management and provision of healthcare. In the limited space that is available to a woman, she cares for her children and her own wellbeing by growing domesticated species, transplanting forest species in her home garden or cultivated field, and managing the vegetation in her immediate surroundings. The women have overcome the vulnerability of having access to a limited space and few resources to meet their healthcare needs, demonstrating the resilience and adaptation associated with socio-ecological systems in sustainable development literature (Folke 2006; Gallopín 2006). If deforestation rates continue to increase, the loss of rainforest species may not severely impact the availability of medicinal plants for women and their children since they will likely continue to draw upon the resources easily accessible in disturbance and weedy vegetation, and will employ adaptive strategies to safeguard limited resources, such as we observed in the cultivation of vulnerable species like *Caesalpinia bonduc*.

Conclusions

Our research emphasizes the role of disturbance vegetation in gynecological and pediatric healthcare in both savannah and forest-dominated landscapes in Western Africa. It demonstrates women's resilience in meeting healthcare needs in the limited geographic space that is available to them and suggests their ability to adapt in the face of future deforestation. It also highlights substantial differences in plant use practices between women who sell plants commercially and women who harvest plants for personal use, particularly in the case of market women in Bénin. Although our research suggests that Western African women's medicinal plant harvest can be considered generally sustainable due to their heavy reliance on human-altered habitats, additional research is needed on the ecology and regeneration of medicinal plant species in order to make specific conclusions on the sustainability of their harvest. Conservation efforts should mainly focus on Gabonese timber trees, especially *Baillonella toxisperma* and *Pterocarpus soyauxii* and the commonly sold market species in Bénin, *Xylopia aethiopica, Khaya senegalensis, Monodora myristica*, and *Caesalpinia bonduc*.

Abbreviations

BEN, Herbier National du Bénin; LBV, Herbier National du Gabon; L, Naturalis Biodiversity Center; IUCN, International Union for Conservation of Nature; CITES, Convention on International Trade of Endangered Species; DCA, Detrended Correspondence Analysis; NTFPs, Non-Timber Forest Products

Competing interests
The authors state that they have no competing interests.

Authors' contributions
AMT carried out the ethnobotanical questionnaires in Bénin and Gabon, collected and identified the plants, analyzed the data, and drafted the manuscript. SR helped conduct the questionnaires and collect plants in Bénin and contributed to revising the manuscript. EvV helped to conduct the questionnaires, collect and identify plants in Gabon, and revised the manuscript. TvA conceived of the study, acquired funding, participated in its design and coordination, helped to identify the plants, and helped to draft the manuscript. All authors read and approved the final manuscript.

Acknowledgements
We foremost would like to thank the women who shared their time, knowledge, and patience with us during the questionnaires. We also thank the professors at the University of Abomey-Calavi in Bénin, especially A. Akoegninou and B. Sinsin, along with the staff of the National Herbarium of Bénin (BEN) for their logistical support. We would like to thank H. Aguessy and l'Institut de Développement et d'Echanges Endogènes (IDEE), K. Ostertag, L. Atindehou, and R. Bouraima for their assistance in the Bénin fieldwork. The Gabon fieldwork was supported by the research staff at L'Institut de Pharmacopée et de Médecine Traditionnelles (IPHAMETRA), the National Herbarium of Gabon (LBV), H. Bourobou, le Centre National de la Recherche Scientifique et Technologique (CENAREST), and the Agence Nationale des Parcs Nationaux (ANPN). A special thanks is extended to H. Eyi Ndong, S. Eyi, J.P. Ongoda, and the Grand Kami of Assiami for their assistance in the Gabonese fieldwork. In the Netherlands, we would like to thank M. Sosef for his logistical support, I. Abraao for help with the statistical analysis, and D. Quiroz, L. Guinee, and the botanists at the National Herbarium of the Netherlands (L) for their assistance with plant identification. The Netherlands Organization for Scientific Research (NWO) provided funding for this research (ALW-Vidi grant nr. 864.09.007) but had no additional involvement in the study.

Chapter Three

Comparing local perspectives on women's health with statistics on maternal mortality: an ethnobotanical study in Bénin and Gabon

Alexandra M. Towns and Tinde van Andel

Published in *BMC Complementary and Alternative Medicine* 14: 113, 2014

Abstract

Background

According to the World Health Organization (WHO), reproductive health problems are the leading cause of morbidity and mortality for women in Africa. In spite of this scenario and the importance of plants in African health care, limited research has been conducted linking maternal health and plant-based medicine. The objective of our research was to examine how closely Beninese and Gabonese women's health perspectives, medicinal plant knowledge, and plant use practices reflect the statistical causes of maternal mortality.

Methods

In Bénin (2011) and Gabon (2012), we conducted 87 ethnobotanical questionnaires with the corresponding collection of 800 botanical specimens. We used free-listing analysis, citation frequency and species counts to determine women's top health concerns. We also interviewed 18 biomedical healthcare providers in national hospitals and local clinics.

Results

Informants' perceptions of the main causes of maternal suffering included malaria, infertility, and menstruation and pregnancy concerns. Women were knowledgeable on plants to treat the top causes of maternal morbidity, but knew more plants for conditions such as anemia, infertility, breast milk production, and the maintenance of menstruation and pregnancy. The biomedical staff recognized the role of traditional medicine in their patients' lives and expressed concern for herbal remedies to facilitate birth, but were restricted by national policies on advising on medicinal plant use.

Conclusions

Plants serve as an entry point to understanding Beninese and Gabonese women's perceptions of common health concerns and local health management strategies. Plant use practices in both countries did not closely parallel the top statistical causes of maternal mortality, but highlighted key issues such as menstruation and infertility as salient health concerns for women. More research is needed on the role of plants in women's gynecological healthcare.

Keywords

Gynecology; Herbal medicine; Maternal morbidity; Reproductive health; Infertility; Menstruation; Africa

Background

Gynecological morbidity is among the most severe health issues in the developing world (Horton 2010; UNFPA 2013). In Africa specifically, the major statistical causes of maternal mortality are hemorrhage (34%), sepsis/infections (10%), and hypertensive disorders (9%) (Khan et al. 2006; Kinney et al. 2010). These health conditions have contributed to the response of major international health organizations in creating the fifth goal of the United Nations Millennium Development Goals (MDGs): to improve maternal health by drastically reducing the maternal mortality ratio and achieving universal access to reproductive healthcare by 2015 (United Nations 2013). Although national governments in Bénin, West Africa and Gabon, Central Africa have signed on to the MDGs, and some progress has been acquired between 1990 and 2010, neither country is on track to meet its target for 2015 (UNDP 2012). In 2010, the maternal mortality ratio for Bénin was 350 per 100,000 live births and 230 per 100,000 live births in Gabon (WHO 2012).

In spite of these health conditions, and widespread international and national commitment to achieving improved reproductive health, little research has been conducted on the role of medicinal plants in African women's healthcare. This scenario is a startling contrast to the daily lives of Africans, as traditional medicine is the primary form of healthcare for 80% of the African population (WHO 2008). Even more notable is the lack of women's knowledge in ethnobotanical research (Pfeiffer and Butz 2005), in spite of the specialized knowledge women have on medicinal plants (Camou-Guerrero et al. 2007). Women depend largely on traditional medicine in rural areas, where health centers are poorly equipped (Kamatenesi-Mugisha and Oryem-Origa 2007; Pouliot 2011), but also urban areas, where biomedical treatment is offered in modern hospitals and health centers (Cocks and Dold 2006; Osamor and Owumi 2010). For over twenty years, doctors and anthropologists have expressed their concerns about the frequent use of herbs as menstrual inducers and vaginal drying agents in West Africa and Western Central Africa (Runganga and Kasule 1995;Brown and Brown 2000; Myer, Kuhn, and Stein 2005; Ngom 2000), yet medicinal plant use for reproductive health issues is still largely understudied (Njamen and Mvondo 2013; Abdillahi and Staden 2013).

What is missing from the current understanding of African women's health is how African women perceive and manage their own health (Harlow and Campbell 2000), particularly through their use of plants. Not only could documented plant use patterns identify the important plant species used in women's health, but also the health priorities and practices of urban and rural African women. The aim of this paper was to examine how closely African women's health perceptions, plant knowledge, and plant use practices parallel the statistical causes of maternal mortality prioritized by national governments and international organizations. Through analyzing women's knowledge and use of medicinal plants, we sought to understand local perspectives on women's health, considering the knowledge and use of medicinal plants to be indicators of how Beninese and Gabonese women manage their own health. We included the perceptions of local government and private healthcare providers in order to capture the local biomedical viewpoint. We posed the following questions: (1) *Among all plants used for women's health, how many are used to treat the statistical causes of maternal morbidity and mortality?* (2) *What percentage of plants is used to treat locally-determined reproductive health concerns not addressed by international health organizations?* (3) *How do local biomedical healthcare providers perceive the use of traditional plant-based medicines for women's health?* We expected plant use patterns to closely reflect the major maternal illnesses identified by international health organizations. Outcomes of this study can inform (inter) national health agendas in Bénin and Gabon, contribute to better understanding local medicinal practices, and serve as a starting point for further research on plant efficacy and safety with regard to maternal health.

Methods

Research ethics

The research team worked according to the Code of Ethics of the International Society of Ethnobiology (International Society of Ethnobiology 2006), and followed all research procedures and protocols at Naturalis Biodiversity Center and Leiden and Wageningen Universities. In Bénin, we obtained a formal invitation from the Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, received formal approval and a research permit (# 041511) from the Faculté des Sciences et Techniques, Université d'Abomey-Calavi, and a plant export permit (#0000591) from the Service de la Protection des Vegetaux et du Control Phytosanitaire, Ministre de l'Agriculture, de l'Elevage et de la Peche. In Gabon, we received a letter of invitation (#176), formal approval, and research permit (#AR0028/12) from the Centre National de la Recherche Scientifique et Technologique (CENAREST), authorization to enter the National Parks (#000026) from the Agence Nationale des Parcs Nationaux (ANPN), and authorization (#00145, #00219) from the Institut de Phamacopee et de Medicine Traditionelles (IPHAMETRA) to export our botanical specimens. Given the ethnobotanical nature of our research, further ethical approval by a bioethics board was deemed not required by these institutions. All data were handled and stored anonymously.

Study area and sampling

Bénin, with a population of over 9.8 million people, is located in West Africa, between Nigeria and Togo (CIA 2013a). The main ethnic groups are Fon (39%), Adja (15%), and Yoruba (12%). According to the United Nations Development Program (UNDP), which bases its Human Development Index (HDI) on life expectancy, education, and income, Bénin is considered a country of "low human development" (UNDP 2013a). Its vegetation cover is mainly savanna (FAO 2010a). Gabon, located in Central Africa, borders the Atlantic Ocean at the Equator, between Republic of the Congo and Equatorial Guinea, and has a population of over 1.6 million people, mainly of Fang, Bapounou, Nzebi, and Obamba ethnic groupings (CIA 2013b). Gabon is considered by the UNDP to be a country of "medium human development" (UNDP 2013b). It is estimated that up to 80% of Gabon is covered with forest (Sosef et al. 2006). Both countries, although highly varied in population, level of human development, and vegetation cover, have populations that use traditional medicine as their primary form of healthcare.

The Bénin fieldwork took place between April and October 2011 in the six departments of Kouffo, Zou, Plateau, Ouémè, Atlantique, and Mono. We worked with the major ethnic groups represented in the country, mainly Fon and Yoruba people and related ethnicities. Research in Gabon began in June 2012 and concluded in December 2012, spanning the six departments of Estuaire, Woleu-Ntem, Haut-Ogooué, Ngounié, Moyen-Ogooué, and Ogooué-Ivindo. In Gabon, we worked with Bantu-speaking ethnic groups, namely the Fang, Mitsogo, Obamba, and Bapounou peoples. In each country, we started the data collection at the market, working with willing and knowledgeable herbal medicine saleswomen and then utilized snow-ball sampling to identify additional women in urban and rural communities.

Ethnobotanical questionnaires

By spending time at the markets and conversing informally with female merchants, we were able to identify local health concerns, commonly utilized species, and respected and knowledgeable collaborators. These activities enabled an emic approach to plants and healthcare and built the trust and mutual understanding necessary to collect data on sensitive information such as sexuality and fertility (Newing 2011). This information was used to develop an ethnobotanical women's reproductive health questionnaire, based on Alexiades' (Alexiades and Sheldon 1996) recommended guidelines

for collection of ethnobotanical information.The questionnaires were designed in English and then translated into Beninese and Gabonese French during each fieldwork phase. They consisted of (1) health issue free-listing exercises and (2) open-ended questions inquiring about herbal remedies (plant, use, preparation, and administration) used for statistical causes of maternal mortality and locally-determined health concerns. We conducted a total of 87 questionnaires, 46 in Bénin and 41 in Gabon. The Beninese informants were divided between 42 women and four men, and distributed between 23 market, 17 rural and six urban settings. The Gabonese participants were divided between 40 women and one man, and distributed between 30 rural, six market, and five urban settings. Men were included in the research as informants due to their recognition in their communities as having substantial knowledgeable on the use of plants in women's reproductive health issues. Participants received monetary compensation for their involvement in the research. Interpreters were employed in situations where participants did not speak French. After introducing ourselves and our research institute, closely explaining the nature of our research, and receiving verbal consent, we conducted the questionnaires in the participants' own surroundings.

Plant collection

Directly following each questionnaire, we accompanied informants into the surrounding areas to collect plant species mentioned in the interviews. For questionnaires completed with market sellers, we purchased the cited plant species directly from the market stalls. We used standard ethnobotanical collection methods (Alexiades and Sheldon 1996) to allow for an adequate taxonomic identification of the species, and the documentation of local names, recipes, and perceived effects. We collected over 800 plant vouchers and information on their medicinal uses (see Appendix 1 and Appendix 2). Vouchers of all collected plants were deposited at the main herbaria in each country (BEN in Bénin and LBV in Gabon), with a complete set of duplicates stored at the National Herbarium of the Netherlands (WAG), now merged with Naturalis Biodiversity Center.

Biomedical healthcare provider interviews

We interviewed a total of 18 (six in Bénin and 12 in Gabon) biomedical healthcare providers, including nurses, midwives, doctors, and gynecologists. The interviews took place at national hospitals in urban areas (Cotonou in Bénin and Libreville in Gabon) as well as government and private health clinics in rural communities. These semi-structured interviews included (1) free-listing of salient reproductive health problems, (2) questions related to culturally-bound disease concepts, (3) open-ended questions about practitioners' experiences with patients who utilized plant-based medicine prior to seeking biomedical care and (4) opinions on the benefits and risks of traditional medicine.

Data analysis

The ethnobotanical questionnaires were analyzed with three main indices. The first index was the number of times an illness was mentioned in the free-listing exercise. Each informant was asked to give her opinion on the top three health issues that caused the most suffering for women. Secondly, we calculated the knowledge frequency of the informants by averaging the number of citations for each health issue and the percentage of informants who knew at least one herbal remedy for each health condition. Lastly, we calculated the number of plant species cited per health issue, which captured informants' practices of treating diseases. The health issues with the most cited species were considered to be of high importance to the community, based on the principle that the greater importance of a health condition, the most plant species are used to treat it (van Andel et al. 2008; Milliken and Albert 1997; Ruysschaert et al. 2009; Milliken 1997). We summarized the responses of the local biomedical healthcare providers and selected key examples to illustrate their experiences with women who self-treated with medicinal plants prior to arriving at clinics and hospitals.

Results

Free-listing analysis

Malaria, pregnancy-related concerns, and infections were the most commonly mentioned health complaints by women in the Beninese free-listing activity (Table 1). Pregnancy-related conditions included a range of concerns such as avoiding miscarriage, managing early pregnancy sicknesses (stomachache, vomiting, and diarrhea), strengthening the fetus, and preparing for childbirth. The statistical causes of maternal health were not strongly reflected in the free-listing activity, with the exception of infections, which may not be directly correlated with the biomedical definition of sepsis. Post-partum hemorrhage ranked sixth among Beninese informants' concerns, tied with headache. Hypertension was mentioned by only two of the 46 informants.

Table 1 Frequency of women's health complaints cited by 46 informants in Beninese free-listing activity

Health issue	Frequency
malaria	0.46
pregnancy-related	0.33
infections	0.24
fever	0.20
infertility	0.20
menstrual-related	0.20

Menstrual-related concerns, stomachache, and infertility were the health complaints most frequently cited in the Gabonese free-listing activity (Table 2). Menstrual-related concerns included painful menstruation, black-colored menses, and heavy cramps. Like the informants in Bénin, women in Gabon did not perceive post-partum hemorrhage or high blood pressure as top concerns. Infections were mentioned by two of the 41 informants.

Table 2 Frequency of women's health complaints cited by 41 informants in Gabonese free-listing activity

Health issue	Frequency
menstrual-related	0.44
stomachache	0.41
infertility	0.22
backache	0.17
malaria	0.10
childbirth-related	0.10
worms	0.10

Informants' knowledge of herbal remedies

Beninese women were most knowledgeable on herbal remedies for pregnancy-related concerns, anemia, high blood pressure, and breast milk stimulation (Table 3). Herbal treatments were administered in pregnancy: (1) to strengthen and protect the fetus (26%), (2) to be consumed as nutritious (plant-based) foods (17%), (3) to prepare the body for delivery (15%), (4) to promote general health and well-being of the mother (13%), (5) to treat/prevent early first trimester illnesses (12%), (6) to treat malaria (6%), and (7) other (fatigue, stomachache, antibiotic, etc.) (11%). Herbal remedies for childbirth-related concerns were mainly reported to be used to facilitate childbirth, but also to assist in the removal of the placenta and for use as a post-birth womb cleanse. The majority of Gabonese women knew herbal remedies for breast milk stimulation, anemia, vaginal cleansing, and menstrual-related concerns (Table 3). Herbal remedies for facilitating childbirth were reported to be used beginning in the seventh month of pregnancy. Of the 41% of informants who knew a treatment for postpartum hemorrhage, half of these responses were for hot water massage, in which herbs were not involved.

Table 3 Informant knowledge on women's health issues in Bénin (46 questionnaires) and Gabon (41 questionnaires)

Health issue	# of citations (% informants[1])	# of citations (% informants[1])
	Bénin	Gabon
anemia	62 (98%)	63 (88%)
breast milk stimulation	44 (85%)	78 (93%)
pregnancy-related	103 (98%)	60 (66%)
menstrual-related	65 (83%)	53 (76%)
high blood pressure	49 (87%)	43 (63%)
childbirth-related	70 (78%)	56 (66%)
vaginal cleanse	39 (67%)	64 (76%)
sexually transmitted infections	66 (83%)	13 (34%)
infertility	31 (67%)	39 (46%)
postpartum hemorrhage	37 (73%)	22 (41%)

[1]percentage of informants with knowledge of at least one treatment

Health conditions with the most species

Beninese informants mentioned a total of 248 species for women's reproductive health (see Appendix 1). More species were cited for pregnancy and menstruation, 36% and 32% respectively, than for other health conditions, followed by anemia (25%) and infertility (23%) (Table 4). Informants mentioned species to treat menstrual-related concerns that concerned length (too long, delayed, irregular), pain (too heavy, too painful), texture (slimly, sticky), color (black, clear) and smell (too odorous). *Sarcocephalus latifolius* was frequently cited as an herbal tea remedy to treat menstrual complications (see Appendix 1).

Table 4 Number of species used per health condition in Bénin (46 questionnaires) and Gabon (41 questionnaires)

Health condition	# of species (% of 248 species)	# of species (% of 189 species)
	Bénin	Gabon
pregnancy-related	90 (36%)	41(22%)
menstrual-related	79 (32%)	28 (15%)
anemia	62 (25%)	21 (11%)
high blood pressure	39 (16%)	34 (18%)
infertility	58 (23%)	13 (7%)
vaginal cleanse	28 (11%)	37 (20%)
childbirth-related	38 (15%)	25 (13%)
breast milk stimulation	23 (9%)	29 (15%)
sexually transmitted infections	40 (16%)	13 (7%)
postpartum cleanse	28 (11%)	23 (12%)
postpartum hemorrhage	28 (11%)	12 (6%)

Gabonese informants mentioned a total of 189 species for women's health (see Appendix 2). Women used 22% of the herbal pharmacopeia for pregnancy, 20% for vaginal cleansing and 18% of species for high blood pressure (Table 4). Breast milk stimulation and menstruation followed, each with 15% of the total numbers of species. Gabonese participants commonly cited the use of the leaves of *Alchornea cordifolia* in direct vaginal insertion for a vaginal cleanse (see Appendix 2). Further analysis on the frequency of species mentioned in our study will be published elsewhere.

Perspectives of the local biomedical healthcare providers

The Beninese biomedical healthcare providers cited malaria most often as a health threat for pregnant women in the free-listing activity. The Gabonese healthcare providers cited sexually transmitted infections most frequently, followed by stomachache, malaria and infertility. They suggested a strong causal link between infertility and the high number of sexually transmitted infections and clandestine abortions. Biomedical staff in both countries recognized the role of traditional medicine in their patient's reproductive lives, and shared examples of both positive and negative effects. Doctors in Gabon praised the use of a post-partum hot water massage for mothers' recovery after childbirth. Staff in private clinics in Bénin mentioned that traditional healers were occasionally called into the clinic to assist in complicated births. However, severe negative effects were also reported, such as the combined use of traditional and modern medicine leading up to childbirth in Bénin. Doctors in Gabon described situations with patients who used plants to speed up contractions that eventually led to uterine rupture.

Although we did not find a strong pattern that biomedical healthcare providers viewed plant-based traditional medicines either negatively or positively for women's health, both sets of informants clearly conveyed that national policies did not authorize the use of traditional medicine in hospitals. These policies limited the amount of information they were able to share with their patients. They suggested that these restrictions influenced patients' willingness to discuss their plant use practices with them. Gabonese healthcare providers frequently expressed a concern for the lack of scientific documentation on the effects of medicinal plants and the lack of standard dosage in traditional medicine.

Discussion

Locally-perceived health issues

Malaria in pregnancy was commonly cited by women as a health concern in the free-listing activities as well as by the biomedical healthcare providers. International efforts to combat malaria are evidenced in the promotion of malaria prevention therapies for pregnant women by the WHO and the sixth goal of the MDGs (WHO 2013a; WHO 2013b). Biomedicine recognizes malaria as a serious health threat during pregnancy due to the increased risk of low birth weight and maternal and infant anemia (Eisele et al. 2012; Gutman and Slutsker 2011; Huynh et al. 2011; Fleming 1989). Although malaria is seen as a common concern by local women, local healthcare providers, and (inter) national health organizations, there is little attention from international organizations on the use of plants to treat malaria, especially for pregnant women. Informants in our study were careful to distinguish between plants used for general cases of malaria and those used for pregnant women with this disease. Recent pharmacological research has highlighted the role of medicinal plants in treating malaria in both countries (Yetein et al. 2013; Lekana-Douki et al. 2011), but more research is needed to understand the effects of medicinal plant use during pregnancy. We did not systematically ask about malaria in our questionnaires since we did not consider malaria to be a reproductive health issue at the time of designing our questionnaire. This oversight is likely reflected in the low number of plant species cited by informants and is also apparent in international gynecological health programs, as malaria is often not associated with reproductive health.

Menstrual complaints ranked high on the free-listing exercises of both sets of informants. The majority of women knew how to treat menstrual-related conditions and numerous plant species were cited as treatments. Menstruation itself was not considered an illness, but irregularities, pain, and variations in color and smell of blood were frequent concerns. Although not a priority in national or international women's health agendas, menstrual management has been identified as a priority issue by women across developing regions of the world (Harlow and Campbell 2000; Ten 2007; Bhatia et al. 1997). It has direct implications for not only hygiene and infections, but also for productivity and participation in society (Water Supply and Sanitation Collaborative Council 2013). Menstruation limits women's participation in traditional social functions in both Bénin and Gabon. Likewise, as has been documented in Tanzania, menstruation negatively impacts young women's ability to attend school, resulting in lower attendance and achievement (Sommer 2010). In Gabon, painful menstruation was linked in cultural terms to infertility. Beninese informants mentioned the correlation between heavy menstruation and anemia as a reason to regulate menstruation. Given the high value placed on fertility in most African societies (Caldwell and Caldwell 1987), regular menstruation serves as an indication that a woman can get pregnant; effective menstrual management secures future childbearing (Levin 2001).

Infertility was among the four most frequently mentioned reproductive health concerns by all women, and ranked high on the tables of participants' knowledge and plant species. Infertility, especially secondary infertility, has been documented as a reproductive health issue in Sub-Saharan Africa (Larsen 2000; Cates, Farley, and Rowe 1985), as well as a psychological and social concern (Dyer et al. 2002; Naab, Brown, and Heidrich 2013). It has been estimated that up to 30% of couples from sub-Saharan

Africa have primary or secondary infertility (Rutstein and Shah 2004); a 1983 study showed that 32% of Gabonese women remain childless and the end of the childbearing years, the highest of all African countries involved in the study (Frank 1983). Biomedical health providers in Gabon echoed informants' concerns of infertility and linked it to the high number of sexually transmitted infections and clandestine abortions. Their experiences were supported by a study in eastern Gabon, which found high levels of upper genital tract infections in infertile women (Collet et al. 1988). The prevalence of infertility has also been described in recent publications on the use of modern fertility treatments in developing country contexts (Daar and Merali 2002; Balen and Gerrits 2001). The WHO published a bulletin in 2010 on the issues facing women in the "infertility belt" of Africa, and called for more available and affordable fertility treatments (Cui 2010). Given expenses involved in modern fertility treatments and the social stigma against being infertile, plants offer women an affordable and private way of addressing this ailment (Telefo et al. 2011).

Infertility was also apparent in cultural-bound diseases mentioned by women in both countries. In Bénin, a culturally-bound disease known a "loudjo" (Fon) was cited as a common case for infertility in which a women's body rejects sperm. Gabonese participants described a cultural bound disease known as "ona" or ''onyaboom" (Fang) caused by worms that rest in the womb and cause sterility. Three additional cultural bound diseases were mentioned in the Gabonese fieldwork (see Appendix 2), although they were not the focus of this manuscript, since they were only mentioned by one informant each. These cultural illnesses included "les urines" (Fang/French)- an infection characterized by frequent urination, "zchaw" (Fang)- a gynecological abnormality similar in description to fibroids and cysts, and "mfoes" (Fang)- an illness characterized by back pain. These diseases highlight local understanding of health and are important for biomedical healthcare providers to be aware of in order to have a comprehensive understanding of local healthcare (Sabuni 2007).

Pregnancy-related symptoms were common health concerns in both countries. It can be expected that pregnancy has many herbal treatments, due to the numerous stages over nine months in which a woman would seek healthcare. Maintaining a pregnancy and ensuring a safe birth are closely linked to the high social value of fertility (Caldwell and Caldwell 1987). The role of medicinal plants in pregnancy and childbirth has been reflected in other African countries and worldwide (de Boer and Lamxay 2009; Ticktin and Dalle 2005; Veale, Furman, and Oliver 1992; Malan and Neuba 2011).

Breast-milk stimulation was a common concern for Gabonese informants. The cultural importance of breast milk in Africa is well documented (Davies-Adetugbo 1997; Hofmann et al. 2009; Yeo et al. 2005). While the WHO does not mention breast milk-related problems in their programming, concerns of inadequate breast milk quantity are a common concern for women worldwide and cited as a reason for not fulfilling the WHO guidelines of six months of exclusive breastfeeding (WHO 2013c). Shared breastfeeding has been reported as common practice among women in Gabon, with estimates of up to 40% of women engaging in the practice (Ramharter, Chai, and Adegnika 2004).

Statistical top causes of maternal mortality

Informants in our study did not report the top statistical causes of maternal morbidity and mortality as their most urgent gynecological health concerns. However, over three-fourths of the Beninese informants knew an herbal remedy for treating both high blood pressure and post-partum hemorrhage. Nearly half of the Gabonese informants knew at least one treatment for post-partum hemorrhage and 63% of the women knew plants used to treat high blood pressure. Although further research is needed in order to make more substantial claims, the relative low number of plants cites in our study for postpartum hemorrhage, in particular Gabon, may be reflected in the high rates of maternal mortality associated with hemorrhage. This case reflects a situation where biomedical solutions may be urgently needed in order to improve maternal health in Africa (Prata et al. 2005). Some informants were not

familiar with hypertension, which is an area where health programs efforts also should improve their educational efforts. It was also not clear whether informants' concepts of high blood pressure matched biomedical definitions of the illness.

Sepsis, the third most common cause of maternal morbidity and mortality, is a health issue that has not been clearly-defined in health programs worldwide. Many reports suggest that the burden of sepsis on morbidity and mortality are largely underreported (Seale et al. 2009; Jawad, Lukšić, and Rafnsson 2012; Bruijns, Green, and Wallis 2012). Infections, both general and sexually-transmitted, were mentioned by both sets of informants, but sepsis as a distinct category was not cited. It is possible that sepsis is reflected in the numerous recipes and plants used for vaginal cleansing and uterus cleanses. In Gabon especially, vaginal cleanses were a common health practice, with 76% of informants knowledgeable on herbal treatments. Although these cleanses may not be directly associated with sepsis or infections, they may have a role in either preventing vaginal infections or increasing infections by disturbing vaginal flora. Although some research has explored the role of intravaginal practices in increased HIV infections (Runganga and Kasule 1995; Brown and Brown 2000; Myer, Kuhn, and Stein 2005; Low et al. 2011), more research is needed to draw further conclusions on the role of vaginal cleansing in women's reproductive healthcare, and more generally sepsis and infections.

The statistical causes of maternal mortality were also not reported by the local biomedical staff as urgent gynecological health concerns. This outcome could be explained by the generalized nature of African maternal mortality statistics (Khan et al. 2006; Kinney et al. 2010), which may not accurately reflect the health status of the populations with which we worked. The reliability of these numbers as an accurate measure of a population's health also comes into question, as recent literature on African economic statistics has proposed (Jerven 2009). The differences in perspectives nevertheless highlight key conceptual differences on well-being, health, and illness. Awareness of these differences can improve healthcare for African women by enhancing educational efforts and designing health initiatives that are culturally-appropriate to local communities.

Key insight from local healthcare providers

The local doctors, midwives, and gynecologists embody the biomedical perspective on the local level. They work at the interface between the local women's practices and perceptions and the biomedical science promoted in government hospitals and clinics. The biomedical staff in our study recognized the role of plant-based traditional medicine in their patients' lives, including the benefits and the risks, but were unable to make recommendations or offer medical advice due to the lack of documentation on plants' effects and the restrictions of national health policies. Local biomedical staff are uniquely positioned at the intersection of the two medical systems (Langwick 2008), a role that deserves further research and analysis in order to understand how the pluralistic medical system can better serve women in Africa.

Strength and weakness of our research

Our methodology of using three indices to capture the perceptions, knowledge, and plant use patterns enabled a triangulation of the most salient health concerns for the informants involved in this study. While we are confident that our results reflect the views of those individuals involved in our research, both countries have diverse ethnicities whose knowledge and perceptions were not represented in this study. Additional studies are needed to avoid generalizing our results to the entire female Beninese and Gabonese populations and to address differences in health perceptions between ethnic groups. Likewise, our use of snowball sampling resulted in uneven numbers of women from urban, rural, and market settings and the knowledge of several men. Our aim was not to make comparisons between marketplaces and rural and urban settings, but to capture local women's perceptions and routine practices. Five men were included in the study since they were recognized in their communities as being knowledgeable on plants used for women's reproductive health. Although we did not have a large

enough sample to make a statistical comparison, we found that men often had specialist knowledge on issues such as female infertility and complicated births. Future research can investigate differences in knowledge between the sexes and among varied settings.

Conclusion

In the diverse settings of Bénin and Gabon, plants serve as an entry point to understanding salient gynecological concerns and common health practices. Plants and women's knowledge contribute to the local population's management of the top statistical causes of maternal mortality, but other health conditions such as menstruation and infertility were more salient health concerns. Echoing the stances of the biomedical staff of both countries, more research is needed on the role of plants in women's gynecological healthcare. A renewed commitment to strengthening national policies on traditional medicine could improve the health services offered to women, helping to avoid the adverse effects of combing both systems, and further realize the goal of African women and (inter) national health programs alike of reducing maternal morbidity and mortality.

Abbreviations

MDGs, Millennium development goals; BEN, National Herbarium of Bénin; LBV, National Herbarium of Gabon; WAG, Former Wageningen University branch of the National Herbarium of the Netherlands, now merged with Naturalis Biodiversity Center; WHO, World Health Organization

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

AMT carried out the ethnobotanical questionnaires, conducted the biomedical health care provider interviews, collected and identified the plants, analyzed the data, and drafted the manuscript. TvA conceived of the study, acquired funding, participated in its design and coordination, helped to identify the plants, and helped to draft the manuscript. Both authors read and approved the final manuscript.

Authors' information

AMT is a PhD student at Leiden University, Naturalis Biodiversity Center in the Netherlands. TvA is a postdoc researcher at Leiden University, Naturalis Biodiversty Center in the Netherlands.

Acknowledgements

This research was made possible financially through the Netherlands Organization for Scientific Research (NWO), Vidi grant nr. 864.09.007. For the Bénin fieldwork, we would like to thank the professors at the University of Abomey-Calavi in Bénin, especially Akoegninou A and Sinsin B, along with the staff of the National Herbarium of Bénin (BEN). We would like to thank the Association des Sages-Femmes du Bénin, Aguessy H and l'Institut de Développement et d'Echanges Endogènes (IDEE), Ruysschaert S, Ostertag K, and Bouraima R for their assistance in the Bénin fieldwork. The Gabon fieldwork was supported by the research staff at L'Institut de Pharmacopée et de Médecine Traditionnelles (IPHAMETRA), the National Herbarium of Gabon (LBV), Bourobou HB, le Centre National de la Recherche Scientifique et Technologique (CENAREST), and the Agence Nationale des Parcs Nationaux (ANPN) in Gabon. The authors would like to share a special thanks to van Vliet E, Eyi Ndong H, Eyi S, Ongoda JP and Ndombi OI, as well as the midwives and gynecologists at the Centre Hôpital Universitaire de Libreville (CHUL). In the Netherlands, we would like to thank Sosef M for his logistical support, and the expert botanists at the National Herbarium of the Netherlands (WAG) for their assistance with plant identification. We are grateful to Vandebroek I and De Gezelle J for their review of this manuscript.

Appendix 1

Species cited in 46 wome's health questionnaires in Bénin: scientific botanical name, name in local language(s), used plant part, preparation, use category and AMT collection number

Botanical Name	Local Name[a]	Used part	Preparation[b]	Use category[c]	AMT#[d]
Abrus precatorius L.	degbeybegbey (F), yekpeyekpeman (F), viviman (N)	root, leaves	T	contraception, infertility, pregnancy	NC
Acacia nilotica (L.) Delile	bonni (F)	seeds	T	menstruation	338
Acanthospermum hispidum DC.	togbama (M), kpononmi (N)	plant, leaves	T	HBP, infertility, pregnancy	376, 381, 535
Acmella caulirhiza Delile	awlekpekpe (S)	plant	T	postpartum hemorrhage	397
Acridocarpus smeathmannii (DC.) Guill. & Perr.	gbanguinan (F)	root, bark	T	anemia	300, 355, 599
Acrostichum aureum L.	Sofoco (S)	leaves	T	pregnancy	NC
Aframomum melegueta K.Schum.	atakoun (F)	fruit	T	childbirth, galactagogue, menstruation, STIs	309
Afzelia africana Pers.	aguakpogoto (F)	bark	VW	STIs	362
Aganope stuhlmannii (Taub.) Adema	siensiendo (F)	root, bark	T	infertility, menstruation	NC
Agelaea pentagyna (Lam.) Baill.	ahouanhlazou (S)	leaves	T	pregnancy	383
Albizia adianthifolia (Schum.) W.Wight	awagotingoto (F)	bark	T	menstruation	369
Allium cepa L.	petite onion (Fr)	stem	V, T, VW, A	galactagogue, HBP, infertility, menstruation, postpartum infections	117
Allium sativum L.	aiyo (G)	stem	T, D	childbirth, cysts, fibroids, HBP, menstruation	NC
Aloe macrocarpa Tod.	aloes (M)	leaves	J	anemia	487
Ampelocissus leonensis (Hook.f.) Planch.	tekple (N)	plant	T	infertility, pregnancy	320
Anacardium occidentale L.	cadjou (F)	bark, leaves, root	T, VW, HB	HBP, infertility, STIs, postpartum infections, pregnancy	331
Ananas comosus (L.) Merr.	ananas (Fr)	fruit	T	anemia	NC
Anchomanes cf. *difformis* (Blume) Engl.	agohouéhè do (F)	root	T	infertility	315
Annickia polycarpa (DC.) Setten & Maas	atahé (F)	bark	T	menstruation	NC
Annona muricata L.	shapshap (F)	leaves	T	HBP, STIs	NC
Annona senegalensis Pers.	nyuglo (F), bejunongley (M), tineybobo (T)	leaves, root	E, P, T	childbirth, STIs, pregnancy	602, 644
Anthocleista sp.	clabalabagoto (F)	bark	T	intestinal cleanse	523
Anthocleista vogelii Planch.	gotoundo (F)	root, leaves, wood	T	infertility, intestinal cleanse, stomachache	348
Arachis hypogaea L.	arachide (Fr)	seeds	E	galactagogue, pregnancy	NC
Argemone mexicana L.	wetcheyon (G)	leaves	T, VW	pregnancy, STIs, vaginal cleanse	NC

Botanical Name	Local Name[a]	Used part	Preparation[b]	Use category[c]	AMT#[d]
Artocarpus cf. *altilis* (Parkinson ex F.A.Zorn) Fosberg	blèfutu asu (M)	leaves	T	HBP	NC
Asteraceae sp.	atentebe (T)	plant	T	stomach ache	292
Azadirachta indica A.Juss.	kini (F)	leaves	T	abortion, pregnancy, stomachache	NC
Baphia nitida Lodd.	sokpèkpè (F)	wood	T, A	contraception, cysts, fibroids, intestinal cleanse, menstruation, postpartum cleanse	319
Barteria cf. *nigritana* Hook.f.	oko goto (F)	bark		anemia	NC
Bauhinia thonningii Schum.	kloman (F), banmo (T)	leaves	E, T	pregnancy, HBP	647
Beta vulgaris L.	la betterave (Fr)	root	E	anemia	NC
Blighia cf. *unijugata* Baker	agboviawondo (N)	bark	T	intestinal cleanse	NC
Boerhavia erecta L.	tikpatikpalala (T)	leaves	E	pregnancy	298
Bridelia ferruginea Benth.	houssoukokoé (F)	root, leaves, bark	T, A, VW	anemia, contraception, infertility, menstruation, postpartum infections, STIs, vaginal cleanse	NC
Bryophyllum pinnatum (Lam.) Oken	afitiman (S)	leaves	T	postpartum cleanse	NC
Burkea africana Hook.	atapa (T)	leaves	E	pregnancy	646
Caesalpinia bonduc (L.) Roxb.	adjikuiman (F)	seeds, leaves, root	D, E,T, W	childbirth, diuretic, infertility, menstruation, postpartum bleeding, postpartum cleanse, postpartum infections, pregnancy, STIs, vaginal cleanse	484, 651
Caesalpinia pulcherrima (L.) Sw.	orgueil de chine (Fr)	fruit (young), leaves, bark	T, P	HBP, infections	480
Cajanus cajan (L.) Millsp.	eweotini (N)	leaves	T	menstruation	NC
Caladium bicolor (Aiton) Vent.	wèkènoukoun (F)	plant	TC	menopause cause	568
Calotropis gigantea (L.) Dryand.	kpinto (F)	leaves	T	cough	NC
Canna cf. *indica* L.	sidakin (G)	plant	T	STIs	NC
Capsicum annuum L.	pimment (Fr)	fruit	T, P, EN, A	cysts, fibroids, hemorrhoids- internal, HBP, intestinal cleanse	256
Carica papaya L.	kpinman (F,G)	leaves, fruit, root	T, D	anemia, galactagogue, infertility, contraception, cysts, fibroids, HBP, pregnancy, menstruation, vaginal cleanse	NC
Carissa spinarum L.	ahouanzodo (F)	root	T, VW, A	anemia, cysts, fibroids, menstruation, postpartum infections, STIs	332, 373, 504, 524
Cassytha filiformis L.	agbégbékan (F)	plant	T, VW	pregnancy, vaginal cleanse, infertility	326
Ceiba pentandra (L.) Gaertn.	kpatindèhoun (F), batidenia (M)	leaves	D	childbirth	567
Celosia cf. *argentea* L.	soman (G)	leaves	T	anemia	NC
Celtis cf. *zenkeri* Engl.	agbohingla (S)	bark	T	cysts, fibroids	NC
Ceratotheca sesamoides Endl.	komokuile (T), agboma (F)	leaves, whole plant	D, E, T	anemia, childbirth, pregnancy	655

Botanical Name	Local Name[a]	Used part	Preparation[b]	Use category[c]	AMT#[d]
Chamaecrista mimosoides (L.) Greene	kilafimitche (S)	plant	VW	STIs	389
Chamaecrista rotundifolia (Pers.) Greene	azima (F, G)	leaves, whole plant	VW, T	infertility, pregnancy, STIs	NC
Chassalia kolly (Schumach.) Hepper	djêtindo (F)	root	T	childbirth, intestinal cleanse, cysts, fibroids, menstruation	187, 328
Chromolaena odorata (L.) R.M.King & H.Rob.	agatou (F, G, N)	leaves	T, VW	vaginal cleanse	NC
Chrysophyllum albidum G.Don	azongogoegoto (G)	bark	T	galactagogue	NC
Chrysopogon sp.	tékanwannon (F)	plant	T	menstruation	339
Cissampelos mucronata A.Rich	djokodje (K)	leaves	T	postpartum hemorrhage	515
Cissampelos mucronata A.Rich.	djokodjè (F, G)	leaves, whole plant	T	infertility, CBD loudjo, infertility, menstruation, pregnancy	314
Cissampelos owariensis P.Beauv. ex DC.	tjokodje (F)	leaves	D	infertility, pregnancy	NC
Cissus populnea Guill. & Perr.	dedo (F)	root	D	childbirth	122
Citrullus colocynthis (L.) Schrad.	tchègba (F), kaka (T)	leaves, seeds, fruit	E, T	STIs, intestinal cleanse, pregnancy	238, 303
Citrullus lanatus (Thunb.) Matsum. & Nakai	wanyiwanyikoun (F)	fruit	T	intestinal cleanse	505
Citrus aurantiifolia (Christm.) Swingle	clé (F, G)	leaves, fruit, root	E, EA, T	childbirth, galactagogue, HBP, intestinal cleanse, menstruation, pregnancy, breast inflammation, postpartum cleanse, postpartum infections, infertility	345
Citrus sp.	klèman (F)	leaves, root, fruit	T	HBP, menstruation, pregnancy, intestinal cleanse, menstruation, stomachache	347
Clausena anisata (Willd.) Hook.f. ex Benth.	gbozohoun (F)	leaves, bark, root	VW, T	menstruation, postpartum infections, STIs	330, 576
Cleistopholis patens (Benth.) Engl. & Diels	hounsoué do (F, G, N)	bark, leaves, root	T	infertility, intestinal cleanse, pregnancy	375
Cleome viscosa L.	agatouma (F)	plant	VW	STIs	NC
Cnestis ferruginea Vahl ex DC.	akpaflo (F)	seeds, root	T	menstruation, anemia	340
Cochlospermum planchonii Hook.f. ex Planch.	betou (T)	leaves	E	pregnancy	656
Cocos nucifera L.	agodo (F, G, N)	fruit, root, seeds, fruit water	D, T	anemia, galactagogue, cysts, fibroids, HBP, yellow fever, menstruation	370, 378
Combretum cf. *grandiflorum* G.Don	adounsitoman (G, S)	leaves	D, T	childbirth, infertility	NC
Commelina erecta L.	tchankoko (F)	rhizome	T	menstruation	334
Corchorus olitorius L.	krenkren (F)	leaves, root	E, T	food, menstruation	166
Costus lucanusianus J.Braun & K.Schum.	tetregoudou (G)	plant	T	cysts, fibroids	372
Costus sp.	tetregouman (S)	leaves	T	intestinal cleanse, vaginal cleanse	NC
Crateva adansonii DC.	hontonzonzouin (F)	leaves	T, VW	HBP, menstruation, STIs, vaginal cleanse	NC
Crescentia cujete L.	kamma (F)	leaves	D	intestinal cleanse	NC
Croton gratissimus Burch.	jelele (F)	leaves, bark, root	T, P	CBD loudjo, childbirth, HBP, menstruation, pregnancy	327
Cucumeropsis cf. *mannii* Naudin	goussitchègba (F, G)	seeds	T	infertility, intestinal cleanse, menstruation	NC
Curculigo pilosa (Schumach. & Thonn.) Engl.	ayote (F)	tuber	V, D, T	galactagogue, intestinal cleanse, menstruation	118, 333

Botanical Name	Local Name[a]	Used part	Preparation[b]	Use category[c]	AMT#[d]
Curcuma sp.	chyiaoumkoko (F)	rhizome		infections	196
Cyanthillium cinereum (L.) H.Rob.	hunsikusey (F)	plant, leaves	T	CBD loudjo, contraception, pregnancy,	540, 595
Cymbopogon citratus (DC.) Stapf	teeman (F, N)	leaves	T	anemia, childbirth, galactagogue, pregnancy, stomachache	NC
Cynometra megalophylla Harms	bougoto (F, N, G)	bark	T	anemia	NC
Daniellia oliveri (Rolfe) Hutch. & Dalziel	nyado (F), inya (T)	leaves, bark, wood	E, D, HB, P	pregnancy, galactagogue, infertility	584, 652
Desmodium gangeticum (L.) DC.	zèdali (F, N, G)	leaves, whole plant	T, D	childbirth, infertility, pregnancy	316
Desmodium velutinum (Willd.) DC.	bandowo (F, N, G)	leaves, whole plant, fruit	T, VW	CBD loudjo, HBP, menstruation, pregnancy	250, 508
Dialium guineense Willd.	loma (M)	leaves	D, E	galactagogue, intestinal cleanse, vegetable	481
Dichapetalum madagascariense Poir.	gbago (F)	leaves	T	cysts, fibroids, HBP, pregnancy, menstruation	142, 169
Diodella sarmentosa (Sw.) Bacigalupo & Cabral ex Borhidi	sèhwi (F, G)	plant, leaves	T	infertility, menstruation, pregnancy	317, 528
Dioscorea sp.	gando (F)	root, fruit	T	cysts, fibroids, menstruation, anemia	357
Dysphania ambrosioides (L.) Mosyakin & Clemants	godo (F), amantrouzou (F)	plant, leaves	EA, VW, T	menstruation, postpartum infections, STIs, vaginal cleanse	479, 519
Ehretia cymosa Thonn.	mionman (F), bodomey (T)	leaves	E, T	menstruation, pregnancy, HBP	380, 657
Elaeis guineensis Jacq.	l`huile rouge (Fr)	seeds, oil from seeds, infructescence, leaves	E, EA, HB, T	galactagogue, internal hemorrhoids, HBP, muscle pain, fatigue, pregnancy	578
Eleusine indica (L.) Gaertn.	akpi (K)	leaves	D	childbirth	513
Entada africana Guill. & Perr.	kpakpassoumehaman (S)	leaves	T	contraception	394
Entada gigas (L.) Fawc. & Rendle	gbagbara (F)	seeds, bark	T	infertility, pregnancy	NC
Erythrina senegalensis DC.	pbaklesido (F)	bark, root	T	anemia, contraception, infertility, menstruation pregnancy	131, 527
Fabaceae sp.	fonvi (S)	plant	T	menstruation	NC
Ficus sur Forssk.	agpoto (T)	root, leaves	T	anemia, pregnancy	293, 388, 510, 653
Flacourtia indica (Burm. f.) Merr.	gbohouncadjè (F)	root, leaves	T, D	anemia, pregnancy	127, 356
Flacourtia sp.	gbougbadjo (G)	wood	T	intestinal cleanse	371
Flueggea virosa (Roxb. ex Willd.) Royle	tcheke-tcheke (F)	leaves	T	fever, intestinal cleanse, malaria, pregnancy	193
Fulvifomes cf. *fastuosus* (Lév.) Bondartseva & S. Herrera	chutin (F)	fungus	T	infertility	123
Ganoderma sp.	djouatin (F)	fungus	T	pregnancy	NC
Garcinia kola Heckel	ahowo (G)	wood	T	menstruation	368
Garcinia sp.	kola (F)	bark, seeds	T, E	anemia	NC
Gardenia ternifolia Schumach. & Thonn.	adakpla (F)	plant, root, leaves	T	HBP, malaria, pregnancy	301, 510, 521, 564
Gladiolus dalenii Van Geel	baka (F)	stem	T	menstruation	335

Botanical Name	Local Name[a]	Used part	Preparation[b]	Use category[c]	AMT#[d]
Gmelina arborea Roxb.	fofitin (F)	leaves	T	HBP	359
Gomphrena celosioides Mart.	papatajè (K)	plant	T	HBP	516
Gossypium barbadense L.	tchekey	plant			612
Gossypium hirsutum L.	avokanfochekey (F)	leaves	D, T	anemia	NC
Grewia cf. *carpinifolia* Juss.	oriman (G)	leaves	T	pregnancy	NC
Gymnosporia senegalensis (Lam.) Loes.	yedoman (F)	leaves, bark	T	cysts, fibroids	NC
Helianthus sp.	botiowo (T)	leaves	EN	intestinal cleanse	278
Heliotropium indicum L.	koklusu danpaja (M)	plant, leaves	D, T	childbirth, HBP	522
Heterotis rotundifolia (Sm.) Jacq.-Fél.	hêhêman (F)	leaves, bark	T, D, VW	anemia, childbirth, cysts, fibroids, HBP, infertility, menstruation, pregnancy, protection against sorcery, postpartum infections, STIs	NC
Hibiscus acetosella Welw. ex Hiern	podey (M)	leaves	T	anemia	151
Hibiscus sabdariffa L.	bissap (Fr)	leaves	T	cysts, fibroids, pregnancy	485
Hibiscus surattensis L.	kpofin (F, G, N)	plant, leaves	T	anemia, infertility, pregnancy	150, 310, 503
Hymenocardia acida Tul.	fefeya (T), orukpa (T)	leaves	E	pregnancy	641, 649
Hyptis suaveolens (L.) Poit.	kulubi (T)	leaves, root	E, T	galactagogue, STIs, pregnancy, stomachache	275, 536
Imperata cylindrica (L.) Raeusch.	cekunu (F), eweekan (N)	leaves	VW	pregnancy, vaginal cleanse	NC
Indigofera hirsuta L.	zogbeyzi (M)	leaves	T	pregnancy	170
Indigofera pulchra Willd.	azima (F)	plant	T	pregnancy	614
Ipomoea aquatic Forssk.	ahinandje (S)	plant	T	postpartum hemorrhage	399
Ipomoea batatas (L.) Poir.	patat douce (Fr)	leaves	T	contraception	NC
Irvingia gabonensis (Aubry-Lecomte ex O'Rorke) Baill.	bègbègma (M), asroma (M)	leaves	T	diarrhea, dysentery, hemorrhoids	482
Jatropha curcas L.	yinkpotin (N), eweakporo (N)	leaves	T, HB, VW	anemia, HBP, malaria, menstruation, stomachache	263, 483
Jatropha gossypiifolia L.	yokpotinmannovo (N)	root	T	anemia	353, 572
Justicia flava (Vahl) Vahl	tchoutchougboutchou (F, S)	leaves, whole plant	T	anemia, menstruation	393
Khaya senegalensis (Desv.) A.Juss.	zouzou (F), kasesral (F)	bark, leaves	A, T, D, HB, VW	abortion, anemia, cysts, fibroids, HBP, infertility, menstruation, postpartum cleanse, postpartum infections, pregnancy, STIs, stomachache, vaginal cleanse	121, 284, 526
Kigelia africana (Lam.) Benth.	gnanblikpo (F)	leaves, bark, fruit	EA, T	breast inflammation, cysts, fibroids, infertility, intestinal cleanse, menstruation, stomachache	249, 342, 396
Lannea acida A.Rich.	akou (T)	bark	T	anemia	282
Lannea barteri (Oliv.) Engl.	houmansitékannon (F)	bark, leaves	T	anemia, menstruation	351
Lantana camara L.	hlatchayo (F)	leaves, whole plant	T, VW	postpartum infections, STIs, vaginal cleanse	NC
Laportea aestuans (L.) Chew	kesukesu (F)	plant	T	menstruation	111
Lippia multiflora Moldenke	yinya (F)	leaves	T, VW	cysts, fibroids, STIs, vaginal cleanse	311

Botanical Name	Local Name[a]	Used part	Preparation[b]	Use category[c]	AMT#[d]
Lippia sp.	aglala (F)	leaves	T, VW	HBP, menstruation, postpartum infections, STIs, vaginal cleanse	NC
Lycopodiella cernua (L.) Pic. Serm.	hingble (F, S)	plant	P, T	childbirth, pregnancy	132
Mallotus oppositifolius (Geiseler) Müll.Arg.	adji (T), cecewima (M)	plant, leaves	E, T	intestinal cleanse, postpartum cleanse, postpartum infections	168
Mangifera indica L.	amangagoto (F, G, N)	leaves, bark	HB, T	anemia, pregnancy	191, 382
Manihot esculenta Crantz	kootema (F)	leaves	D	anemia	NC
Melaleuca leucadendra (L.) L.	kpimansin semeton (S)	leaves	D	childbirth	395
Merremia tridentata (L.) Hallier f.	fakale (G)	leaves	T	infertility	NC
Milicia excelsa (Welw.) C.C.Berg	lokoma (F)	leaves	T	contraception	NC
Millettia thonningii (Schum. & Thonn.) Baker	assandjouman (S)	leaves	T	postpartum hemorrhage	398
Millettia thonningii (Schum. & Thonn.) Baker	assoinssoin (F), otietie (G, N)	leaves, bark	T	anemia, galactagogue, infertility, intestinal cleanse, pregnancy, vaginal cleanse	501
Mimosa quadrivalvis var. *leptocarpa* (DC.) Barneby	ahossiboasa (F)	leaves	T, D	HBP, childbirth, HBP, pregnancy	302, 581
Mitragyna inermis (Willd.) Kuntze	lagpatima (M)	leaves	T	STIs	171
Momordica charantia L.	gninsinkin (F)	plant, fruit, leaves	EA, E, T, VW	abortion, anemia, contraception, HBP, intestinal cleanse, postpartum infections, STIs, pregnancy, vaginal cleanse	361
Monodora myristica (Gaertn.) Dunal	sassalikoun (F)	bark, seeds	A, T, V, VW	anemia, galactagogue, infertility, menstruation, postpartum infections, STIs	119, 184, 308
Morinda lucida Benth.	koinsido (F)	leaves, root, bark	A, T	abortion, anemia, contraception, cysts, fibroids, intestinal cleanse, postpartum cleanse, menstruation	112, 321
Moringa oleifera Lam.	kpatiman (F, G), patovide (M)	leaves, bark	E, P, T, VW	childbirth, cysts, fibroids, HBP, STIs, pregnancy	NC
Newbouldia laevis (P.Beauv.) Seem.	dèsèsiigièma (F), akoko (N)	leaves	T, D	anemia, HBP, pregnancy	NC
Nicotiana cf. *tabacum* L.	azoma (F)	leaves	V	galactagogue	NC
Ocimum americanum L.	hissihissi (F)	plant, leaves	T, HB, VW	postpartum infections, pregnancy, STIs, vaginal cleanse	701
Ocimum basilicum L.	kesukesu (M)	leaves	T	menstruation	143
Ocimum gratissimum L.	tchayo (F, G), koumoba (T)	leaves, whole plant	D, T, VW, HB	anemia, breast milk purifier, contraception, intestinal cleanse, menstruation, postpartum cleanse, postpartum infections, pregnancy, STIs, vaginal cleanse	NC
Ocimum sp.		plant, leaves	E, EA, T, D, VW	anemia, fatigue, HBP, infertility, intestinal cleanse, menstruation, muscle pain, postpartum infections, pregnancy, STIs, vaginal cleanse, vaginal infections	NC

Botanical Name	Local Name[a]	Used part	Preparation[b]	Use category[c]	AMT#[d]
Olax subscorpioidea Oliv.	mitindo (F, G, N)	root	T	cysts, fibroids, infertility, intestinal cleanse, menstruation	329
Oldenlandia affinis (Roem. & Schult.) DC.	ahonhoun (F, G)	plant, leaves	T	childbirth, infertility	206, 313
Parinari curatellifolia Planch. ex Benth.	iyafo (T)	leaves	E	pregnancy	650
Parkia biglobosa (Jacq.) G.Don	ahouagoto (F)	leaves, bark, seeds	T, D, P, EN	hemorrhoids-internal, HBP, postpartum cleanse	384
Paullinia pinnata L.	hèdoulifindo (F)	root, leaves	A, E, D, T, VW	anemia, contraception, HBP, menstruation, pregnancy	125
Pavetta corymbosa (DC.) F.N.Williams	lohou (F)	root, leaves	D, T, VW	infertility, pregnancy, vaginal cleanse	312
Pennisetum cf. *glaucum* (L.) R.Br.	mil (Fr)	leaves	D, T	anemia	NC
Peperomia pellucida (L.) Kunth	fifaman (F)	leaves	T	infertility	323
Pergularia daemia (Forssk.) Chiov.	abognfufu (T)	leaves	E	galactagogue, pregnancy	283, 640
Periploca calophylla (Baill.) Roberty	honman (F)	leaves	T	pregnancy	NC
Persea americana Mill.	avocaman (F, G)	leaves	T, D	anemia, HBP, malaria, pregnancy	NC
Phaulopsis ciliata (Willd.) Hepper	chouchougrouchou (F)	plant		protection against spirits	200
Phyllanthus amarus Schumach. & Thonn.	hlinwé (F, G)	plant, leaves	E, T, VW	HBP, intestinal cleanse, menstruation, postpartum cleanse, pregnancy	239, 344, 642
Phyllanthus muellerianus (Kuntze) Exell	agemukogu (T)	root	T	anemia	296
Phymatosorus scolopendria (Burm. f.) Pic. Serm.	degoma (F, G, N)	leaves	VW, T	STIs, pregnancy	120, 377
Physalis cf. *angulata* L.	korogba (N)	plant	T, VW	STIs, vaginal cleanse	NC
Piper guineense Schumach. & Thonn.	piment du guinea (Fr)	fruit, leaves	E, T	contraception, CBD loudjo, pregnancy	NC
Platostoma africanum P.Beauv.	koumobaokuta (T)	leaves	E	pregnancy	648
Polygala arenaria Willd.	mli (F)	plant		infection	205
Portulaca oleracea L.	denkama (F)	plant	EA	pregnancy	110
Prosopis africana (Guill. & Perr.) Taub.	kakema (F)	plant	T, HB, VW	postpartum infections	NC
Psidium guajava L.	guave (Fr)	fruit	E	pregnancy	NC
Pterocarpus erinaceus Poir.	kosso (G, S), eweakpekpe (N)	bark, leaves	T	anemia, cysts, fibroids, menstruation	379
Pterocarpus santalinoides DC.	gbètin (F)	leaves	T	infertility, stomachache	NC
Pycnanthus angolensis (Welw.) Warb.	yayado (F)	root	T	anemia	NC
Raphia sp.	dema (F, M)	wood, leaves	T	placenta removal	NC
Rauwolfia vomitoria Afzel.	vonmausin (G)	leaves	T	pregnancy	374
Rhaphiostylis beninensis (Hook.f. ex Planch.) Planch. ex Benth.	kplakplakando (F)	wood, leaves, root	T, D	intestinal cleanse, menstruation, postpartum cleanse	129 500
Ricinus communis L.	tondedji (F)	leaves	D	abortion, intestinal cleanse, menstruation	NC
Rourea coccinea (Schumach. & Thonn.) Benth.	vikplomba (F, G, S)	leaves	T, E	anemia, infertility	167
Sabicea calycina Benth.	aviama (F, S)	plant, leaves	VW	STIs, pregnancy	391
Saccharum officinarum L.	canne asucre (Fr)	stem	T	anemia	NC
Sansevieria sp.	kpoyando (G)	root	T	infertility	NC

Botanical Name	Local Name[a]	Used part	Preparation[b]	Use category[c]	AMT#[d]
Sarcocephalus latifolius (Sm.) E.A.Bruce	kodo (F, G), umbesi (T)	root	T, M, D	abortion, anemia, childbirth, cysts, fibroids, galactagogue, infertility, intestinal cleanse, menstruation, postpartum cleanse, postpartum infections, pregnancy, stomachache	295
Schwenkia americana L.	zron (F)	plant	D, T	childbirth, pregnancy	324, 352
Secamone afzelii (Roem. & Schult.) K.Schum.	zoucoutou (F), anonsiman (F)	plant, leaves	E, T	anemia, galactagogue, infertility, postpartum infections, pregnancy	322, 349, 639, 597
Securidaca longipedunculata Fresen.	abiwèrè (F, G, N)	leaves	T, D, VW	childbirth, infertility, menstruation, postpartum cleanse, pregnancy, vaginal cleanse	318, 336
Senna alata (L.) Roxb.	amasou (F)	leaves, flower	T, A	cysts, fibroids, intestinal cleanse, menstruation	343, 502
Senna italica Mill.	agwègbé (F)	leaves	D, T	constipation, intestinal cleanse	307
Senna obtusifolia (L.) H.S.Irwin & Barneby	kpanwoun (S)	leaves	T	anemia	NC
Senna occidentalis (L.) Link	agonlika (F), ajambulu (T)	leaves	EN	intestinal cleanse	241
Senna siamea (Lam.) H.S.Irwin & Barneby	cassia (F, M)	leaves	T, HB	abortion, childbirth, postpartum cleanse, CBD loudjo, menstruation, pregnancy	165
Sesamum indicum L.	sesame (Fr)	plant, seeds	E, A	menstruation, postpartum infections, pregnancy	NC
Sida acuta Burm.f.	agbegbema (F), etchokotou (G, N)	leaves, root, whole plant	D, E, T, VW	contraception, intestinal cleanse, menstruation, postpartum cleanse, pregnancy	509, 534, 611
Sida cf. *cordifolia* L.	agbidi (F)	leaves	T	postpartum hemorrhage	NC
Smilax anceps Willd.	aglbaliklaklan (F)	root		cysts, fibroids, menstruation	186
Solanum aethiopicum L.	gblèman (F)	leaves	EA	STIs, vaginal cleanse	566
Sorghum arundinaceum (Desv.) Stapf	jehooma (M)	leaves	T	STIs	172
Sorghum bicolor (L.) Moench	adako (F), okaono (T)	leaves	T	anemia, menstruation	247
Sorghum sp.	le sorgho (Fr)	seeds	EA	infections	NC
Spathodea campanulata P.Beauv.	adade (G, N, S)	plant, leaves, bark	T, VW	HBP, infertility, menstruation, pregnancy, STIs	363, 390
Spondias mombin L.	akikon (F)	leaves, bark	T, VW	HBP, malaria, menstruation, vaginal cleanse	128, 360, 494, 635
Stachytarpheta cayennensis (Rich.) Vahl	alotrohe (S)	plant	T	menstruation	387
Stereospermum kunthianum Cham.	adjadey (T)	leaves, root	E, CS	pregnancy	643
Strophanthus hispidus DC.	tchakpa (F), inchao (T)	root, leaves	E, T	childbirth, cysts, fibroids, menstruation, pregnancy, stomachache	277, 350, 358
Struchium sparganophorum (L.) Kuntze	acodigoue (S)	plant	T	anemia	385
Syzygium aromaticum (L.) Merr. & L.M.Perry	atinkingbadota (F)	flower buds	T, V, A, VW	anemia, galactagogue, contraception, infertility, intestinal clenase, menstruation, postpartum infections, STIs	116
Syzygium guineense (Willd.) DC.	mlammido (N)	root	VW	vaginal cleanse	NC
Tapinanthus globiferus Tiegh.	hansimlin (F)	leaves	T	anemia	571
Tectona grandis L.f.	teckdo (F)	leaves, root	HB, T	anemia	NC

Botanical Name	Local Name[a]	Used part	Preparation[b]	Use category[c]	AMT#[d]
Terminalia glaucescens Planch. ex Benth.	alotoun (F)	root, leaves	T, VW	intestinal cleanse, menstruation, vaginal cleanse	305, 627
Tetrapleura tetraptera (Schum. & Thonn.) Taub.	lindja (F)	fruit	VW, T	infertility, menstruation, postpartum infections, STIs, vaginal cleanse	304
Tridax procumbens (L.) L.	kpokpo (F, G)	plant	T	anemia, cysts, menstruation	512
unidentified (AMT 271)	indi (T)	root	T	postpartum infections	271
Uvaria chamae P.Beauv.	aylahado (F)	root, leaves	T	anemia, infertility, menstruation, pregnancy	126, 529
Vepris verdoorniana (Exell & Mendonça) Mziray	agbede (S)	leaves	T, VW	anemia, contraception, infertility, menstruation	386
Vernonia amygdalina Delile	amavive (F)	leaves, whole plant	E, HB, T	galactagogue, postpartum infection, pregnancy, vaginal cleanse	491, 645
Vitex doniana Sweet	foman (F)	leaves, root	T, A	hemorrhoids, menstruation	570
Waltheria indica L.	atasu yonunuvima (F), misomituwey (M), kasa (T)	Plant, leaves, root	D, T	anemia, infertility, intestinal cleanse, menstruation, postpartum hemorrhage	130, 253, 565
Xylopia aethiopica (Dunal) A.Rich.	kpédjrékoun (F)	fruit	T, A, VW	anemia, contraception, infertility, menstruation, postpartum infections, STIs	NC
Zanthoxylum sp.	heja (M)	leaves	T	intestinal cleanse	NC
Zanthoxylum zanthoxyloides (Lam.) Zepern. & Timler	hêdo (F), chanuwele (T)	bark, root, leaves	T, A, E	abortion, anemia, contraception, hemorrhoids- internal, intestinal cleanse, postpartum cleanse, menstruation, pregnancy, postpartum infections, STIs	145, 288, 654
Zapoteca portoricensis (Jacq.) H.M.Hern.	akanmoun (F)	root	T, A	abortion, contraception	NC
Zea mays L.	gbade (F)	flower stigmas (silk), fruit	T, D, E	anemia, galactagogue, cysts, fibroids	NC
Zingiber officinale Roscoe	ata (T)	rhizome	A, T	cysts, fibroids, hemorrhoids- internal	NC

[a] Local languages are abbreviated: (F)= Fon; (Fr)= French; (G)= Goun; (M)= Mina; (N)= Nago; (S)= Seto; (T)= Tcha.
[b] Preparations are abbreviated: (A)= soaked in alcohol; (CS)= chew and spit; (D)= drink; (E)= eat; (EA)= external application; (EN) = enema; (HB)= herbal bath; (J)= juice; (M)= massage; (P)= powder; (T)= tea; (TC) = touch contact; (V)= vapor; (VW)= vaginal wash; (W)= waistband
[c] Use category abbreviations are as follows: CBD= cultural bound disease; HBP = high blood pressure; STIs= sexually transmitted infections.
[d] Botanical voucher number and collector initials; NC= not collected.

Appendix 2

Species cited in 41 women's health questionnaires in Gabon: scientific botanical name, name local language(s), used plant part, preparation, use category and collection number

Botanical Name	Local Name[a]	Used part	Preparation[b]	Use category[c]	AMT#[d]
Abelmoschus esculentus (L.) Moench	etatam (F), gombo (Fr), dongodongo(B), mibodo (B)	leaves, fruit	EN, VI, E	childbirth, pregnancy	845
Abutilon mauritianum (Jacq.) Medik.	odongi		D or EN	childbirth	NC
Acalypha paniculata Miq.	oekoenkoenakoen (F)	leaves	VI	childbirth, pregnancy	844
Acanthus montanus (Nees) T.Anderson	nvovo (F), pachango (M)	leaves	EN, D, E, T	childbirth, galactagogue, menstruation	1367, 1317
Aframomum citratum (C.Pereira) K.Schum.	azum (F)	leaves, root	EN	menstruation, stomachache before delivery	NC
Aframomum giganteum (Oliv. & D.Hanb.) K.Schum.	obadzom (F)	fruit	SiB	pregnancy	NC
Aframomum sp.	piment indigiene (Fr), ontonou (Ob)	fruit, leaves, stem	S, VI, EN, EA, D	hemorrhoids, pregnancy, stomachache, vaginal cleanse	1152
Afrostyrax cf. sp.	mujumbu	bark	EN, D	infertility, postpartum infections	NC
Ageratum conyzoides (L.) L.	etombijoro (Om), hediki (M)	plant, leaves	VI, D	menstruation, vaginal cleanse	1318
Albizia sp.	evovule sak (F)	leaves, plant	VI, EN	cyst, stomachache, vaginal cleanse	876, 1228
Alchornea cordifolia (Schumach. & Thonn.) Müll.Arg.	bonjay (B, M), nkabi (F), mabonja (S), mabunzi (Ok), mobonzibonzi (Os)	leaves, plant	D, T, VW, VI	anemia, HBP, malaria, STIs, vaginal cleanse	827, 838, 870, 1180, 1186, 1295, 1408
Allium cepa L.	oignon (Fr)	stem	T	HBP	NC
Allium sativum L.	ail (Fr)	stem	T	HBP	NC
Alstonia cf. *boonei* De Wild.	ekoek (F)	bark	D	vermifuge	855
Alstonia congensis Engl.	makouka (B), okouka (M)	bark	T, D	bodyache, galactagogue, menstruation, stomachache	846, 1190
Amaranthus cruentus L.	folon (F)	leaves, plant	EN, E	childbirth, contraception	1240
Amaryllidaceae sp.	molongu (F)	tuber	EN	pregnancy	869
Annickia affinis (Exell) Versteegh & Sosef	nfo (F)	bark	D, T, VW, VI	anemia, childbirth, HPB, pregnancy, STIs	NC
Annona cf. *senegalensis* Pers.		root	D	HBP	NC
Annona muricata L.	corossolier (Fr)	leaves, bark	T, EN	HBP, pregnancy	871
Anonidium mannii (Oliv.) Engl. & Diels	ebom (F)	bark	EN	protect fetus, pregnancy	NC
Anthocleista cf. sp.	ayindo (F)	bark	T	HBP	765
Anthocleista vogelii Planch.	monduando (B, M)	bark, leaves	D, E	general good health, HBP, menstruation, STIs	1258

Botanical Name	Local Name[a]	Used part	Preparation[b]	Use category[c]	AMT#[d]
Antrocaryon klaineanum Pierre	angokon (F)	bark	T, EN, VW	anemia, galactagogue, infertility, placenta removal, postpartum cleanse, postpartum infections, pregnancy, STIs, vaginal cleanse	767, 1204
Aoranthe cladantha (K.Schum.) Somers	tchege (B, M), ibanzao (M)	bark	T, D	galactagogue, infertility, menstruation	896, 1230, 1300
Asparagus warneckei (Engl.) Hutch.		leaves, plant	E, EN	vaginal cleanse, menstruation	1230
Asplenium cf. *africanum* Desv.	ayan (F)	plant	SiB	pregnancy	NC
Aucoumea klaineana Pierre	nkomma (F)			disinfectant	823
Baillonella toxisperma Pierre	moabi (F), adzap (F)	bark	D, EN, VW	infertility, menstruation, placenta, postpartum cleanse, postpartum infections, vaginal cleanse, vermifuge	NC
Bambusa vulgaris Schrad	bambou de chine (Fr)	leaves, stem	D, T	HBP	984
Brillantaisia owariensis P.Beauv.	alembetorro (M)	leaves	VI	vaginal cleanse	NC
Caloncoba cf. *welwitschii* (Oliv.) Gilg	miamongon (F)	bark	VI	vaginal cleanse	NC
Canna indica L.	ekonzok (F)	leaves	HB	headache	1233
Capsicum annuum L	petite piment (Fr)	fruit, seeds	EN, T, VW	backache, childbirth, galactagogue, hemorrhoids, postpartum cleanse, postpartum infections, stomachache, vaginal cleanse	NC
Carapa procera DC.	pongabonga (M)	bark	D	contraception	NC
Carica papaya L.	papaya (Fr)	fruit, leaves, root	E, EN, T	galactagogue, contraception, HBP, STIs	NC
Carpolobia alba G.Don	onong (F)	root, leaves	D, E	childbirth, HBP	NC
Cecropia cf. *peltata* L.	parasolier (Fr)	root	D	infertility	NC
Ceiba pentandra (L.) Gaertn.	baobab (Fr)	bark	D	anemia	882
Chromolaena odorata (L.) R.M.King & H.Rob.	langalanga (Ob)	leaves	EA	sores	1178
Cissus aralioides (Welw. ex Baker) Planch.	agondjie (F)	leaves	EN	menstruation	867
Cissus cf. *oreophila* Gilg & M.Brandt		cord, plant, leaves	T	pregnancy, menstruation	1296
Citrus aurantiifolia (Christm.) Swingle	citron (Fr)	fruit	D, T	HBP, malaria, postpartum hemorrhage, pregnancy	NC
Cleistopholis cf. *glauca* Pierre ex Engl. & Diels	nohoney (Ok)	cord	W	pregnancy	NC
Cleistopholis cf. *patens* (Benth.) Engl. & Diels	ohoey (B)	cord	W	pregnancy	1279
Clerodendrum formicarum Gürke		plant	EN	pregnancy	1236
Coelocaryon preussii Warb.		bark	T	anemia	1305
Cola nitida (Vent.) Schott & Endl.	ngwan (F)	seeds, bark	EN	CBD les urines, childbirth	NC
Cola sp.	kola (F)	seed, bark	D, VW, E	childbirth	NC
Combretum aphanopetalum Engl. & Diels	otoelefok (F)	leaves	VI	vaginal cleanse	866
Combretum racemosum P.Beauv.	mosombasomba (Ok)	leaves	VI	vaginal cleanse	NC

Botanical Name	Local Name[a]	Used part	Preparation[b]	Use category[c]	AMT#[d]
Commelina cf. *diffusa* Burm.f.	essang (F)	leaves	VI	vaginal cleanse	1362
Costus afer Ker Gawl.		flower	T	STIs	NC
Costus sp.	myen (F)	plant, leaves	HB, D, EN	anemia, fibroids, cysts, galactagogue, pregnancy, menstruation, postpartum hemorrhage, vaginal cleanse, vermifuge	NC
Cucumeropsis mannii Naudin	inzaka (B, M), concombre traditionnel (Fr)	fruit, seeds	D, E	childbirth, infertility	854
Cyathula prostrata (L.) Blume	diztaztu (Ok), chabanakoko (B)	flower, plant		HBP, vaginal cleanse	1294, 1400
Cylicodiscus gabunensis Harms	edum (F)	bark	D, HB, T	anemia, pregnancy, vermifuge	NC
Cymbopogon citratus (DC.) Stapf	tisane (Fr)	leaves	T	HBP	NC
Cymbopogon sp.	citronelle (Fr)	leaves, root, stem	SB, D, T	HBP, STIs, pregnancy	NC
Dacryodes cf. *edulis* (G.Don) H.J.Lam	osigi (Ob)	leaves	VI	vaginal cleanse	1181
Daniellia klainei A.Chev.	oengay (B)	bark	T	contraception	1268
Desmodium adscendens (Sw.) DC.	obumen zeney (F)	leaves	E	infertility	NC
Dinophora spenneroides Benth.	massessi (B)	leaves	VI	vaginal cleanse	1194
Dioscorea bulbifera L.	ebouba (M)	fruit	EA	abscesses	1312
Dioscoreophyllum volkensii Engl.	tziga (F)	plant	D	postpartum hemorrhage	1249
Drypetes sp.	esop (F)	innerside bark	VI	vaginal cleanse	878
Elaeis guineensis Jacq.	essong (F)	heart, oil, leaves	E, D	contraception, galactagogue, infertility, placenta removal	NC
Emilia coccinea (Sims) G.Don	alonvoe (F)	leaves	D	menstruation	825
Ethulia cf. *conyzoides* L.f.		leaves	VI	postpartum infections	NC
Euphorbia hirta L.	derebelli (Os)	plant	E	childbirth	1411
Ficus cf. *thonningii* Blume	atak (F)	bark	D, EN, HB	galactagogue, infertility, pregnancy	NC
Ficus exasperata Vahl	ako (F)	bark	D	childbirth, pregnancy	848
Ficus mucuso Welw. ex Ficalho	ekoko (F)	leaves, bark	D, T	anemia, backache	826
Flagellaria cf. *guineensis* Schumach.	enganisang (F)	leaves	EN	postpartum hemorrhage	NC
Fleroya ledermannii (K.Krause) Y.F.Deng	tobu (M), epoukou (M)	bark	D	contraception, infertility, menstruation, pregnancy	897
Funtumia africana (Benth.) Stapf	otanda (B)	bark	D, T	galactagogue	1287
Gnetum africanum Welw.	nkoumou (Ob)	leaves	E	pregnancy	824
Gossypium barbadense L.	coton (Fr)	leaves	T, D	HBP, postpartum hemorrhage	NC
Gouania longipetala Hemsl.	musangia (B)	bark	D	vaginal cleanse	1276
Guibourtia tessmannii (Harms) J.Leonard	obaka (B, M), kevasingo (F)	bark	D, T	diabetes, HBP, infertility, postpartum hemorrhage, pregnancy	764
Halopegia azurea (K.Schum.) K.Schum.		leaves	L	pregnancy	NC
Harungana madagascariensis Lam. ex Poir.	atuin (F)	leaves	HB, E, D	HBP, postpartum infections, pregnancy	NC

Botanical Name	Local Name[a]	Used part	Preparation[b]	Use category[c]	AMT#[d]
Heterotis rotundifolia (Sm.) Jacq.-Fél.	ekaso (F)	plant	VI	vaginal cleanse	1248
Heterotis sp.	ekaso (F)	plant	VI	STIs	NC
Hibiscus sp.	lesseille (F)	flower, leaves	D, E, VI	anemia, vaginal cleanse, pregnancy	NC
Hymenocardia acida Tul.	onganana (Ob)	leaves	D	galactagogue	1155
Hymenocardia ulmoides Oliv.	esang (F)	leaves	VI	stomachache, vaginal cleanse	847
Inga edulis Mart.		seeds	VW	fibroids, cysts	NC
Irvingia gabonensis (Aubry-Lecomte ex O'Rorke) Baill.	andofan (F), mangue sauvage (Fr)	fruit, bark	D, EN	galactagogue, infertility, menstruation	1356
Justicia secunda Vahl	fleur rouge (Fr)	plant, leaves	T	anemia	805, 986
Keetia sp.	ratta (F)	bark, leaves	D, VI	infertility, menstruation, vaginal cleanse	766
Lagenaria cf. sp.	calabasse (Fr), londuh (F)	fruit	B	placenta removal	NC
Laggera cf. *alata* (D.Don) Sch.Bip. ex Oliv.	tabac de pygmée (Fr)	leaves	D	fibroids, cysts	NC
Landolphia cf. *owariensis* P.Beauv.	pondzie	leaves	D	anemia, galactagogue, contraception	NC
Lantana camara L.		leaves	T	malaria	1188
Laportea cf. *aestuans* (L.) Chew	terakun (F)	plant	E, VI	childbirth	NC
Laportea cf. *ovalifolia (Schumach. & Thonn.) Chew*	dipakazangoue (Ok)	leaves		contraception	NC
Leea guineense G.Don	mbala (Om)	bark	D	childbirth	NC
Leguminosae sp.		bark	T	menstruation	1304
Lippia adoensis Hochst. ex Walp.	mututu	leaves	T	galactagogue	NC
Lippia cf. *rugosa* A.Chev.	afing (F)	leaves	T	galactagogue	760
Lippia multiflora Moldenke	punya (S), tisane sauvage (Fr)	leaves	T	HBP, galactagogue	1410
Lippia sp.	lewayi (Ob)	leaves	D	menstruation, postpartum cleanse, postpartum hemorrhage	1179
Macaranga spinosa Müll.Arg	asas (F)	leaves	HB, E, SB, VI	pregnancy, menstruation, vaginal cleanse, diarrhea	1192, 1197
Maesopsis eminii Engl.	enkale (F), mongobe (B)	bark	EN, T	infertility, galactagogue	879
Mangifera indica L.	mangue (Fr)	bark, leaves	VW, T	menstruation, postpartum infections, STIs, stomachache	839
Manihot esculenta Crantz	manioc (Fr)	leaves, tuber	E, EN, D	childbirth, galactagogue, postpartum hemorrhage, pregnancy	NC
Mikania chenopodifolia Willd.	madamoiselle (Fr)	plant	SiB	pregnancy	1242
Milicia excelsa (Welw.) C.C.Berg	abang (F)	leaves, bark	D	galactagogue	835, 836, 1368
Millettia cf. *versicolor* Baker	banjanjoko (B)	bark	T	general good health	1306
Momordica charantia L.	mabululu	leaves	D	contraception	NC
Morinda lucida Benth.	akon (F)	bark	HB, T, EN	HBP, intestinal cleanse, pregnancy	1213

Botanical Name	Local Name[a]	Used part	Preparation[b]	Use category[c]	AMT#[d]
Musa sp.	umbolokon (F)	leaves, fruit, bark	D, E, EN, SB	anemia, backache, childbirth, galactagogue, menstruation, placenta removal, STIs, vaginal cleanse, vermifuge	NC
Musanga cecropioides R.Br. ex Tedlie	mohombo (B)	leaves	D	childbirth	985, 1309
Myrianthus arboreus P.Beauv.	angokon (F)	bark	D, EN	pregnancy, postpartum cleanse, postpartum infections	853, 1073
Nicotiana tabacum L.	taba (F)	leaves	EN	CBD zchaw, pregnancy	NC
Nymphaea lotus L.	otoetoe (F)	leaves	VI	vaginal cleanse	NC
Ocimum americanum L.	sizey (S)	leaves	T, D	galactagogue, placenta, postpartum cleanse	1407, 1142
Ocimum gratissimum L.	messep (F), masipetzipo (Os)	leaves, plant	D, T, VI	galactagogue, malaria, menstruation, pregnancy, vaginal cleanse, vaginal cleanse	1072, 1409, 1412, 1143
Ocimum sp.	dziandzie (P)	leaves	D	fibroids, cysts	NC
Oryza sativa L.	riz (Fr)	seed	E	galactagogue	NC
Passiflora foetida L.	ejeszum (F)	stem, leaves	EN	infertility, vermifuge	849
Pentaclethra macrophylla Benth.	mpandzi (M), ompie (T)	bark, fruit	EN, D, VW, E	pregnancy, stomachache, vaginal cleanse	1077, 1263
Perichasma cf. *laeticata* Miers	enzigue (F)	root	E	pregnancy	NC
Periploca nigrescens Afzel.	alarminson (F)	leaves	VI	vaginal cleanse	NC
Persea americana Mill.	avocat (Fr)	leaves	T, VI	HBP, vaginal cleanse	982
Petersianthus macrocarpus (P.Beauv.) Liben	abing (F)	bark, leaves	L, SiB, D, S, VI	anemia, backache, pregnancy, vaginal cleanse	1220
Phyllanthus sp.	kanguh (F)	plant	VI	vaginal cleanse	1245
Picralima nitida (Stapf) T.Durand & H.Durand	dumavendo (B, M)	fruit, bark	EN, D	fibroids, cysts, malaria, vermifuge, HBP	1250, 1316
Piper umbellatum L.	abomanzan (F)	plant, leaves	SiB, EN, SB	hemorrhoids, infertility, placenta removal, pregnancy, vaginal cleanse	761
Piptadeniastrum africanum (Hook.f.) Brenan	nlouey (F)	leaves, bark	L, EN	CBD mfoes, infertility	1219
Pistia cf. *stratiotes* L.	angoun (F)	plant	E	infertility	NC
Plagiocladus diandrus (Pax) Jean F.Brunel	mbango (B)	leaves	E	anemia, HBP	1260
Plagiostyles africana (Müll.Arg.) Prain	eleesula (F)	bark	EN	menstruation, postpartum infections	NC
Plectranthus monostachyus (P.Beauv.) B.J.Pollard	echipo (M)	plant	D	headache	1319
Poga oleosa Pierre	oayko (M)	plant	EA	sores	1314
Portulaca oleracea L.	dikamiya (Ok)	leaves	T	childbirth	1402
Pseudospondias longifolia Engl.	ofoss (F)	bark	D, EN, T	anemia, stomachache	1081
Psidium guajava L.	guave (Fr)	leaves	SB	malaria, vaginal cleanse	NC
Pteridium aquilinum (L.) Kuhn	ebango (B)			childbirth	1274

Botanical Name	Local Name[a]	Used part	Preparation[b]	Use category[c]	AMT#[d]
Pterocarpus soyauxii Taub.	umbel (F), kaolin rouge (Fr)	bark	D, T, SiB	anemia, galactagogue, inferility, placenta removal, pregnancy, STIs	880, 1203
Pycnanthus angolensis (Welw.) Warb.	mitchoko (B)	bark	T	anemia	NC
Quassia cf. *africana* (Baill.) Baill.	icindural (P)	root	T	HBP	763
Rauvolfia vomitoria Afzel.	tchwele (Ob)	bark	SiB	menstruation	1161
Saccharum officinarum L.	canne sucre (Fr)	juice, stem, plant	D, EN, T	fibroids, cysts, HBP, menstruation	829
Santiria cf. *trimera* (Oliv.) Aubrév.	outou (F)	resin, bark	S	CBD zchaw	NC
Sarcocephalus latifolius (Sm.) E.A.Bruce	ondolo (Ob)	fruit, bark	D, EN	galactagogue, stomachache	1156
Scleria boivinii Steud.	zengey (B)	leaves	D	postpartum hemorrhage, stomachache	1307
Scoparia dulcis L.	nzonzo (F), zedsoro (F)	leaves	D	childbirth	1364
Scyphocephalium cf. *ochocoa* Warb.	sogo (F)	bark	E	menstruation	NC
Selaginella myosurus Alston	ehoyi (M), mahoy (B)	leaves	E	pregnancy, HBP	1063, 1198
Senna alata (L.) Roxb.	kinkiliba (F)	leaves	D, T, S	infertility, STIs	1320
Senna occidentalis (L.) Link	ngari (Ob)	leaves	EA, E	stomachache	1184, 1366
Sida acuta Burm.f.	nzisim (F)	leaves, stem, plant	D, EN, W, SiB, VI	childbirth, CBD ona/onyaboom, CBD les urines, pregnancy, postpartum cleanse	828, 1401, 1177, 1406, 1151, 1254, 1237
Solanecio angulatus (Vahl) C.Jeffrey	moyamboa (B)	leaves	D	childbirth	1298
Solanum americanum Mill.	otchango (M)	leaves	E, D	pregnancy	NC
Solanum anguivi Lam.	petit aubergine (Fr), omborоru (Ob)	fruit	D, T	galactagogue, menstruation, postpartum cleanse, postpartum hemorrhage	NC
Solanum lycopersicum Lam.	tomate (Fr)	fruit	D	anemia	NC
Strychnos cf. sp.		bark	SiB	vaginal cleanse	NC
Tabernanthe iboga Baill.	bois sacre (Fr)	root	E	anemia, contraception, HBP	NC
Tetracera alnifolia Willd.	movova/lian-aho (B)		D	STIs	1259
Tetrapleura tetraptera (Schum. & Thonn.) Taub.	tsélé (M)	fruit	T, EN	galactagogue, menstruation, pregnancy	NC
Tetrorchidium didymostemon (Baill.) Pax & K.Hoffm.	zili (F)	bark	D, EN	galactagogue, infertility, menstruation, postpartum infections	875
Theobroma cacao L.	cacaowey (F)	bark, fruit, leaves	D, T	anemia, HBP, postpartum cleanse	872, 1205
Tithonia diversifolia (Hemsl.) A.Gray	magariet (F)	leaves	D	HBP	NC
Treculia cf. *acuminata* Baill.	mpovo (B)	bark	D	fetus strengthener	1262
Treculia erinacea A.Chev.	edzip (F)	bark	T, EN	anemia, infertility	NC
Trichoscypha cf. *bijuga Engl.*	lokouta (B)	leaves	E	HBP	1299
Trichoscypha sp.	aboet (F)	bark	VW	postpartum cleanse	NC
Tristemma cf. *hirtum* P. Beauv.	masessa	leaves	VI	vaginal cleanse	NC
Tristemma littorale Benth.	abillebong (F)	leaves	VI	vaginal cleanse	861, 0873
Tristemma mauritianum J.F. Gmel.		leaves	T	stomachache	1084

Botanical Name	Local Name[a]	Used part	Preparation[b]	Use category[c]	AMT#[d]
unidentified (AMT 1277)	moutey (B)	bark	D	contraception	1277
Urena lobata L	okon (F)	leaves	D	postpartum hemorrhage	1238
Vernonia amygdalina Delile		leaves		stomachache	1189
Xylopia aethiopica (Dunal) A.Rich.	oha (M)	leaves	E	HBP	1321

[a] Local languages are abbreviated: (B)= Babungu; (F)= Fang;(Fr)= French; (M)= Mitsogo; (Ob)= Obamba; (Ok)= Okande; (Om)= Omiene; (Os)= Ossimba; (S)= Sake; (T)= Teke.

[b] Preparations are abbreviated: (B)= blow into it; (D)= drink; (E)= eat; (EA)= external application, (EN) = enema; (HB)= herbal bath; (L)= lay upon; (S)= scarification; (SB)= steambath; (SiB)= sitbath; (T)= tea; (VW)= vaginal wash; (W)= waistband.

[c] Use category abbreviations are as follows: CBD= cultural bound disease; HBP = high blood pressure; STIs= sexually transmitted infections.

[d] Botanical voucher number and collector initials; NC= not collected.

Chapter Four

Traditional medicine and child care in Western Africa: mothers' knowledge, folk illnesses, and patterns of healthcare-seeking behavior

Alexandra M. Towns, Sandra M. Eyi and Tinde van Andel

Published in *PLoS ONE* 9(8): e105972, 2014

Abstract

Background

In spite of the strong role of traditional medicine in childcare in the pluralistic healthcare system in Western Africa, little information is known on mothers' domestic plant knowledge. Identifying local perspectives and treatments of children's illnesses, including folk illnesses, is essential to having a comprehensive understanding of how mothers make healthcare treatment decisions. We aimed to identify which infant illnesses Beninese and Gabonese mothers knew to treat with medicinal plants and for which illnesses they sought biomedical care or traditional healers.

Methods

We conducted 81 questionnaires with mothers in Bénin and Gabon and made 800 botanical specimens of cited medicinal plants. We calculated the number of species cited per illness and the proportion of participants knowledgeable on at least one herbal remedy per illness. Using qualitative data, we described folk illnesses in each country and summarized responses on preferences for each of the three healthcare options.

Results

Participants from both countries were most knowledgeable on plants to treat respiratory illnesses, malaria, diarrhea, and intestinal ailments. Mothers also frequently mentioned the use of plants to encourage children to *walk early*, monitor the closure of *fontanels,* and apply herbal enemas. Major folk illnesses were *atita* and *ka* in Bénin and *la rate* and *fesse rouge* in Gabon. Traditional healers were reported to have specialized knowledge of cultural bound illnesses. Malaria was frequently cited as an illness for which mothers would directly seek biomedical treatment.

Conclusion

Mothers largely saw the three systems as complementary, seamlessly switching between different healing options until a remedy was found. Folk illnesses were found to give insight into local treatments and may reveal important neglected diseases. Due to high reported levels of knowledge on treating top statistical causes of infant mortality and folk illnesses, mothers' medicinal plant knowledge should be included in the analysis of healthcare-seeking behavior for childcare.

Introduction

Sub-Saharan African healthcare is essentially pluralistic, structured around three main systems: biomedical care, traditional healers, and popular knowledge (van der Geest 1997; Nyamongo 2002). In spite of the promotion of biomedicine by international healthcare organizations, traditional medicine remains the primary form of healthcare for more than 80% of African populations (WHO 2008). Traditional medical systems include not only traditional healers, but also the popular knowledge of local populations, known as domestic medicine or home remedies. Most ethnobotanical literature on traditional medicine is concentrated on the knowledge of traditional healers and largely overlooks domestic medicine, the knowledge of women, (Pfeiffer and Butz 2005) and more specifically, the knowledge of mothers (Vandebroek 2013; McDade et al. 2007). Since home remedies (self-treatment with herbs) comprise the majority of African medicine (van der Geest 1997; Pearce 1993; Geissler et al. 2002), domestic knowledge needs to be prioritized in medical research and reinforced in order to improve healthcare and enhance local populations' responses to illness. This point is especially critical in high priority health populations, such as infants and children in sub-Saharan Africa (Black et al. 2010).

African mothers' knowledge of health is directly associated with children's well-being, as women are largely responsible for childcare (Miller 2011; Geissler et al. 2002). Recent ethnobotanical research has found that mothers' knowledge of herbal medicine has a positive effect on child health outcomes, including a decrease in infections (Miller 2011; Tanner et al. 2011). Mothers who had high levels of plant knowledge and use have been shown to have healthier children (McDade et al. 2007) and a greater likelihood to take ill children to a dispensary, suggesting that knowledge in one healthcare domain corresponds with better overall understanding of health (Miller 2011).

In spite of these correlations, biomedical studies have largely measured mother's health-seeking behavior on factors related to biomedical care, such as formal education, distance to provider, and cost of obtaining care (Rutherford 2010). This literature overlooks if and what role local concepts of illness have in treatment choices and results in the loss of incorporating this information into infant health programs (Beiersmann and Sanou 2007). Local concepts of illness include not only local names, perceptions, and symptoms of biomedical illnesses, but also *cultural bound syndromes*, "a group of folk illnesses, each of which is unique to a particular group of people, cultural, or geographical area (Helman 2007). Some scholars have cautioned that the "cultural" component of the term *cultural bound syndromes* emphasizes the biomedical perspective that biological illnesses are more objective than folk illnesses (Helman 2007). We use the term in order to designate those illnesses not generally defined and recognized in biomedicine.

Understanding local perspectives of the treatment of major children's illnesses identified by the WHO (Colvin et al. 2013), such as malaria (Nsungwa-Sabiiti et al. 2004; Beiersmann and Sanou 2007) and diarrhea (de Zoysa et al. 1984; Green 1985), as well as the treatment of children's folk illnesses (Straus et al. 2011; Mogensen 2000), is essential to having a comprehensive understanding of childcare in Africa. In this study, we assessed how mothers make healthcare decisions by identifying which infant illnesses mothers in Western Africa treat with medicinal plants and for which illnesses they seek biomedical care or consult traditional healers. We worked in Bénin and Gabon, two African countries with diverse populations, vegetation types, cultures, and levels of human development. Our research was based on the following research questions: *Which children's illnesses do Beninese and Gabonese mothers treat with medicinal plants? What are the major children's folk illnesses in each country? For which ailments do mothers seek treatment from biomedical doctors? Which illnesses do mothers prefer to be treated by traditional healers?*

Methods

Study areas

Bénin is located in West Africa, with a surface area of 112,622 sq. km and a population of 9.8 million people (CIA 2013a). It is ranked below the Sub-Saharan average in the Human Development Index (HDI) and considered a country of "low human development" (UNDP 2013a). It has an infant mortality ratio of 58 deaths per 1,000 live births (CIA 2013a). Gabon is located in Western Central Africa, with a surface area of 267,667 sq. km, and a population of 1.7 million people (CIA 2013b). The UNDP ranked Gabon 106th in the Human Development Index, slightly above countries of "medium human development" (UNDP 2013b). It has an infant mortality ratio of 48 deaths per 1,000 live births (CIA 2013b).

Data collection and analysis

Between April and October 2011 we worked in rural and urban areas of Bénin, mainly with Fon and Yoruba ethnic groups in the southern departments Collines, Kouffo, Zou, Plateau, Ouémè, Atlantique, Mono, and Littoral (Fig. 1).

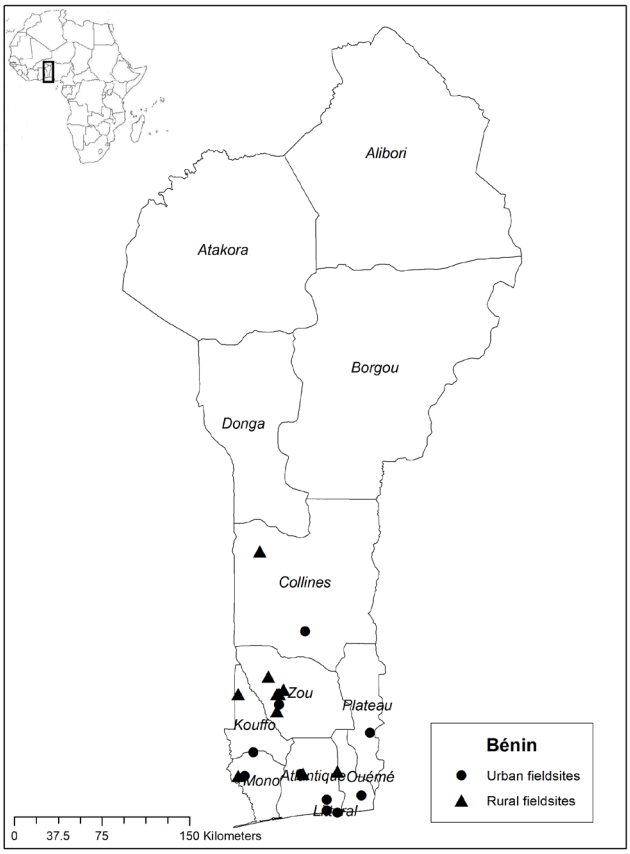


Fig. 1 Map of the Bénin fieldwork sites in 2011

From June until December 2012, we worked with Bantu-speaking ethnic groups in Gabon, namely, the Fang, Mitsogo, Obamba, and Bapounou peoples, in the departments of Estuaire, Woleu-Ntem, Haut-Ogooué, Ngounié, and Ogooué-Ivindo (Fig. 2).

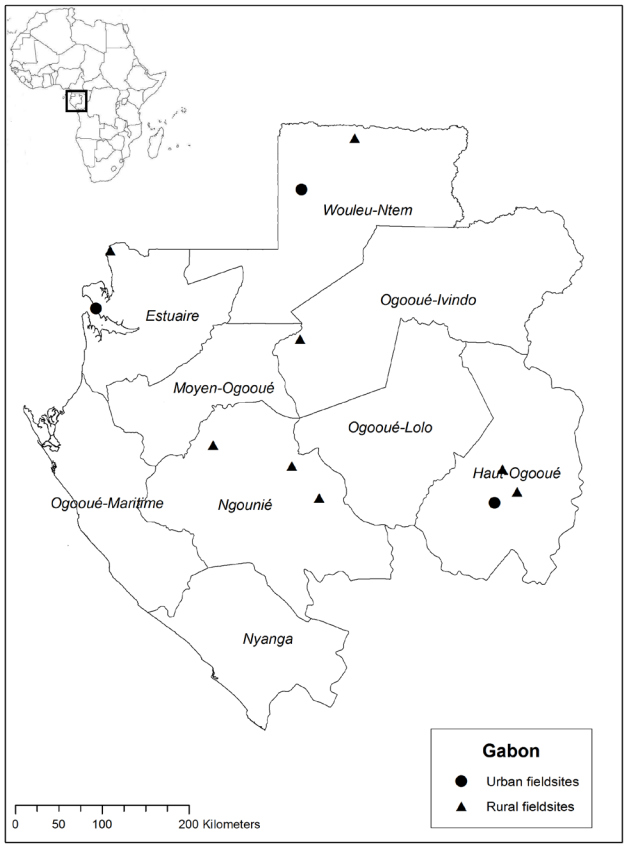


Fig. 2 Map of the Gabon fieldwork sites in 2012

We started our research at the herbal marketplaces in each country, taking time to familiarize ourselves with commonly utilized species, local illnesses and healthcare practices. From these initial market contacts, we utilized snowball sampling to identify women from surrounding urban and rural communities. We conducted an ethnobotanical questionnaire on practices related to childcare, including questions on herbal remedies for specific illnesses, definitions of folk illnesses, and preferences for the three types of healthcare. In total we interviewed 43 Beninese and 38 Gabonese mothers. In Bénin we worked with the following ethnic groups: Fon and related (70%), Yoruba and related (14%), Adja and related (5%) and mixed ethnicities (11%). In Gabon we worked with the following ethnic groups: Fang (45%), Mitsogo (16%), Babungu (16%), Obamba (8%), Bapounu (5%), and other (Ossimba, Omiene, Bateke) (10%). All women received financial compensation equivalent to local salaries for their time and involvement. We conducted the questionnaires orally in French, at participants' homes and workplaces, and employed local language interpreters when needed.
After each of the 81 questionnaires, we accompanied participants to collect the plants that were cited in the interviews. We used standard botanical collection methods to make vouchers of plants from the

surrounding gardens, forests, and savanna landscapes (Martin 2004). For women that we interviewed on the market, we purchased plants directly from market stalls and made trips into the field together to collect fresh samples when possible. In addition to the voucher specimens, we collected detailed information on their use, effects, and local names (see Table S1 and S2). We deposited vouchers of all collected plants at the Herbier National du Bénin (BEN) and the Herbier National du Gabon (LBV). A complete set of duplicates was exported to the Wageningen branch of National Herbarium of the Netherlands (WAG), now merged with Naturalis Biodiversity Center, where the specimens were identified by the research team and several botanical specialists. Our plant collection did not involve endangered or protected plant species.

We assessed mothers' knowledge of domestic medicine by calculating the number of species for each health issue and the percentage of mothers who knew at least one herbal recipe for each illness. We then summarized descriptions of folk illnesses and selected qualitative data from our interviews to illustrate which illnesses mothers treated with the three systems of healthcare: biomedicine, their own plant knowledge, or traditional healers. Maps of the fieldwork locations were created in ArcGIS 10.1 using open source geospatial data from DIVA-GIS (http://www.diva-gis.org/).

Ethics statement

We adhered to all components of the Code of Ethics of the International Society of Ethnobiology (International Society of Ethnobiology 2006), including carefully explaining the nature of our research, receiving oral consent, providing monetary compensation for involvement in the work, anonymizing informants' identities during data analysis, and working in a fully mindful and respectful manner. Oral consent was acquired in place of written consent due to the largely illiterate populations with whom we worked. We followed all research procedures and protocols at Leiden University, Naturalis Biodiversity Center, and the host institutes in each country. For the Bénin fieldwork, we acquired a formal invitation from the Faculté des Sciences Agronomiques, Université d'Abomey-Calavi (UAC), received a research permit (# 041511) from the Faculté des Sciences et Techniques (UAC), and obtained a plant export permit (#0000591) from the Service de la Protection des Vegetaux et du Control Phytosanitaire, Ministre de l'Agriculture, de l'Elevage et de la Peche. For the Gabon fieldwork, the Centre National de la Recherche Scientifique et Technologique (CENAREST) provided a letter of invitation (#176). After approving our research proposal, CENAREST granted research permit (#AR0028/12). We acquired authorization to enter the National Parks of Gabon (#000026) from the Agence Nationale des Parcs Nationaux (ANPN), and authorization to export botanical specimens (#00145, #00219) from the L'Institut de Pharmacopée et de Médecine Traditionelles (IPHAMETRA). We received formal administrative approval from our host institutes and were not required to submit our proposals to a human subjects review board for further review.

Results

Mothers' knowledge of treating biomedical childhood illnesses with plants

Beninese participants cited 255 medicinal plant species and Gabonese participants cited 179 species. All species, together with vernacular names, scientific names and specific uses, are listed in Appendix 1 (Bénin) and Appendix 2 (Gabon). The highest percentages of plants in both countries were used to treat those child illnesses considered to be of major concern by the WHO: diarrhea, respiratory conditions, and malaria. Over 95% of women in Bénin and over 84% of women from Gabon knew at least one recipe to treat those diseases (Table 1). Respiratory-related ailments included illnesses such as the flu, cough, asthma, bronchitis, and specific folk illnesses related to respiratory problems in the case of Gabonese informants. Mothers also mentioned children's ailments such as earache, chicken pox, colic, stomachache and vomiting, which we left out of the table because few plants and treatments were cited.

Children's Folk illnesses in Bénin

Mothers from Bénin mentioned two main folk illnesses, *atita* (Fon) and *ka* (Fon), and several cultural practices. *Atita* was described as a rash with "red bumps coming from the anus" or "itchy and stinging" red bumps in the groin and armpits. It was reported to be caused by the over-consumption of sugar or peanuts by the child or by the mother during pregnancy. The most common treatment for *atita* was an herbal bath or boiled plants consumed as tea (Appendix 1). *Ka* was described as an infection with large red bumps that were caused by the heat. It was reported to be treated by herbal baths, ingested teas, and through applying macerated plants directly to the infection.

The care and maintenance of open *fontanels* was a common practice in Bénin. Mothers' considered it to be important for the soft spot of the fontanel to be able to "breathe" and eventually close. They used various herbal pomades, washes, and ingested teas for young children whom became ill from the failure of the fontanels to close. Beninese mothers highly valued their children to *walk early* in life. They encouraged their children with massages, herbal baths, and ingested teas. *Walking early* was seen as a sign that the child was developing normally and gaining independence, which would enable the mother to rest. Enemas were administered to newborn infants to remove the meconium, as well as to older infants for daily cleanses and constipation relief. These enemas frequently contained ground red peppers (*Capsicum annuum*) or different species of melegueta pepper (*Aframomum* spp.) mixed with water. Strengtheners were used in herbal treatments for premature birth, as newborn strengtheners, and in general to assist an infant's growth. Delayed and stunted growth was explained by mothers to be caused either by malnutrition or if an expectant mother came in contact with a praying mantis (hence the hunched over appearance and thin arms of an infant). It was treated with an herbal bath with an herbal recipe that included the eggs of a praying mantis. Various herbal treatments were applied to the umbilical cord of newborns to hasten the recovery period, as well as the application of herbs to assist in the healing process of circumcision.

Children's Folk Illnesses in Gabon

Gabonese and Beninese mothers shared the cultural practices of monitoring the closure of the *fontanels*, encouraging children to *walk early*, and bathing newborns and young children to give strength. Monitoring the closure of *fontanels* (*abobane* in Fang) in Gabon was considered necessary to avoid "bad wind or spirits" that could enter, resulting in a child's stunted growth. Herbal treatments included applying pomade made from leaves directly to the infants' head and applying peanut butter to the palate of the mouth (Appendix 2). Mothers pointed out that not all children suffered from open *fontanels*. Encouraging children to *walk early* also was seen as the mothers' recuperation of independence; they could do more work because the child could run outside with its siblings. One of the most commonly mentioned Gabonese folk illnesses was known as *fesse rouge* in French (*ntcheke* in the Babungu language, *kusu* in Punu, *tzogho* in Fang, and *kengey* in Teke). Like its literal French translation, the symptoms of *fesse rouge* included a red, irritated bottom caused "by sitting in the dirt," "by microbes," or "during childbirth when heat enters the body through the anus." Treatments included applying herbal pomades and herbal enemas.

Folk illness *la rate (tzit* in Fang and *kabama* in Teke*)* which in English is translated as "the spleen," was characterized by a tender, swollen left side of the body and a skinny overall physical build. An earlier stage of *la rate*, known as *ebem* in Fang, was characterized by high fever and green feces. Although most respondents were not aware of the cause of *la rate*, some participants mentioned God's will, anemia, and malnutrition as possible causes. Treatments included herbal massages, herbal enemas, and traditional "vaccinations"- the creation of small incisions on the left side of the body with a razor blade and application of the fresh juice of plants into the cuts. Folk illness *pogha* (in *Mitsogo* and *Babungu* languages) was characterized by fever, fatigue, convulsions, but distinct from the symptoms of malaria. It was reported to be caused either by God's will or the mother's food consumption when the child was young. Herbal baths were the primary form of treatment. Included in the calculations for respiratory-related ailments (Table 1) were several recipes mentioned by Fang women for respiratory-related folk illnesses, including *onkoe abijel*: "respiratory problems caused by bad water during delivery," *onkouabial*: "bad lungs after birth," and *ebulonkuk*: "bad lungs caused by sorcery."

Mothers' knowledge of treating folk illnesses with plants

Aside from the use of plants for intestinal cleansing, fewer women knew how to treat folk illnesses than biomedical illnesses (Table 1). In Bénin, percentages of mothers who knew recipes for them ranged from 80% for *atita* to 65% for *ka*. In Gabon, over two-third of all participants knew herbal treatments for common children's folk illnesses. Table 1 also shows that folk illnesses are location-specific. With the exception of fontanels and walk early, Beninese CBS like *atita* and *ka* were unknown to Gabonese mothers, while *fesse rouge* and *la rate* were not known in Bénin. Although the terms and perceived causes of *atita* in Bénin and fesse rouge in Gabon do not coincide, the two folk illnesses were somewhat similar in description. The CBS *pogha* was only mentioned as an illness by mothers in the Gabonese department of Ngounie.

Table 1 Children's health issues treated with medicinal plants by mothers in Bénin and Gabon

Health Issue	# species (%) N= 255	#participants[1] (%) N=43	# species (%) N = 179	#participants[1] (%) N=38
	Bénin	Bénin	Gabon	Gabon
respiratory-related	53 (21)	42 (98)	49 (27)	32 (84)
diarrhea	39 (15)	41 (95)	27 (15)	34 (89)
malaria	54 (21)	41 (95)	36 (20)	33 (87)
intestinal cleanse *	58 (23)	41 (95)	31 (17)	33 (87)
measles	34 (13)	37 (86)	17 (9)	30 (79)
strengthener *	59 (23)	40 (93)	21 (12)	22 (58)
fontanels *	31 (12)	35 (81)	23 (13)	28 (74)
post-circumcision	32 (13)	37 (86)	14 (8)	21 (55)
walk early *	22 (8)	28 (65)	17 (9)	29 (76)
umbilical cord	13 (5)	32 (74)	12 (7)	24 (63)
convulsions/crisis*	32 (13)	33 (77)	4 (2)	4 (10)
teething	25 (10)	30 (70)	2 (1)	4 (10)
anti-sorcery *	21 (8)	25 (58)	6 (3)	6 (16)
fever	37 (15)	19 (44)	14 (7)	7 (18)
atita *	31 (12)	35 (81)	-	-
*ka**	26 (10)	29 (67)		-
fesse rouge *	-	-	26 (15)	28 (74)
*la rate**	-	-	34 (19)	26 (68)
*pogha**	-	-	10 (6)	6 (16)

[1]Percentage of mothers from each country who knew at least one herbal recipe
*Folk illness or treatment

Health-seeking behaviors of Beninese mothers

Although there was little consensus on one preference for healthcare (Table 2), Beninese women generally reported starting to treat their children with medicinal herbs, following up with biomedical care, and seeking traditional healers as a third resort. An 80-year old Mina woman said "Traditional medicine is first. Some use the hospital first, for example for fever or if one needs blood. A traditional healer is called upon to consult the *fa* (oracle) and for sacrifices." Women who reported to never consult traditional healers mentioned the church and prayer as spiritual forms of treatment. Self-administered herbal medicine was reported to be preferred for treating children's illnesses due to its ability to help defecate well, its use as preventative medicine, and its perceived effectiveness. Respondents often mentioned using plants to self-treat for a certain number of days (ranging from two days to one week) and then seeking biomedical care. Biomedicine was acknowledged to have the advantage of having advanced technology and materials but was perceived as being more expensive. A 36-year old Yoruba woman said, "Traditional medicine is used for constipation and *atita*- those you

can treat at home. Modern medicine is used for difficult cases- they are better equipped. Traditional healers are consulted for superhuman cases because they know more about this domain." Advanced forms of illnesses, especially malaria, were commonly reported to be treated with biomedicine. Seeking traditional healers to treat victims of sorcery and folk illnesses were strong themes. Traditional healers were reported to treat illnesses "that surpass the knowledge of doctors," and for causes such as sorcery or witchcraft. A minority of mothers reported the common folk illnesses as well as asthma, to be "men's knowledge," outside of the maternal domain of skills. It was not clear if men's knowledge meant the specialized knowledge of (male) traditional healers or more generally, fathers in the community. An 80 year old Fon woman said, "First try to treat at home with herbs for a couple of days. If they do not work, go to the hospital. If this does not work, go to a traditional healer. Asthma and fetus health are men's knowledge. *Fontanels* are traditional healers' knowledge."

Table 2 Most frequent responses by mothers to healthcare seeking options question in Bénin (N=43) and Gabon (N=38)

Response	% of mothers Bénin	% of mothers Gabon
Ranking of three health care options		
First choice self-treatment with plants	42	29
First choice biomedicine (malaria, anemia, fever)	16	32
First choice biomedicine (always)	0	21
First choice traditional healer	7	18
Second choice biomedicine	30	13
Second choice self-treatment with plants	0	11
Third choice traditional healer	23	3
Never consult traditional healer	5	11
Healthcare choice for specific cases		
Traditional healer for sorcery	44	5
Biomedicine for advanced cases (malaria, anemia)	35	5
Self-treat with plants for specific illnesses (diabetes, measles, stomachache)	21	13
Self-treat with plants for simple cases (malaria, diarrhea)	28	0
Traditional healer for specific cases (fontanels, paralysis)	12	8
Men for specific illnesses (walk early, asthma)	9	0

Health-seeking behaviors of Gabonese mothers

There was also a large range of responses from Gabonese women (Table 2). Nearly the same number of Gabonese mothers preferred self-treatment as a first form of healthcare as mothers who preferred treating children first with biomedicine. The strongest consensus of women cited specific illnesses, especially malaria, in which they would seek biomedical care directly. A 40-year old Obamba woman said "Use modern medicine for malaria, etc. We're evolved for serious illness. Use traditional medicine if modern medicine doesn't work, or if it's not serious. A *ganga* is outdated, we no longer use them." However, other women favored the consultation of a *ganga,* the spiritual leader of the community, or the *nyembe*, the spirit in a women's secret society in the Ngounie department, in order to know where to treat the illness. This was a reoccurring theme, suggesting a strong the role of spirituality and religion in childcare, especially for folk illnesses. A 50 year old Fang woman said, "One should seek modern medicine for an operation; injections go straight to the blood and therefore work faster... Traditional medicine depends on God's grace; prayer helps too. Go to a *ganga* for sorcery." We found a reoccurring theme among Gabonese mothers that three systems were largely complementary. A 42-year old Fang woman said: "Try traditional medicine, if it does not work, the *genies* (spirits) will tell you to go to modern medicine. Work with the spirits! Between modern medicine and traditional medicine, there is a good collaboration. Gabon is currently in good position between the two systems." A 61-year old Omiene women said "The three systems are complementary; you will find a solution between the three. It also depends on one's belief system; some people are hesitant to go to a *ganga*."

Discussion and Conclusion

Biomedical illnesses and their treatment

The majority of women in Bénin and Gabon knew herbal treatments to treat the top causes of infant mortality: respiratory problems (98%, 84% respectively), malaria (95%, 87%), and diarrhea (95%, 89%). This outcome suggests that traditional medicine, and more specifically mothers' knowledge of plants, is a major factor in the management of these common childhood health ailments. Even though mothers were knowledgeable on treating these illnesses, however, they also distinguished situations where they would seek biomedical care prior to using domestic medicine, such as complicated cases of malaria, anemia, or fever. Studies in other African countries also found that mothers preferred to treat malaria with biomedical care (Montgomery et al. 2006). Only a few mothers mentioned diarrhea specifically as a case that they would seek biomedical care as a first option, suggesting diarrhea is largely treated by mothers with plants as was found in a recent study in Sierra Leone (Bakshi, McMahon, and George 2013). Likewise, respiratory ailments were not specifically mentioned as a case for seeking biomedical care. The high percentage of women who know how to treat these illnesses and the high number of plants attributed to their treatment suggest a parallel recognition of major causes of infant morbidity and mortality between the mothers and the statistics of the WHO, indicating agreement between local and biomedical priorities for children's health. This agreement between medical priorities is not always the case, in a similar study on women's health in Bénin and Gabon, we found that local and biomedical priorities did not coincide (Towns and van Andel 2014).

Folk illnesses and their treatment

Folk illnesses ranked directly after the major biomedical illnesses for children in terms of mothers' medicinal plant knowledge. Our research supports ethnobotanical studies from other parts of the world that have indicated local populations commonly prefer to treat folk illnesses with traditional medicine (Vandebroek 2013; Quinlan 2010; Mathez-Stiefel, Vandebroek, and Rist 2012). While many participants in our study knew herbal remedies to treat folk illnesses, it is clear that traditional healers and religion have a strong role in this domain. Men, more generally speaking, were also regarded as having specialized knowledge in Bénin. Fathers also have a role in the treatment of children's illnesses, in terms of their own knowledge of medicinal plants (McDade et al. 2007) and their role in family decision-making (Montgomery et al. 2006).

Folk illnesses are of interest to biomedical health care providers, not only because they often make up a significant portion of local health complaints (Vandebroek 2013) but they may address underlying neglected diseases. Fontanels are common children's folk illnesses around the world, and in other African countries such as Swaziland, Zimbabwe, Botswana and Malawi (Kay 1993). Certain (bulging or sinking) appearances of the fontanels may be symptoms of a range of disorders from dehydration to malnutrition to Down Syndrome (Kiesler and Ricer 2003). Moreover, when mothers apply paste on the fontanel prior to arriving at the hospital, doctors cannot assess the fontanel very well (because of the plant pomades) and may misdiagnose the child's illness. *La rate* resembles the symptoms of sickle-cell disease, a common yet neglected illness of children in Western Africa (Grosse et al. 2011), especially its characteristic concentrated pain on the left side and spleen enlargement (Meier and Miller 2012). This overlap is a fertile ground for improved research and educational programs on sickle cell disease (Makani, Williams, and Marsh 2007). Enemas for intestinal cleanses, especially for newborns and small children, were a common practice in both countries. In the Ivory Coast, Gottlieb (Gottlieb 2004) found that enemas were used to make a baby defecate at a given time. Biomedical research has highlighted the danger in using enemas, especially among young children (Bland et al. 2004).
Even if these illnesses are not recognized as biological in nature, their treatment nevertheless has consequences, either positive or negative, on children's health. Taking local perspectives and treatments

into account not only informs biomedicine of cultural concepts of illness and healing (Etkin 1998), it also facilitates an understand of plant' effects through pharmacological studies (Reyes-García 2010), and enables an understanding of how traditional systems of healing and biomedicine are already interacting on the ground (Langwick 2011).

Complementarity of three systems

The lack of any one definitive pattern of healthcare-seeking behavior among mothers in our study reflected the truly pluralistic healthcare systems of both countries (van der Geest 1997), the dynamic process of deciding how to care for children (Colvin et al. 2013), and the fact that mothers see the three African systems of healthcare as largely complementary. Mothers' general *pattern of resort* (Ryan 1998) was to self-treat with plants first, seek biomedical care for specific illnesses or as a second source of healthcare and to consult the spiritual realm, including *ganga*s and the *nyembe* in Gabon, to treat folk illnesses. However, as found in a recent study in South Africa (Friend-du Preez, Cameron, and Griffiths 2013), this pattern varied according to illness; each healthcare option was seen to have specific advantages and disadvantages. Biomedicine was perceived to have the advantage of advanced technology and materials, especially for treatments related to blood transfusions. Some mothers in Bénin reported a preference of using self-collected herbal medicine over biomedical care due to the expensive of modern treatment.

Future research can take demographic and socio-economic data into account to further the understanding of preferences for childcare treatment (Bakshi, McMahon, and George 2013). Infant and child healthcare will be enriched if local knowledge, illness concepts, and medicinal plants fit into a larger framework that studies healthcare from a community perspective (van der Geest 1997), including researchers from outside the biomedical field (Vandebroek 2013). With the Millennium Development Goals concluding in 2015, and the reality that both countries have not met their targets of reducing infant mortality rates (UNDP 2013b; UNDP 2013a), there is a renewed opportunity for infant healthcare initiatives to become more comprehensive.

Acknowledgments

In Bénin, we would like to thank the professors at the University of Abomey-Calavi, especially A. Akoegninou and B. Sinsin, as well as the staff of the National Herbarium of Bénin (BEN), and l'Institut de Développement et d'Echanges Endogènes (IDEE). We are grateful to S. Ruysschaert, K. Ostertag, and L. Atindehou for their assistance in the Bénin fieldwork. The Gabon fieldwork was supported by the research staff at L'Institut de Pharmacopée et de Médecine Traditionnelles (IPHAMETRA), the National Herbarium of Gabon (LBV), HB Bourobou, le Centre National de la Recherche Scientifique et Technologique (CENAREST), and the Agence Nationale des Parcs Nationaux (ANPN) in Gabon. The authors would like to share a special thanks to E. van Vliet E, H. Eyi Ndong, J.P. Ongoda, A. Izouret, and the Grand Kami of Assiami for their assistance with the questionnaires. In the Netherlands, we would like to thank M. Sosef for his logistical support and the expert botanists at Wageningen University for their assistance with plant identification.

Appendix 1

Species cited in 43 childcare questionnaires in Bénin: scientific botanical name, vernacular plant name(s), plant part used, preparation, use category and collection number

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #[d]
Abelmoschus esculentus (L.) Moench	gombo (Fr)	leaves, fruit	HB, EA	newborn, fontanels	NC
Abrus precatorius L	bouchenchen (T), djindjeklendjeman/viviman (F, G)	leaves	E, T, HB	cough, post-circumcision, respiratory problems	297
Acacia cf. *erythrocalyx* Brenan	ewan (N)	stem	HB	walk early	NC
Acacia cf. *sieberiana* DC.	adouwe (G)	leaves	T	teething	NC
Acacia nilotica (L.) Delile	banni (F)	seeds	T	asthma	NC
Acanthospermum hispidum DC.	toba/ahowonglon (F), kpononnou (G), owgboman (N), tchako (T)	leaves, whole plant	D, T, EN	cough, malaria, fever, CBD ka, respiratory problems, walk early	211, 237
Acrostichum aureum L.	sofofo (G)	leaves	T	walk early	428
Adansonia digitata L.	kpassa (F), baobab (Fr),	leaves, bark	HB	premature birth, strengthener	NC
Adenia cissampeloides (Planch. ex Hook.) Harms	akolebodjou (N)	leaves	T	malaria	445
Aframomum melegueta K.Schum.	atakounkui (Y,N)	fruit	HB	measles	NC
Agelaea pentagyna (Lam.) Baill.	ahwahazoun (F,G)	leaves	T	strengthener, stomach ache, intestinal cleanse	NC
Ageratum conyzoides (L.) L.	suyonou (G), legboku (K)	whole plant	T	respiratory problems, fever	430, 530
Albizia cf. *adianthifolia* (Schum.) W.Wight	ayolo (F)	wood	T	asthma	NC
Alchornea cordifolia (Schumach. & Thonn.) Müll.Arg.		leaves	T	CBD atita, convulsions	631
Allium sativum L	l'ail (Fr), aiyo (F,G,N)	stem	D, T, A, HB, EN	convulsions, constipation, intestinal cleanse, measles, CBD atita, diarrhea, fontanels	NC
Allium sp.	ayomanwoniwono (F)		T	constipation	NC
Aloe macrocarpa Tod.	aloes (Fr)	exudate	D	constipation	NC
Alternanthera pungens Kunth	inchako (T), baglon (A)	leaves	EN, T	walk early, anti-sorcery, malaria	236, 239, 490
Amaranthus viridis L.	amadjin (F)	leaves, whole plant	EA	CBD ka, measles	582
Ampelocissus leonensis (Hook.f.) Planch.	adoyo/teple (F), ecama (A)	whole plant	T	cough, malaria	408, 463
Anacardium occidentale L.	kanghougoto (F,G), canjew (T)	bark	T	cough, respiratory problems, asthma, teething, post-circumcision	425,257
Ananas comosus (L.) Merr.	ananas (Fr)	fruit	T	malaria	NC
Annona muricata L.	shapshap (M)	leaves	D	asthma	134
Anthocleista vogelii Planch.	gontoudo (F), goussouedo (G), irakpo (T)	root, wood	T	intestinal cleanse, stomachache, meconium removal, constipation	281

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #[d]
Arachis hypogaea L.	arachide (Fr)	leaves		fetus strengthener	NC
Arecaceae sp.	gueyo (F,G)	leaves	T	walk early	427
Arecaceae sp.	itowonti (A)	seeds		anti-sorcery	477
Argemone mexicana L.	ahondja/wetcheyon (F, G, N, Y), magele (T)	leaves	T, HB, EA	newborn strength, malaria, meconium removal, stomachache, intestinal cleanse, fontanels, fever	233, 492, 609
Asteraceae sp.	atanatebe (T)	leaves	E	constipation	292
Azadirachta indica A.Juss.	neemma/kininma (F), lili (T)	leaves	T, HB	stomach ache, vomiting, malaria, measles, convulsions	274
Baphia nitida Lodd.	susupeyma (F)	leaves, wood	HB, EA	newborn strength, CBD ka	NC
Barteria cf. *nigritana* Hook.f.	okoukou (F,N), okotcho (Y)	bark, leaves	HB	newborn strength, strengthener, premature birth	451
Bauhinia thonningii Schum.	kloma (F), akluema (A)	leaves	EA, T	toothache, strengthener	466, 560
Blighia cf. *sapida* K.D.Koenig	lissekui (F)	seed	E	asthma	NC
Blighia cf. *unijugata* Baker	agbovian (F, G)	bark	T	diarrhea	NC
Boerhavia diffusa L.	kasualee (F)	leaves	HB	CBD ka	467
Bombax cf. *buonopozense* P.Beauv.	aloviaton (F)	exudate, leaves	D, EA	cough, post-circumcision	NC
Bridelia ferruginea Benth.	honssounkuékué (F)	leaves, bark, root	HB, T	CBD atita, strengthener, asthma, walk early, newborn strength, CBD ka, convulsions, post-circumcision	NC
Bryophyllum cf. *pinnatum* (Lam.) Oken	afoman (N), affiman (G)	leaves	T	walk early	NC
Caesalpinia bonduc (L.) Roxb.	agekwin (A,F,G)	seeds, leaves	AT, T	anti-sorcery, CBD atita, newborn strength, intestinal cleanse, constipation	517
Caesalpinia pulcherrima (L.) Sw.	tegbesu (F), orgueil de chine (Fr)	leaves	HB, T	CBD atita, preventative, convulsions, asthma	NC
Cajanus cajan (L.) Millsp.	kulikwun, klema (F), pulema (K), kolo (N, T)	leaves	T, HB	measles	255, 497, 551
Calotropis gigantea (L.) Dryand.	wagashima (A, F, K, M), pbento (F)	leaves	T, D, EA	anti-sorcery, cough, umbilical cord, measles, strengthener, asthma	469
Calotropis procera (Aiton) Dryand.	bambamo (T)	leaves	EA	umbilical cord	285
Capsicum annuum L.	piment (Fr), vavofli-fliman (G)	fruit, whole plant	EN, EA, T	toothache, intestinal cleanse, wounds, convulsions	439
Carica papaya L.	pbema (F), Kpinman (N, Y)	seeds, leaves	T, HB, T, D	malaria, strengthen, constipation, fever	NC
Carissa spinarum L.	aheyhey (F)	whole plant	EA	walk early	NC
Cassia sieberiana DC.	agbilikopao (T)	wood	T	vermifuge	280
Cassytha filiformis L.	agbegbekan (F, G)	whole plant	T, HB	fontanels, strengthener	NC

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #[d]
Ceratotheca cf. *sesamoides* Endl.	agboma (F)	leaves	EA	fontanels	NC
Chamaecrista mimosoides (L.) Greene	kinafimitche (F,G,N)	whole plant	T	anti-sorcery	NC
Chamaecrista rotundifolia (Pers.) Greene	azima (F)	leaves, whole plant	T	malaria, constipation, newborn strength	NC
Chassalia kolly (Schumach.) Hepper	atindjedo (G), okpao (Y), akpa (N)	root, leaves	T, EA, HB	intestinal cleanse, fontanels, post-circumcision	NC
Chromolaena odorata (L.) R.M.King & H.Rob.	agatou (F, N, T), gueflu (K)	leaves	EA, HB	post-circumcision, fever, headache	251, 448, 499
Citrullus colocynthis (L.) Schrad.	kakanya (T)	leaves	EA	vermifuge	NC
Citrullus lanatus (Thunb.) Matsum. & Nakai	goussi (F,G)	fruit	T	intestinal cleanse, constipation	NC
Citrus aurantiifolia (Christm.) Swingle	cleman (F,G), citron (Fr)	leaves, fruit, root, bark	T, D, E, A, HB	constipation, intestinal cleanse, measles, convulsions, malaria, stomachache, cough, meconium removal, clear throat of newborn, respiratory problems, vomiting	264
Citrus sp.	orange (Fr)	skin from fruit	EA	wounds	NC
Clausena anisata (Willd.) Hook.f. ex Benth.	gbozoun (F), gbossouazowin (G), arukoumbo (T)	leaves	HB, T, E	CBD atita, constipation, newborn strength, umbilical cord, headache, cough	260, 426, 442, 454
Cleistopholis patens (Benth.) Engl. & Diels	honsoungoto (F), housinkoman (G)	bark, leaves	T	constipation, stomachache, teething	NC
Cleome gynandra L.	khaya (M)	leaves	D	yellow fever, earache	139, 486
Cleome viscosa L.	akaya (F), kayasu (M)	leaves	M, HB	teething, walk early	136,604
Clerodendrum cf. *capitatum* (Willd.) Schumach. & Thonn.	weman/wedo (F,G)	leaves, root	T, HB	CBD ka, CBD atita, malaria, fever	NC
Cnestis ferruginea Vahl ex DC.	gbovian	leaves	D, T, HB	diarrhea, measles	209
Cocos nucifera L.	agodo (F, G)	root	T	malaria, constipation, intestinal cleanse	370, 461
Cola millenii K.Schum.	aloviaton (A)	leaves	T	malaria, fever	NC
Combretum cf. *grandiflorum* G.Don	adoucito (F, G, N)	leaves	T	diarrhea, teething	NC
Combretum collinum Fresen.	bodumey (T)	root	D	CBD atita	294
Combretum micranthum G.Don	kinikiniba (F, G, N, Y)	leaves	EA, D, HB, T	measles	NC
Combretum sp.	adouco (F), adoukin (G)	leaves	T, HB	measles, diarrhea, teething, fontanels, anti-sorcery	400, 405
Commiphora africana (A.Rich.) Endl.	feliyimi (G), origi (T)	leaves, branch	T, AT	cough, convulsions	434
Convolvulaceae sp.	eweyeye (G)	whole plant	T	cough	435
Corchorus olitorius L.	crencren (F)	leaves	D	malaria, constipation	NC
Costus afer Ker Gawl.	teteglete (F)	leaves	E	protection against accidents	636

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #[d]
Crateva adansonii DC.	hontonzouzouin (F, G)	leaves, root	HB, T	post-circumcision, CBD ka, anti-sorcery, intestinal cleanse, malaria	135, 613
Crescentia cujete L.	treci (A), ka (F), calebasse (Fr)	fruit, leaves	EA, T	convulsions, CBD ka	489
Crotalaria cf. *retusa* L.	awiyan (F)	leaves	EA	fontanels, post-circumcision	NC
Croton gratissimus Burch.	hèmandédji (F, G), adjekofole (N, Y)	leaves	T, EA, E, HB	anti-sorcery, measles, fever, CBD ka	456
Cucumis metuliferus E.Mey. ex Naudin	gboounon (F)	fruit	T, A	measles	NC
Cyanthillium cinereum (L.) H.Rob.	mayantin (F), houssinkussè (F, G)	leaves, whole plant	EA, D, HB, T	CBD atita, post-circumcision, walk early, premature birth	410, 473
Cymbopogon sp.	timan (F)	leaves	T	malaria	NC
Cymbopogon citratus (DC.) Stapf	citronelle (F, Fr)	leaves	T	intestinal cleanse, strengthener, meconium removal	NC
Cynometra megalophylla Harms	foladgoto (F), bougoto (G)	bark	HB, T	CBD atita, newborn strength	453
Daniellia oliveri (Rolfe) Hutch. & Dalziel	zanlinkpon (F), eweiya (N, Y), inya (T)	resin, bark, leaves	HB, T	anti-sorcery, walk early	286, 462
Dennettia cf. *tripetala* Baker f.	iberi (T)	fruit	EA	umbilical cord	NC
Desmodium velutinum (Willd.) DC.	trèdoavohou (F, G)	leaves	T	asthma, cough, diarrhea, fontanels, teething	415, 468
Dialium guineense Willd.	atituey (M)	leaves	T	malaria	148
Dichapetalum madagascariense Poir.	gbaglo (A, F, G)	leaves	T, HB	malaria, fever, convulsions, measles, CBD ka	NC
Dichrostachys cinerea (L.) Wight & Arn.	badawouin (F)	root	T	measles	NC
Dracaena fragrans (L.) Ker Gawl.	anyama (K)	leaves	EA	ear ache	533
Dysphania ambrosioides (L.) Mosyakin & Clemants	godo (F), azobidi (K)	whole plant, leaves	HB, EA, T	newborn strength, post-circumcision, asthma, fontanels, vermifuge	557
Eclipta prostrata (L.) L.	zoma (F)	leaves	HB, T	post-circumcision, malaria	596
Ehretia cymosa Thonn.	kanbala (F), miyonman (G)	leaves	T	diarrhea, malaria, fever	460
Elaeis guineensis Jacq.	tjotjo (F), huile rouge (Fr), inkiyo (T)	oil from seed	EA, T	wrinkly newborns, fontanels, convulsions, wounds, fever, measles, respiratory problems, umbilical cord	NC
Entada gigas (L.) Fawc. & Rendle	gbagbla (F)	seeds	T, HB	constipation, intestinal cleanse, constipation	418
Erythrina cf. *senegalensis* DC.	pbaklesi (F)	leaves	HB	diarrhea	559
Erythrococca anomala (Juss. ex Poir.) Prain		leaves		teething	495
Eucalyptus sp.	eucalyptus (Fr)	leaves	T, HB	cough, respiratory problems, malaria	NC
Euphorbia hirta L.	anossikan (G)	whole plant	HB	measles	NC
Evolvulus cf. *alsinoides* (L.) L.	droman (G)	leaves	T	teething	NC
Fabaceae sp.	vonsou	seeds	E, EA	diarrhea, fontanels	NC
Ficus cf. *lutea* Vahl	adako (T)	bark	T	diarrhea	NC
Ficus exasperata Vahl	igpi (T)	sap	EA	umbilical cord	252

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #[d]
Ficus sur Forssk.	voma (F), oweyokpoto (F, G), okpoto (Y)	leaves, bark	HB, T	fever, strengthener, premature birth	579
Flacourtia indica (Burm. f.) Merr.	agbonkadjè (F)	leaves, root	T, HB	diarrhea, measles	NC
Flueggea virosa (Roxb. ex Willd.) Royle	tchèkè-tchèkè (F), ayiku (T)	leaves	T, HB, E, D	constipation, strengthener, meconium removal, convulsions, intestinal cleanse, teething, malaria	276, 569
Garcinia kola Heckel	ahowe (F)	seeds	T, HB	newborn strength, intestinal cleanse	NC
Garcinia sp.	ahowé/kola (F)	leaves, seeds	HB, T, E	newborn strength, malaria, anti-sorcery, fontanels, diarrhea	419
Gardenia ternifolia Schumach. & Thonn.	dakplasou (F)	leaves	D	malaria, fetus strengthener	NC
Gladiolus dalenii Van Geel	baka (F)	tuber	E	asthma	NC
Glycine max (L.) Merr.	soja (F)	seeds	D	constipation	NC
Gmelina cf. *arborea* Roxb.	fiofiotin (F)	leaves	T	constipation	NC
Hackelochloa granularis (L.) Kuntze	azosongo (F, G)	whole plant	T	strengthener	NC
Heliotropium indicum L.	kokolosutepadjay (F), koulodin (N)	whole plant	HB, T	fever, CBD atita, CBD ka	447
Heterotis cf. *rotundifolia* (Sm.) Jacq.-Fél.	hèhèman (F)	leaves	T	anti-sorcery, fever, convulsions, malaria, post-circumcision	NC
Hibiscus acetosella Welw. ex Hiern	hungbe (A), yangba (F)	leaves	T	strengthener, malaria	465, 594
Hibiscus sp.	podey (M)	leaves	T	malaria, fever	NC
Hibiscus surattensis L.	kpofin	whole plant	T	anti-sorcery	NC
Hoslundia opposita Vahl	klongble (G)	leaves	HB	strengthener	437
Hygrophila auriculata (Schumach.) Heine	hosugoto (K)	bark	T	asthma	496
Hymenocardia acida Tul.	fefeya (T)	leaves	E	teething	NC
Hyptis suaveolens (L.) Poit.	sonsupeypeyma/koueflou (F), kouloubi (T)	leaves	HB, T, E	fever, mosquito repellant, diarrhea, CBD atita, CBD ka, dysentery	291, 406, 472
Icacina cf. *trichantha* Oliv.	agebebema (F)	leaves	T	diarrhea	NC
Imperata cf. *cylindrica* (L.) Raeusch.	seman (F, G), eweekan (N)	leaves	T	teething, respiratory problems	NC
Indigofera sp.	ahoobey (A)	leaves	T	strengthener, constipation	366
Indigofera sp.	fonvi (F,G,N)	whole plant	T, HB	walk early	429
Jatropha cf. *curcas* L.	babaki (A), ajakpotu (F), eweakporo (N, Y), kitipopo (T)	leaves, branch	T, HB, SB	malaria, fever, intestinal cleanse, convulsions	659
Jatropha multifida L.	wêkêman (F)	leaves	T	CBD atita	403
Jatropha sp.	jatrophado (N)	root	T	respiratory problems	NC
Justicia flava (Vahl) Vahl	tchoutchouglouchou (F, G)	whole plant	E, HB	anti-sorcery, newborn strength, fontanels	633
Kalanchoe crenata (Andrews) Haw.	afaman (F, Y), adodo (T)	leaves	EA, D	umbilical cord, cough	261
Kedrostis foetidissima (Jacq.) Cogn.	tchiyoman (F, G)	leaves	T	convulsions, malaria, fever	NC

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #[d]
Khaya senegalensis (Desv.) A.Juss.	zounsa (F, N), agao (T)	bark, leaves	HB, T, A, EA	newborn strength, walk early, teething, strengthener, convulsions, premature birth, malaria, CBD ka, CBD atita, anti-sorcery, post-circumcision	244, 284
Kigelia africana (Lam.) Benth.	ylanblikpo (F), pando (T)	bark	T, HB	constipation, intestinal cleanse	249, 458, 577
Lagenaria breviflora (Benth.) Roberty	obiri (N, Y)	whole plant, leaves	T, HB	CBD ka	446
Lagenaria cf. sp.	iytrue (A)	leaves	T	cough	NC
Lannea acida A.Rich.	zuzugoto (F), aku (T)	bark	HB, T	walk early, newborn strength, strength	282
Lannea barteri (Oliv.) Engl.	hounman (F)	leaves	T, HB	premature birth, strengthener	NC
Lannea sp.	mangbevide (F)	bark	T	convulsions	NC
Lantana camara L.	hlatchayo (F, G, N, Y)	leaves	T, HB	post-circumcision, diarrhea, CBD atita, CBD ka	404
Lawsonia inermis L.	laliman (F, G)	leaves	T	malaria	NC
Lecaniodiscus cf. *cupanioides* Planch. ex Benth.	ganotun (F, G)	leaves	HB	premature birth	NC
Lippia multiflora Moldenke	yonya (F, G), yeye/tchaga (T)	leaves	T, HB, EA	anti-sorcery, diarrhea, CBD atita, CBD ka, post-circumcision, teething, cough	270, 402
Lycopodiella cernua (L.) Pic. Serm.	hingble	whole plant	T	anti-sorcery, measles, malaria, fever	433
Mallotus oppositifolius (Geiseler) Müll.Arg.	gbenoukan (F), tchnetchne (G), ayaja (T)	leaves, root, bark	HB, T, EA	CBD atita, asthma, meconium removal, teething	243, 436, 452
Mangifera indica L.	amangua houhou (F, N, Y), mangue (Fr)	leaves, bark	T, HB	respiratory problems, fever, strengthener, newborn strength	NC
Manihot esculenta Crantz	manioc (Fr)	root	D	malaria	NC
Melaleuca leucadendra (L.) L.	bpema (F)	leaves	HB	malaria	NC
Merremia tridentata (L.) Hallier f.	abibey (A), tama (F), fakale (G)	leaves, whole plant	T, HB	diarrhea, sores, CBD atita, fontanels, CBD ka	212, 364, 421, 432
Milicia excelsa (Welw.) C.C.Berg	loko (A, F)	exudate	EA	fontanels	NC
Millettia thonningii (Schum. & Thonn.) Baker	assousouman (F)	leaves	T	malaria	NC
Mimosa cf. *quadrivalvis var. leptocarpa* (DC.) Barneby	boassaman (F)	leaves	T	fontanels	NC
Momordica balsamina L.	kpalari (N)	leaves	T, HB	measles	NC
Momordica charantia L.	yinsikin (F), assossikan (G), tchati (T)	whole plant, leaves	T, HB, A, EA, E	measles, diarrhea, CBD atita, fever, constipation, antibiotic	149, 254, 409, 525
Monodora cf. *tenuifolia* Benth.	sonoufoko (F, G)	seeds	T, HB	walk early, measles	NC

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #[d]
Monodora myristica (Gaertn.) Dunal	sassalinkoun (F)	seeds	EA, T	umbilical cord, post-circumcision, constipation, intestinal cleanse, toothache, preventative	NC
Morinda lucida Benth.	atikeysibey (A), honswuey (K), kwenso (M)	leaves	HB, T, D	convulsions, constipation, intestinal cleanse, fever	133, 365, 537
Moringa oleifera Lam.	kpayêdêdê (F), kpatinman (F, G), batamavi (K)	leaves	DR, T, HB, D	headache, diarrhea, fever, headache, anti-sorcery	NC
Mucuna cf. sp.	feman (F)	leaves	HB	newborn strength	NC
Mucuna pruriens (L.) DC.	dukey (A), ewe agbakila (N)	leaves	A, HB, T	measles, diarrhea	488, 450
Musa sp.	banane (Fr)	leaves	T, D	strengthener, convulsions	NC
Newbouldia laevis (P.Beauv.) Seem.	adama (F), akokoun (F, G, T), desey sigema (M)	leaves, seeds	EA, T, D, HB	post-circumcision, constipation, malaria, newborn strength, fever, anti-sorcery,	279
Nicotiana tabacum L.	azoman (F), taba (N), ayureawe (T)	leaves	T, EA	malaria, convulsions, umbilical cord, fontanels	NC
Ocimum americanum L.	hisihisi (F), fio (G)	leaves, whole plant	EA, T, HB, EN,	sore throats, wounds, asthma, cough, fever, post-circumcision, CBD atita, constipation, meconium removal, newborn strength, diarrhea, fontanels, CBD ka, measles, strengthener	544
Ocimum basilicum L.	akohoun (F, G, Y)	leaves	T, D	constipation	NC
Ocimum gratissimum L.	tchayo (F, G, N), koumoba (T)	leaves, whole plant	T, HB, EA, E, EN	post-circumcision, CBD atita, premature birth, convulsions, walk early, asthma, cough, enema, intestinal cleanse, constipation, meconium removal	272, 498
Ocimum sp.	kessou-kessou (F, G)	whole plant, leaves	T, D, HB	antibiotic, constipation, anti-sorcery, diarrhea, post-circumcision, malaria, newborn strength, fever	NC
Olax subscorpioidea Oliv.	mitindo (F)	root	T	intestinal cleanse, constipation	NC
Oldenlandia cf. *affinis* (Roem. & Schult.) DC.	ahonman (F, G)	leaves	EA, HB	fontanels, premature birth	NC
Opuntia sp.	cactus (Fr)	root, leaves	T	cough	NC
Pancratium trianthum Herb.	kouyoman (F, G)	leaves, stem	T	asthma, cough, anti-sorcery	210, 422
Parkia biglobosa (Jacq.) G.Don	awe (F, G), igba (T)	branch, bark, leaves	HB, T	strengthener, constipation, respiratory problems, convulsions, diarrhea, walk early, anti-sorcery, measles	NC
Passiflora foetida L.	avounyinmitoé (F)	whole plant	T	CBD ka	NC

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #[d]
Paullinia pinnata L.	ahichan (A), hedoulifi/lokoman (F, G), ganganizema (M)	leaves, root	HB, T	diarrhea, newborn strength, convulsions, post-circumcision, cough	114, 146
Pavetta cf. *crassipes* K.Schum.	gongwako (T)	leaves	T	malaria	NC
Pavetta corymbosa (DC.) F.N.Williams	lohoun (F)	leaves	T	malaria, newborn strength	NC
Pennisetum cf. *glaucum* (L.) R.Br.	mil (Fr)	seeds	E	measles	NC
Pergularia daemia (Forssk.) Chiov.	bonukeykey (A), awinikunsiewa (M)	leaves	EA	fontanels, cough	493
Periploca calophylla (Baill.) Roberty	homa/asobokan (F)	leaves	EA	newborn strength, umbilical cord	475, 583, 608
Persea americana Mil.	avocamanhouhou (F)	leaves	D	asthma	NC
Phyllanthus amarus Schumach. & Thonn.	hlinwhé (F), tehisso (N, Y), aibiso (T)	whole plant, leaves	T	constipation, meconium removal, malaria, newborn strength, intestinal cleanse, vermifuge, diarrhea	NC
Physalis cf. *angulata* L.	korogba (F, N), kongba (Y)	whole plant	T, HB	constipation, CBD ka, CBD atita, measles	NC
Piper guineense Schumach. & Thonn.	pimment du guinea (Fr), injaive (T)	fruit	DR, T, D, EA, HB	headache, CBD ka, CBD atita, fontanels, asthma, strengthener, constipation	658
Plectranthus monostachyus (P.Beauv.) B.J.Pollard	koumoba (T)	leaves	T	constipation	242
Pleurotus tuber-regium (Rumph. ex Fr.) Singer 1951	aisankoum (F)	fungus	E	asthma	601
Portulaca grandiflora Hook.	dri (G)	whole plant	T	teething	NC
Prosopis africana (Guill. & Perr.) Taub.	kakè (F, G)	wood	HB, T	newborn strength, walk early, constipation, fever	401
Pseudocedrela cf. *kotschyi* (Schweinf.) Harms	tchagigi (T)	leaves	T	vermifuge	NC
Psidium guajave L.	kinkouman (F, G, N)	leaves	T, EA, D	diarrhea, post-circumcision, asthma	NC
Psychotria psychotrioides (DC.) Roberty	atindohoussa (F)	bark	HB	post-circumcision	NC
Psychotria vogeliana Benth.	deblago (G)	leaves	T	post-circumcision	414
Pteleopsis suberosa Engl. & Diels	kulikuligoto (F)	bark, leaves	T, HB	CBD atita, CBD ka, newborn strength, measles	NC
Pterocarpus erinaceus Poir.	kosso (G)	bark	T	walk early	NC
Pterocarpus santalinoides DC.	gbengbè (F, G), begbema (M)	leaves	T, HB, D	diarrhea, newborn strength, constipation, CBD atita	138, 634
Pupalia lappacea (L.) Juss.	tredoagbokokui (F)	seeds	EA	fontanels	455
Pycnanthus cf. *angolensis* (Welw.) Warb.	yaya (F)	leaves	T	asthma, cough	NC
Raphia hookeri G. Mann & H. Wendl.	dekui/alitadekoun (F, G)	seeds	T, HB	fontanels	NC
Raphia sp.	ramo (F)	leaves	C	anti-sorcery	NC
Rauwolfia vomitoria Afzel.	vonmansi (G)	leaves	HB, T	fontanels, fever	514

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #[d]
Remirea maritima Aubl.	houyin/housso (F, G)	whole plant	T	teething	417
Rhaphiostylis beninensis (Hook.f. ex Planch.) Planch. ex Benth.	gbagblakan (F, G)	wood	T	newborn strength, constipation, intestinal cleanse	NC
Rhodognaphalon cf. *brevicuspe* (Sprague) Roberty	patindeyhun (F)	leaves	EA	rib/bone displacement	NC
Ricinus communis L.	fefekoupa (T)	leaves	SB, D	fever, stomachache	NC
Rourea coccinea (Schumach. & Thonn.) Benth.	vikplonbaman (G), amedje (N)	leaves	T	post-circumcision, diarrhea	441
Rytigynia senegalensis Blume	gbadema (F, N, Y)	leaves	T, HB	malaria, measles	411
Sansevieria liberica Gérôme & Labroy	kpohiando/kponman (F)	root, leaves	T	malaria, fever	NC
Sarcocephalus latifolius (Sm.) E.A.Bruce	kudo (F), umbesi (T)	root	T	intestinal cleanse, constipation, malaria	NC
Schrebera arborea A.Chev.	fadou (F)	seeds	HB	fontanels	407
Schwenckia americana L.	amankoukui (F)	leaves, whole plant	HB, T	post-circumcision, measles, CBD atita, fontanels	NC
Secamone afzelii (Roem. & Schult.) K.Schum.	zungikusi (F), zougoudou (G), ablengblo (T)	leaves	T, HB, EA, E	convulsions, CBD ka, fontanels, constipation, intestinal cleanse, CBD atita, cough	299, 597
Securidaca cf. *longipedunculata* Fresen.	patado (F)	root	T	asthma, cough	NC
Senna alata (L.) Roxb.	amasou (F), dumadòsogomè (K)	leaves	T, D	intestinal cleanse, constipation, meconium removal	518
Senna hirsuta (L.) H.S.Irwin & Barneby	batomayi (F)	leaves	HB	fever	471
Senna obtusifolia (L.) H.S.Irwin & Barneby	kpanhouman (F)	leaves	EA	umbilical cord, wounds	507
Senna occidentalis (L.) Link	agolikan (F), anajabulo (T)	leaves	T, EA, HB	diarrhea, fontanels, newborn strength, strengthener, convulsions, crisis, fever, malaria	241, 600
Senna siamea (Lam.) H.S.Irwin & Barneby	zangla/cassia (A, F), acacia (G, T)	leaves	T, HB	malaria, constipation	273, 459
Sesamum indicum L.	sesame (Fr)	seeds	E	teething	NC
Sida cf. *rhombifolia* L.	ghema (M)	leaves	EA	toothache	NC
Solanum aethiopicum L.	gboman/gble (F)	leaves	T, HB	diarrhea, post-circumcision	598
Solanum americanum Mill.	moru (T)	leaves	D	cough	262
Solanum dasyphyllum Schumach. & Thonn.	irwawaudi (T)	leaves	HB	teething	240
Solanum lycopersicum Lam.	tomati (F)	leaves	EA	measles, infections, abscesses	NC
Sorghum bicolor (L.) Moench	adako (F)	leaves	T	toothache	NC
Sorghum sp.	hokoveman (G)	leaves	HB	strengthener	438
Spondias mombin L.	akinkoma (F), djogbeman (G)	leaves	T	diarrhea, teething	440, 635
Stachytarpheta cayennensis (Rich.) Vahl	alotrohe (G)	whole plant	HB	premature birth	NC
Stipularia africana P.Beauv.	towedo (F, G)	root, leaves	T	cough, convulsions, malaria, fever	424

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #[d]
Strophanthus hispidus DC.	afeyfey (T)	leaves	HB	malaria	358
Strophanthus sp.	tegbesu (F)	leaves	E, T	convulsions	588
Stylosanthes erecta P.Beauv.	aduma (A, F)	whole plant, leaves	HB, T	teething	464
Syzygium aromaticum (L.) Merr. & L.M.Perry	atinkenbodata (F, G, M, N)	flower buds, bark	D, HB, T, EA	constipation, newborn strength, post-circumcision, umbilical cord, intestinal cleanse, preventative	NC
Syzygium guineense (Willd.) DC.	mlanmi (G)	leaves	T	CBD atita	431
Tectona grandis L.f.	teekma (F, M)	leaves	HB	newborn strength	NC
Terminalia glaucescens Planch. ex Benth.	alotou (F), aloaton (G)	root	T, HB	asthma, cough, post-circumcision, CBD atita, anti-anti-sorcery	NC
Tetrapleura tetraptera (Schum. & Thonn.) Taub.	lindja (F)	fruit	T	asthma	NC
Thonningia sanguinea Vahl	atinmahudè (F, G), oyo (N, Y)	whole plant	T	respiratory problems, asthma, cough, constipation, teething	NC
Tithonia diversifolia (Hemsl.) A.Gray	botowo	leaves	EN, HB	convulsions	278
Trema orientalis (L.) Blume	afere (N, T, Y)	leaves	T, SB	walk early, fever	258
Tribulus terrestris L.	gendarme (F)	whole plant	T	teething	420
Tridax procumbens (L.) L.	kpokpo (G, N, Y)	whole plant	A, T, HB	convulsions, strengthener	478
Triumfetta rhomboidea Jacq.	adjatou (F)	leaves	EA	post-circumcision	NC
unidentified (AMT 141)	weydumey (M)	whole plant	HB	anti-sorcery	141
unidentified (AMT 265)	kanchino (T)	bark	T	diarrhea	265
Uraria picta (Jacq.) DC.	asoinsoin (F)	leaves	T	malaria, respiratory problems, asthma, cough	416
Utricularia cf. *spiralis* Sm.	kologakolesi (T)	leaves	HB	fetus strengthener	NC
Uvaria chamae P.Beauv.	aylahado/aylahaman (F,G, M, N)	root, leaves	T	convulsions, constipation, CBD atita, asthma, malaria, fever, newborn strength	NC
Vepris cf. *verdoorniana* (Exell & Mendonça) Mziray	akode (F,G)	leaves	T	malaria, constipation, intestinal cleanse	NC
Vitellaria paradoxa C.F.Gaertn.	limangoto (F,G), beur de karite (Fr)	seeds, bark	T, EA	cough, respiratory problems, diarrhea	NC
Waltheria indica L.	avoudido (F), avidido (G)	root, whole plant	T	convulsions	423
Xylopia aethiopica (Dunal) A.Rich.	kpedjre (F, G, M, N), arn (T)	fruit, bark	EA, D, T, HB, SB	umbilical cord, intestinal cleanse, constipation, post-circumcision, malaria, toothache, diarrhea, meconium removal, stomachache, fever, strength	NC
Zanthoxylum sp.	atchanhanwou (F), heja (M)	leaves	T	diarrhea, intestinal cleanse, constipation	147, 457

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #[d]
Zanthoxylum zanthoxyloides (Lam.) Zepern. & Timler	hedou (F)	root	T	diarrhea	NC
Zapoteca portoricensis (Jacq.) H.M.Hern.	azonkidjado (F), ingbanu (T)	root	EN, T	intestinal cleanse, convulsions	245
Zea mays L.	mais (Fr)	fruit	T, E	diarrhea, CBD ka, measles	NC
Zingiber officinale Roscoe	dote (F), gingembre (Fr), atalye (T)	rhizome	T, EA, EN, D	asthma, fontanels, intestinal cleanse, constipation	NC

a Local languages are abbreviated: (A)= Adja; (F)= Fon; (Fr)= French; (G)= Goun; (K)= Kotafon; (M)= Mina; (N)= Nago; (T)= Tcha; (Y)= Yoruba.
b Preparations are abbreviated: (A)= soaked in alcohol; (AT) attach; (C)= ceremony; (D)= drink; (DR)= drops; (E)= eat; (EA)= external application; (EN) = enema; (HB)= herbal bath; (M)= massage; (SB)= steam bath; (T)= tea
c Use category abbreviations are as follows: CBD= cultural bound disease
d Botanical voucher number and collector initials; NC= not collected.

Appendix 2

Species cited in 38 childcare questionnaires in Gabon: scientific botanical name, vernacular plant name(s), plant part used, preparation, use category and collection number

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #
Acalypha paniculata Miq.	oekoenkoenakoen (F)	leaves, bark	A	CBD onkoe abijel	NC
Acanthus montanus (Nees) T.Anderson	ndu (F)	leaves	D	cough	NC
Acmella caulirhiza Delile	andongsie/andusi (F)	leaves	DR	fontanels	759, 856
Aframomum citratum (C.Pereira) K.Schum.	adzom (F)	herb	DR, D	umbilical cord, malaria, CBD la rate	NC
Aframomum giganteum (Oliv. & D.Hanb.) K.Schum.	obadzom (F)	leaves	HB	respiratory problems	NC
Aframomum melegueta K.Schum	ondodo/ondon/ndong (F), petite pimment (Fr)	fruit	EN, T, S, E, EA	intestinal cleanse, flu, fontanels, post-circumcision, fontanels	780, 1060, 1275
Aframomum sp.	adzom ebaja/ajom/bisom/eson (F), petite pimment rouge/piment indigiene (Fr)	fruit, leaves, root	EA, M, V, SiB, D, E, EN, HB	fontanels, CBD fesse rouge, fever, CBD la rate, post-circumcision, flu, malaria, CBD pogha, fetus strengthener	1088, 1089
Ageratum conyzoides (L.) L.	ikukwey(F), hedilikii/hedoki/kombavingi (M), etombijoro (Om), mambi matap/ manmibatabe (P)	leaves, root	D, EN, HB	diarrhea, fever, CBD ebem, cough, fever	1054, 1318
Albizia sp.	vovo-esak (F)	whole plant	EN	diarrhea	1228
Alchornea cordifolia (Schumach. & Thonn.) Müll.Arg.	agbuin/nkabi/unsusum abui (F)	leaves	DR, T, SB, EN	toothache, malaria, CBD fesse rouge	1062, 1231
Alchornea floribunda Müll.Arg	alan/alan-bwikili (F)	leaves, root	HB, EN	earache, umbilical cord, intestinal cleanse	1057, 1200
Allium cepa L.	onion (Fr)	stem	M	teething	NC
Alstonia boonei De Wild.	ekouk/kenkina (F)	bark	D, T, E, EN	asthma, malaria, CBD la rate, vermifuge	855
Alstonia sp.	ekok (F)	bark	D	vermifuge	809
Amaryllidaceae sp.	molo mundju (F)	leaves	EA	walk early	NC
Annickia affinis (Exell) Versteegh & Sosef	onvolle/nfo/nfol (F), bois jaune (Fr), mukoka (M), muamba pient (P)	bark, leaves	D, T, E, EA	malaria, fetus strengthener, teething, intestinal cleanse, vermifuge, CBD fesse rouge	1099
Annona muricata L.	corosolle (F), corossolier (Fr)	leaves, bark	SB, D, EN	fever, respiratory problems, fetus strengthener	871
Anonidium mannii (Oliv.) Engl. & Diels	ebom (F)	bark	EN, M	fetus strengthener	NC
Anthocleista cf. *schweinfurthii* Gilg	ajinebe (F)	bark	D, A	diarrhea, CBD onkoe abijel	NC
Arachis hypogaea L.	eba-owun (F), huile d'arachide (Fr)	seed	EA	post-circumcision, fontanels	NC
Asparagus warneckei (Engl.) Hutch.	mincoga mikou (F)	root	DR	fontanels	864
Aucoumea klaineana Pierre	okume/torche indigiene (Fr), okeymone (Om)	bark, resin	D, E, C	diarrhea, anti-sorcery, sores	NC

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #
Baillonella toxisperma Pierre	oabi (B), azap (F), moabi (Fr), oabey (Os)	bark, leaves	T, EN, SiB, HB	CBD fesse rouge, post-circumcision, fever	NC
Bambusa vulgaris Schrad	muguisa	bark	EN	CBD fesse rouge	NC
Barteria fistulosa Mast.	boviongo (B), engokom/ensangom/ nsabre (F)	bark	EN, M, T	walk early, fontanels, respiratory problems	837, 1066, 1303
Berlinia bracteosa Benth.	etodo/eybiara (M)	bark	D	intestinal cleanse	NC
Bidens pilosa L.	biele/oyilee (Ob)	leaves	EA	walk early	1154, 1173
Boerhavia diffusa L.	katakala (Ob)	root	EN	intestinal cleanse	1170
Brideli atroviridis Müll.Arg.	monyombo (B)	bark	T	cough	1269
Brillantaisia lancifolia Lindau	ndolo (F)	whole plant	D	asthma	1252
Camptostylus mannii (Oliv.) Gilg	abumbu/ebubun/ebubung (F)	leaves	HB, A, M, D, EN	respiratory problems, colic, intestinal cleanse, malaria, meconium removal	852
Canna indica L.	ekwanzo (F)	leaves	EC	malaria	1061
Capsicum annuum L	oendodo/okam (F), petite piment/ piment/piment rouge (Fr)	leaves, fruit	EN	colic, CBD fesse rouge, diarrhea, meconium removal, CBD la rate, respiratory problems, fontanels, intestinal cleanse	806
Carica papaya L.	papaya (Fr)	leaves, root	T, SB	malaria, fever	988
Carpolobia alba G.Don	onong (F)	root, leaves	HB, D, S, EC	umbilical cord, fetus strengthener, post-circumcision, cough, CBD la rate, malaria, respiratory problems	779, 1056, 1255
Carpolobia sp.	enong (F)	root	S	post-circumcision	NC
Cecropia peltata L.	assong/asung (F)	bark	EN, D	walk early, meconium removal, cold	1074
Ceiba cf. *pentandra* (L.) Gaertn.	guna (M)	bark	E, D	asthma, CBD la rate	NC
Chaetocarpus africanus Pax	otikancha (Ob)	leaves	EA	fontanels	1157
Cissus cf. *aralioides* (Welw. ex Baker) Planch.	ngun-ele (F)	leaves	EA	fontanels	NC
Cissus cf. *dewevrei* De Wild. & T.Durand	otoektoek (F)	leaves	EA	CBD fesse rouge	860
Citrus aurantiifolia (Christm.) Swingle	alas/olass (F), citron (Fr)	fruit, leaves	D, EN, HB, SB, T, EA, E	malaria, measles, chicken pox, cough, newborn health, asthma, stomachache, CBD la rate, constipation, meconium removal, CBD pogha, CBD fesse rouge, diarrhea,	1059, 1168
Citrus sp. *CF*	canne acid (Fr)		HB	measles	NC
Cleisthopholis sp. *CF*	avum (F)	bark	DR	newborn health	NC
Clerondendron sp.	bejim elok/beyemalol/ebele bejium (F), reine des herbes (Fr)	leaves	EA, A, M	fontanels, CBD onkoe	851

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #
Coffea canephora Pierre ex A.Froehner	café (Fr)	leaves	SB	fever	1158
Cogniauxia podolaena Baill.		root	DR	CBD la rate	1229
Cola cf. *digitata* Mast.	hekoa (M)	bark	HB	measles	NC
Cola sp.	abe/abu (F), kola (Fr)	seed, fruit, bark	S, D, E, EA	post-circumcision, cough, fetus strengthener, fontanels	874
Colocasia esculenta (L.) Schott	taro (M)	bark	D	CBD la rate	NC
Combretum aphanopetalum Engl. & Diels	sissa (F)	leaves	EA	CBD fesse rouge	859
Costus ligularis Baker	mukusa rouge (B)	whole plant	T	cough	1297
Costus sp.	myen (F), canne sauvage (Fr), obong (T)	leaves, stems, whole plant	D, EN, M, EA, SiB, EN, HB, DR, T	asthma, diarrhea, malaria, CBD fesse rouge, CBD la rate, measles, fontanels, CBD bad lungs after birth, chicken pox, fever, respiratory problems	987
Coula edulis Baill.	ohoungou (M)	bark	E	diarrhea	NC
Croton cf. *oligandrus* Pierre ex Hutch	obumba		EN	CBD la rate	NC
Croton mayumbensis J.Léonard	dibamba (B)	bark	HB	fetus strengthener, CBD pogha	1264
Cucumeropsis mannii Naudin	inchoko/jokou (B), concombre traditionelle (Fr), joka (Ob)	seed, stem, leaves	E, V, DR, HB	diarrhea, walk early, growth stimulation, cough, fetus strengthener	NC
Cyathula prostrata (L.) Blume	chatee (B), kolo/kolok (F), oborbe grande feuille (Fr)	leaves, seeds, flowers	E, EA	diarrhea, fontanels	831, 893, 1294
Cylicodiscus gabunensis Harms	odouma (B), edum (F)	bark	D, HB, EN	malaria, vermifuge	1301
Cymbopogon citratus (DC.) Stapf	tisane (F)	leaves	T, EN	malaria, measles	NC
Cymbopogon sp.	citronelle (Fr)	leaves	D, T, SB	malaria	NC
Dacryodes cf.sp.	unguu (B), ebo (C)	bark	E	diarrhea	1278
Daniellia klainei A.Chev.	owengey (B)	bark	HB	CBD pogha	1280
Desmodium adscendens (Sw.) DC.	oborbe petit feuille (Fr)	leaves	EA	fontanels	833
Diodella scandens (Sw.) Bacigalupo & E.L.Cabra	oyemze (F)	leaves	EA, E	toothache, cough	886, 1234
Dioscorea bulbifera L.	bibuma abang (F)	tuber		malaria	1207
Dioscorea sp.	nyam (F)	tuber	D	CBD la rate	NC
Distemonanthus benthamianus Baill	eyem (F)	bark, leaves	HB, D, E	newborn health, fetus strengthener, fontanels	NC
Dracaena fragrans (L.) Ker Gawl.	alen-okpo (F)	bark	EN	walk early	1235
Duboscia cf. *macrocarpa* Bocq.	abak (F)	leaves	EN	walk early	NC
Dysphania ambrosioides (L.) Mosyakin & Clemants	ontchoutchoulou (Ob)	whole plant	SB	malaria	1175
Eclipta prostrata (L.) L.	ivainamoye (B), movindera/oyira (Os)	whole plant, leaves	EA, M	CBD fesse rouge, fever, hemorrhoids	1167, 1273, 1403

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #
Elaeis guineensis Jacq.	esong/onbonmiban (F), huile de palme (Fr)	heart, fruit, seeds	E, EA, M	fetus strengthener, fontanels, CBD la rate, heat rash, post-circumcision, sores, intestinal cleanse, meconium removal, umbilical cord, CBD fesse rouge, measles	NC
Eleusine indica (L.) Gaertn.	alekinedou (Om)	root	M	CBD la rate	1164
Emilia coccinea (Sims) G.Don	mungusungusu (B), alanopo/olonvoe (F)	leaves, whole plant	D, EC, HB, EA	measles, newborn health, umbilical cord, walk early, CBD fesse rouge, meconium removal	1247, 1285
Erythrina droogmansiana De Wild. & T.Durand	esoesoek/esok (F)	bark	M, EN, D, C	CBD la rate, anti-sorcery	881
Ficus exasperata Vahl	ako (F)	bark	EA, D	umbilical cord, cough, fetus strengthener	1239
Ficus mucuso Welw. ex Ficalho	ekoko/ekokok (F)	leaves	EN	colic, meconium removal	NC
Fleroya cf. *ledermannii* (K.Krause) Y.F.Deng	otzeyzam (F)	bark	M	CBD bad lungs	NC
Geophila afzelii Hiern	koudou/kudu (B)	whole plant, leaves	V, EA	CBD la rate	1308
Gossypium barbadense L.	coton (F)	leaves	D	asthma	NC
Guibourtia tessmannii (Harms) J.Leonard	oveng (F)	bark, resin	HB, C	newborn health, anti-sorcery	NC
Harungana madagascariensis Lam. ex Poir.	atuin (F)	bark, leaves	SiB, EN, DR, HB,	post-circumcision, diarrhea, CBD fesse rouge, post-circumcision, intestinal cleanse, CBD la rate, measles	778
Heterotis decumbens Jacq.-Fél.	sangancho (Om)	leaves	T	malaria	1166
Hibiscus acetosella Welw. ex Hiern	esang (F), l'oseille (Fr)	flower	M	CBD fesse rouge	885
Hibiscus sp.	osaill (F), ozai (Os)	leaves, whole plant	EA, V	fontanels, walk early	NC
Irvingia gabonensis (Aubry-Lecomte ex O'Rorke) Baill.	mangue sauvage (Fr), muebe (P)	bark, leaves	M, D	CBD la rate, fetus strengthener, fever	NC
Jatropha gossypiifolia L.		leaves	T	asthma	1159
Kalanchoe crenata (Andrews) Haw.	ivivuma (F), odiokiya (M), landunga (Ob), edokia (Os), majujuga (P), jejoujuga, jewa (T)	leaves, whole plant	D, DR, EA	respiratory problems, cold, ear disorders, umbilical cord, antibiotic, cough, flu	758, 979
Lantana camara L.		leaves	T	malaria	1188
Laporteaaestuans (L.) Chew	tak-akun (F)	whole plant	SB	premature birth	1244
Lasianthera africana P.Beauv.	mundungu (B)	bark	HB	growth stimulation, strengthen fetus	NC
Leea guineense G.Don	mbala (Om)	bark	D	fetus strengthener	NC
Leguminosae cf. sp.	rekoa (B)	bark	D	malaria	1265
Leptactina mannii Hook.f.	ewas wasakulu (F), bois des os (Fr)	bark, leaves	HB, D	growth stimulation	814
Lygodium cf. *microphyllum* (Cav.) R. Br.	nzalanu (F)	leaves	E	diarrhea	NC
Macaranga barteri Müll.Arg.	echemey (B)	bark	T	walk early	1288
Macaranga saccifera Pax	mopoapoa (B)	bark	HB	fetus strengthener, CBD pogha	NC

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #
Macaranga spinosa Müll.Arg	macaranga/mungembe (B), lasass (F)	leaves, bark	EC, EN, T	malaria, walk early, meconium removal, respiratory problems	1064
Maesopsis eminii Engl.	enkangalle (F), mangobey (M)	bark	D, EN, T, HB	cough, CBD fesse rouge, malaria, CBD la rate, CBD pogha	NC
Mangifera indica L.	endok (F), mangue (Fr)	leaves, bark, root	T, SB, EN, D	malaria, hemorrhoids, diarrhea, fever, CBD fesse rouge	NC
Manihot esculenta Crantz	menza (F), manioc (Fr), ayaga (Ob)	leaves, tuber	EA, HB, D, EN,	measles, chicken pox, fetus strengthener, intestinal cleanse	NC
Maprounea membranacea Pax & K.Hoffm.	baobao (Fr)	leaves	D	walk early	1348
Melia azedarach L.	kadunga (Ob)	leaves	T	malaria	1169
Millettia gagnepainiana Dunn	fe-enziee (F)	liana	HB	umbilical cord	NC
Millettia mannii Baker	diperie (M), vinekwey (F)	bark, liana	D, A	intestinal cleanse, meconium removal, newborn	NC
Mimosa cf. *diplotricha* Sauvalle	ebata (B)	leaves	V	respiratory problems	1196
Momordica cf. *foetida* Schumach.	eyenzum (F)	whole plant	EN	CBD ebem	NC
Momordica charantia L.	mabubulu (M), mabunbula (P)	leaves	D, EN, HB	colic, diarrhea, intestinal cleanse, crisis, measles, intestinal cleanse	NC
Morinda lucida Benth.	akong (F)	bark	D, EN, T, HB	intestinal cleanse, CBD la rate, malaria	858, 1213, 1214
Musa sp.	banna (B), anginve/atoran/elat- onton-ekon/enbok-ono (F), bannane (Fr), makokodo (Os)	leaves, fruit, root	EN, M, D, EA, HB, SB, T, E, A	convulsions, CBD fesse rouge, CBD la rate, cough, umbilical cord, fetus strengthener, meconium removal, malaria, diarrhea, post-circumcision, fontanels, vermifuge	NC
Musanga cecropioides R.Br. ex Tedlie	enseng (F)	bark	EN	CBD ebem	NC
Myrianthus arboreus P.Beauv.	angokon/ekokom/enkokun-mieng (F)	bark, fruit, leaves	EA, DR, E, D, EN, EC	fontanels, food, fetus strengthener, walk early, diarrhea, malaria	NC
Myrianthus serratus (Trécul) Benth.	afulum (F)	whole plant	HB	newborn health	1251
Newbouldia laevis (P.Beauv.) Seem.	l'izop (Fr), ovendo (Om),	bark, leaves	D, HB	cough, good luck	1187
Nicotiana tabacum L.	tabac (Fr)	leaves	EA, M, EN	CBD fesse rouge	NC
Nymphaea lotus L.	otoeto (F)	leaves	EN	respiratory problems	NC
Ocimum americanum L.	ocim (F)	whole plant, leaves	DR, EA	earache, walk early	NC
Ocimum gratissimum L.	massep (F), aduma duma (Ob)	whole plant, leaves	T, EA, D, EN, M, HB	cold, cough, fever, toothache, CBD fesse rouge, diarrhea, intestinal cleanse, umbilical cord	1072, 1160, 1172
Ocimum sp.	ndzip (F), ndiandzi (P)	leaves, whole plant	D, EN	cough, malaria, intestinal cleanse	NC

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #
Oryza sativa L.	riz (Fr)	seed	E	diarrhea	NC
Palisota cf. sp.	injokou (B)	leaves	HB	growth stimulation	1290
Panda oleosa Pierre	afan (F)	bark	EN	intestinal cleanse	NC
Parinari excelsa Sabine	otcha (B)	bark	HB	CBD pogha	1281
Passiflora foetida L.	matuka makari (P)	leaves	D	newborn health, diarrhea	NC
Pennisetum cf. *glaucum* (L.) R.Br.	wunzuku (P)	leaves		newborn health	NC
Pentaclethra cf. *eetveldeana* De Wild. & T.Durand	tzi (F)	whole plant, bark	DR	colic, intestinal cleanse	NC
Pentaclethra macrophylla Benth.	ebeng/nzesé (F), mpandzi (M), ompie (T)	bark, wood, seeds	M, EN, D	CBD la rate, asthma, fetus strengthener	834, 1077
Perichasma laetificata Miers	tsigue (F)	leaves, stem	EN, A, D	diarrhea	810, 832, 863
Persea americana Mill.	afia (F)	bark		toothache	1078
Phaseolus vulgaris L.	haricot (F)	leaves	D,HB	measles	NC
Phyllanthus amarus Schumach. & Thonn.	kunguh (F)	whole plant	T	flu	1053
Phyllanthus sp.	kanguh (F)	whole plant	T	diarrhea	1245
Picralima nitida (Stapf) T.Durand & H.Durand	dumavendo (B), ansongomo (F), dirundu (M)	bark	D, EN	asthma, CBD la rate, malaria	NC
Piper umbellatum L.	abomanzan/obadzom (F), malemto (P),	leaves, whole plant	EA, EN, HB	hemorrhoids, post-circumcision, intestinal cleanse, growth stimulation, measles	877, 1246
Piptadeniastrum africanum (Hook.f.) Brenan	miso-miso/tum (F)	bark	EN	CBD la rate	816a
Plagiostyles africana (Müll.Arg.) Prain	esula (F)	bark	HB	newborn health	NC
Portulaca oleracea L.	afosi (F), oyabi (Ob)	whole plant	SB, E	premature birth, sores	1176
Pseudospondias longifolia Engl.	ofoss (F)	fruit	E	kids' food	1081
Psidium guajava L.	guave (F)	leaves	D, T, SB	diarrhea	NC
*Psydrax*cf. *palma* (K.Schum.) Bridson	colera (F)	herb	EA	fontanels	NC
Pterocarpus soyauxii Taub.	motobo (B), esi/umbey (F), kaolin rouge (Fr), motomba/padouk (M)	wood, bark	SM, S, EA, HB, D, EN	post-circumcision, fontanels, measles, chicken pox, umbilical cord, fontanels, walk early, crisis, respiratory problems, diarrhea	NC
Pycnanthus angolensis (Welw.) Warb.	ecombo/muchoko (B), etong (F), otchokou (M)	bark, leaves	T, M, D, EN, SiB, HB	respiratory problems, fontanels, excessive salvia, cough, CBD fesse rouge, CBD pogha	1076, 1090, 1195, 1284
Quassia africana (Baill.) Baill.	izien iral (M)	root	D	malaria	895
Rauvolfia mannii Stapf	obaton (F)		E, D, T	malaria, CBD la rate	NC
Ricinodendron cf. *heudelotii* (Baill.) Heckel	essessa (F)	leaves	D	fetus strengthener	NC

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #
Saccharum officinarum L.	enkok (F), canne sucre (Fr)	whole plant, stem	D, T, E	asthma, flu, malaria, meconium removal	NC
Sacoglottis gabonensis (Baill.) Urb.	ozohgo (B)	bark	EA	CBD la rate	NC
Sarcocephalus latifolius (Sm.) E.A.Bruce	ebohwey (Os), ondolo (T)	root, bark	D	malaria, anti-sorcery	1404
Scleria boivinii Steud.	zengey (B, M), fofolou (F), laim sauvage (Fr), kengitsie (P)	leaves, whole plant	DR, EA	umbilical cord	1199
Scoparia dulcis L.	mnserè (F), ogandarga (Om)	leaves, whole plant	D, TP	vermifuge, walk early	830, 1165
Scorodophloeus zenkeri Harms	kaakey (B)	bark	HB	CBD pogha, fetus strengthener	NC
Senna alata (L.) Roxb.	moviovo (B), dowlontou (F), kinkiliba (Fr), kangadiba (M), angare/oumara (T)	leaves	D, EA, EN, T	stomachache, blisters, diarrhea, CBD fesse rouge, malaria, constipation, meconium removal	1210, 1320
Senna occidentalis (L.) Link	besi (F), ngari (Ob)	whole plant, leaves	EN, EA	CBD la rate, skin diseases	1055
Sesamum radiatum Schumach. & Thonn.	mokoka (Os)	leaves	HB	fever	1405
Sida acuta Burm.f.		whole plant	M	walk early	NC
Solanecio angulatus (Vahl) C.Jeffrey	budiambu	leaves	D	crisis	NC
Solanum americanum Mill.	otchango (M)	leaves	D	cough, fetus strengthener, fever	1323
Spathodea cf. *campanulata* P.Beauv.	evuvum (F)	leaves	DR	cough	NC
Staudtia kamerunensis var. gabonensis (Warb.) Fouilloy	oghobey (C)	bark		cough	1256
Streptogyna cf. *crinita* P.Beauv.	bongi (M)	whole plant	E	diarrhea	NC
Tabernanthe iboga Baill.	bois sacre (Fr)	root	D	fetus strengthener, anti-sorcery	NC
Telfairia cf. *pedata* (Sm. ex Sims) Hook.	ayuzum (F)	leaves	D	colic, meconium removal	NC
Terminalia catappa L.	huile d'almande (Fr)	seed	EA, M	fontanels, post-circumcision, measles, fever, CBD fesse rouge	NC
Tetracera sp.	nzrnzu (F)	wood	D	fetus strengthener	NC
Tetrapleura cf. *tetraptera* (Schum. & Thonn.) Taub.	ozara (B)	bark	HB	CBD pogha	1302
Tetrorchidium didymostemon (Baill.) Pax & K.Hoffm.	nzili (F), ngoumou (Ob)	leaves, bark	D, EN	colic, constipation, meconium removal, vermifuge	1171, 1202
Thomandersia congolana De Wild. & T.Durand	umbazal (F)	root	D	fetus strengthener	1253
Tithonia diversifolia (Hemsl.) A.Gray	margarit (F)	leaves, whole plant, flower	EN, EA, HB, M	CBD la rate, intestinal cleanse, malaria, measles, CBD fesse rouge	862
unidentified (AMT 1087)	inziga kusu (F)	liana	D	lung cleanse	1087
unidentified (AMT 1243)	anyang (F)	whole plant	SB	premature birth	1243

Botanical Name	Vernacular Name[a]	Used part	Preparation[b]	Use category[c]	AMT #
Vernonia amygdalina Delile	bikambilar/joloyolo/zomalyo (F), kongobulubu/ondole (Ob), kungubulu (T)	leaves, bark	EN, D, HB, EC	intestinal cleanse, toothache, vermifuge, CBD la rate, measles, malaria, chicken pox	807, 980, 1070, 1153, 1174
Vernonia conferta Benth.	abanga/abankak (F)	bark	T, D	diarrhea	1071, 1201
Vernonia sp.	mopotopoto (B)	whole plant		CBD la rate	1257
Vitellaria paradoxa C.F.Gaertn.	berre de carite (Fr)	seed	M	CBD la rate	NC
Xylopia aethiopica (Dunal) A.Rich.	bikwin (F)	fruit	S	post-circumcision	NC
Zanthoxylum cf. *heitzii* (Aubrév. & Pellegr.) P.G.Waterman	olom (F)	bark	D	asthma	NC
Zea mays L.	mais (Fr)	fruit	EA, HB	measles	NC
Zingiber officinale Roscoe	gingembre (Fr), maketa (Om)	rhizome	D, EA, EN, V	cough, CBD fesse rouge, respiratory problems	NC

a Local languages are abbreviated: (B)= Babungu; (C)= Commercial timber name; (F)= Fang;(Fr)= French; (M)= Mitsogo; (Ob)= Obamba; (Om)= Omiene; (Os)= Ossimba; (T)= Teke

b Preparations are abbreviated: (A)= attach; (C)= ceremony; (D)= drink; (DR)= drops; (E)= eat; (EA)= external application; (EC)= encircle; (EN) = enema; (HB)= herbal bath; (S)= spit; (SB)= steam bath; (SiB)= sit bath; (SM)= envelop in smoke; (T)= tea; (TP)= tap on feet; (M)= massage; (V)= vaccination

c Use category abbreviations are as follows: CBD= cultural bound disease

d Botanical voucher number and collector initials; NC= not collected.

Chapter Five

Volume, value and floristic diversity of Gabon's medicinal plant markets

Alexandra M. Towns, Diana Quiroz, Lieke Guinee, Hugo de Boer, and Tinde van Andel

Published in *Journal of Ethnopharmacology* 155: 1184-1193, 2014

Abstract

Ethnopharmacological relevance

African medicinal plant markets offer insight into commercially important species, salient health concerns in the region, and possible conservation priorities. Still, little quantitative data is available on the trade in herbal medicine in Central Africa. The aim of this study was to identify the species, volume, and value of medicinal plant products sold on the major domestic markets in Gabon, Central Africa.

Materials and methods

We surveyed 21 herbal market stalls across 14 of the major herbal medicine markets in Gabon, collected vouchers of medicinal plants and documented uses, vernacular names, prices, weight, vendor information and weekly sales. From these quantitative data, we extrapolated volumes and values for the entire herbal medicine market.

Results

We encountered 263 medicinal plant products corresponding with at least 217 species. Thirteen species were encountered on one-third of the surveyed stalls and 18 species made up almost 50% of the total volume of products available daily, including the fruits of *Tetrapleura tetraptera* and seeds of *Monodora myristica*. Although bark comprised the majority of the floristic diversity (22%) and the highest percentage of daily stock (30%), the resin of IUCN red-listed species *Aucoumea klaineana* represented 20% of the estimated daily volume of the entire herbal market. Plants sold at the market were mainly used for ritual purposes (32%), followed by women's health (13%), and childcare (10%). The presence of migrant herbal vendors selling imported species, especially from Benin, was a prominent feature of the Gabonese markets.

Conclusion

An estimated volume of 27 tons of medicinal plant products worth US$ 1.5 million is sold annually on the main Gabonese markets. *Aucoumea klaineana* and *Garcinia kola* are highlighted as frequently sold species with conservation priorities. The herbal market in Gabon is slightly higher in species diversity but lower in volume and value than recently surveyed sub-Saharan African markets.

Keywords

Non-timber forest products (NTFPs); informal economy; Central Africa; trade; herbal medicine; plant conservation

Introduction

The role of medicinal plants as non-timber forest products (NTFPs) in Africa has been well established in conservation, ethnobotany and sustainable development literature (Cunningham, 1993; Gaoue and Ticktin, 2007; Shackleton and Shackleton, 2004; Ticktin, 2004). The sale and trade of these plants form part of the informal economy of many African countries and contribute to the economic wellbeing of plant vendors, many of whom are women (Dold and Cocks 2002; Quiroz et al. 2014; Jusu and Sanchez 2013). Medicinal plants make substantial contributions to the income of plant vendors involved in the industry as well as to the health of consumers; the majority of sub-Saharan African populations use traditional medicine to meet their healthcare needs (Anyinam 1995). This pattern is prevalent in rural communities, where health clinics are often poorly equipped (Pouliot 2011), but also in urban centers, where biomedical treatment is readily available in hospitals and health centers (Cocks and Dold 2006; Osamor and Owumi 2010).

The combined effects of the profitability of medicinal plants, the high demand by local populations, and the fact that most plants are harvested from the wild (Schippmann, Leaman, and Cunningham 2002) have contributed to the concern that commercialized species may be overexploited resources. In several African countries, there is evidence that the commercial harvest of herbal medicine to meet a growing urban population has become an environmentally destructive activity (Cunningham, 1993; Dold and Cocks, 2002). Market sellers in Western Africa have been shown to use a larger variety of plants and more vulnerable species than harvesters who collect plants for personal use (Towns et al., 2014), suggesting that studying the medicinal plant trade is useful in investigating the exploitation of wild plants of a larger area (Cunningham, 2001; Williams, Witkowski, and Balkwill, 2009). Studying the medicinal plant market can contribute to improved decision-making in sustainable land-use management and livelihoods (Jusu and Sanchez 2014).

Before focused efforts can be made on estimating the effect of commercial plant harvesting on the surrounding vegetation, baseline figures are needed on the species, value, quantities, and characteristics of the marketplaces in question. Recently, quantitative surveys of herbal markets have become available for African countries, including South Africa (Dold and Cocks, 2002; Williams, Balkwill, and Witkowski, 2000; Williams et al., 2009), Tanzania (McMillen 2008), Morocco (El-Hilaly, Hmammouchi, and Lyoussi 2003), Benin (Quiroz et al. 2014), Ghana (van Andel, Myren, and van Onselen 2012) and Sierra Leone (Jusu and Sanchez 2013). Much less information, however, is available on markets in the Central African region, including Cameroon (Betti 2002) and Equatorial Guinea (Ondo 2001). Gabon is of special interest to conservation given its unique biodiversity (Olson and Dinerstein 1998) and its current ranking as the country with the highest rate of loss of primary forest in Africa (FAO 2010c), but little information is available on its herbal medicine trade.

In order to fill the gap of knowledge on Gabonese commercialized medicinal plant species, we conducted a market survey in the major cities of Gabon. The aim of our study was to identify the species, volume, and value of medicinal plant products sold domestically on major markets in Gabon. We also sought to identify the most frequently sold species and plant parts and the most salient health concerns treated by plants sold at the market. Given Gabon's lower population density and higher standards of living than other African countries, we hypothesized that the Gabonese medicinal plant markets would be smaller in volume and floristic diversity than those in West Africa, Tanzania and South Africa. The outcomes of this market survey can be used to identify priority species for conservation, contribute to an understanding of the role of medicinal plant sales on the socioeconomic wellbeing of market vendors, and highlight the populations' salient health concerns.

Materials and Methods

Study area

Gabon is located in Central Africa, bordering the Atlantic Ocean to the west, the Republic of the Congo to the east and south, and Equatorial Guinea and Cameroon to the north. Up to 80% of Gabon has been estimated to be covered with forest (Sosef et al. 2006), with approximately 65% considered primary forest and remaining land consisting of swamps, mangroves, and savannas (FAO 2010c). The Gabonese population is around 1.6 million people, mainly of Fang, Bapounou, Nzebi, and Obamba ethnic groups (CIA 2013b).

Data collection took place between June and November 2012, in which we visited major herbal medicine markets in the provinces of Estuaire, Woleu-Ntem, Haut-Ogooué, Ngounié, Moyen-Ogooué, Ogooué-Maritime, and Nyanga. We started our data collection in the capital city of Libreville, visiting the two main medicinal plant markets several times a week to speak with vendors and purchase plant species to be processed into botanical vouchers. This regular contact built up the trust necessary to begin our quantitative market surveys and familiarized us with the most common commercial species, local names, and salient health concerns treated with herbal medicine in Gabon. We then conducted a systematic quantitative survey of 21 market stalls, across 14 markets, in major and regional cities in Gabon: Libreville (pop. 619,000), Port-Gentil (pop. 80,000), Franceville (pop. 56,000), Oyem (pop. 38,000), Lambaréné (pop. 24,000), Tchibanga (pop. 24,000) Fougamou (pop. 4,100), and Cocobeach (pop. 1200) (Fig.1).

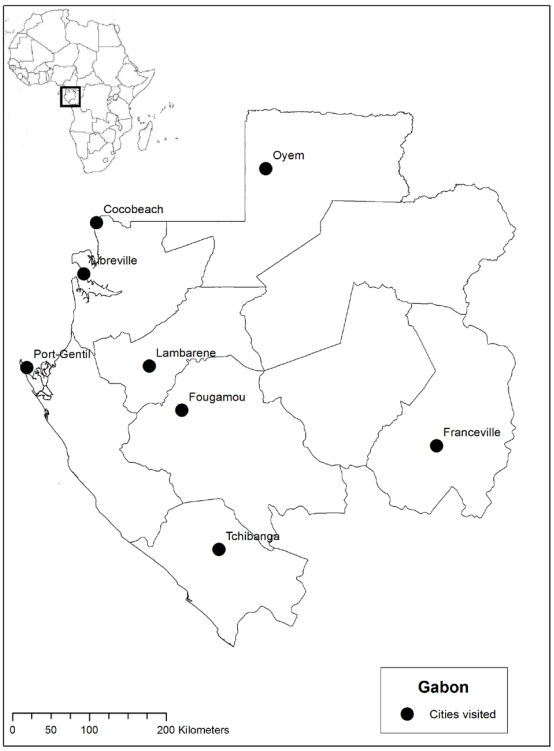


Fig.1 Map of Gabon with market cities visited during our quantitative market survey in 2012.

Quantitative market survey

Following the methodology carried out in market surveys in Ghana (van Andel, Myren, and van Onselen 2012) and Benin (Quiroz et al. 2014) and the guidelines for ethnobotanical market inventories (Cunningham, 2001), we began our quantitative survey by counting the number of herbal medicine stalls at each marketplace (n= 192). We categorized the stalls into five different types: (1) herb stalls (including barks and woody plant parts) (2) spice stalls (with dual purpose food/medicinal fruits and seeds including the palm wine bark *Garcinia kola*); (3) Bwiti stalls (plants used in spiritual practices and ceremonies); (4) ambulant vendors (market vendors on foot), and (5) Beninese herbal stalls (migrants from Benin selling imported plant species). We also collected general data on each market, including type of products sold and number of open days per week.

We then sampled individual stalls by randomly inviting 21 vendors to participate in our market survey. We counted the number of products sold, recorded the price of each product, collected ethnobotanical data of each product (local name, medicinal use, and preparation), tallied the total amount of sales units per stall (bags, bundles, bottles, and individual pieces), and measured each product's weight with a portable digital scale. All plant products recorded for sale are listed in Appendix 1, together with the local and scientific names, plant parts sold, collection numbers, medicinal uses, weights, and prices. We also estimated the total weight of stock in storage. For each surveyed stall, we asked the vendor to estimate his/her weekly sales and to report general information on challenges to selling plants. We also collected basic demographic data from each vendor, including ethnic group, sex, age, and name. Our market survey was part of a larger ethnobotanical inventory on medicinal and ritual plants in Gabon.

Plant collection and identification

For each new species we encountered at the market, we purchased the plant and made botanical vouchers following standard botanical collection methods (Martin 2004). If market samples were too dry or fragmented to be properly identified or lacked fertile plant parts, we later accompanied market vendors into the field to match market specimens with fertile species in the wild. We deposited vouchers at the Herbier National du Gabon (LBV) and exported duplicates to the Wageningen branch of the National Herbarium of the Netherlands (WAG), now part of Naturalis Biodiversity Center (L). We identified the plants using local botanical literature (Flore du Gabon, 1960-2008; Hawthorne and Jongkind, 2006; Raponda-Walker and Sillans, 1961; Sosef et al., 2006;) and the extensive herbarium collections of Gabonese material at Wageningen. Three collections were too difficult to identify with standard botanical keys, two of which were sent to a wood anatomist who utilized microscopic methods and the InsideWood database (InsideWood, 2004-onwards) and one which was identified by DNA analysis following the methodology detailed in Quiroz et al. (2014). We also assessed the conservation status of each species according to the International Union for Conservation of Nature Red List (IUCN Red List of Threatened Species, 2014) and the Convention on International Trade of Endangered Species list (CITES, 2014). Species and author names were updated using the Plant List (www.theplantlist.org). Full names, including authors, of all species are listed in the Appendix 1.

Data analysis

We first calculated the average weight (in kg) and reported price (in US$) of each medicinal plant product. We converted CFA currency prices into US dollars based on the exchange rate at the start of our market survey (US$ 1 = 535 CFA in July 2012). We then totaled the number of sales units of each product sold on the 21 surveyed stalls and calculated the volume (in kg) and monetary value of plant material offered for sale per market stall. We then multiplied these numbers by the number of stalls per marketplace, extrapolating the weight and values to the entire Gabonese market. Average weights were used for those products that we were unable to weigh (183 g for a piece of bark, 144 g for leaves, 104 g for herbs, 101 g for fruits, 78 g for roots, 67 g for wood, and 41 g for seeds). We estimated the price

per kilogram for species for which we did not know the price based on average price per sales unit of purchased products (wood US$ 4.67, roots US$ 3.74, bark US$ 1.85, leaves US$ 1.76, entire plant US$ 1.64, fruit US$ 1.60, seed US$ 1.03, and fungus US$ 0.93). We created a map of the cities visited during the market survey (Fig. 1) in ArcGIS 10.1 using open source geospatial data from DIVA-GIS (http://www.diva-gis.org/).

We performed a Detrended Correspondence Analysis (DCA) in PC-ORD v 5.33 in order to assess the similarity in floristic diversity among the four main stall types (McCune and Mefford 2006). All plant species cited by the 21 vendors were entered into presence–absence data matrices, which identified the two main axes that caused the distribution of the vendors and sold species. We plotted the 1st and 2nd axes in two-dimensional graphs to visualize the variation and overlap in plant species used by different market stalls and the variations in stall diversity between Gabonese and migrant vendors. In order to assess whether we sampled enough stalls, we created species-accumulation curve based on the Shannon diversity index of the number of plant products and species from the sampled market stalls. We calculated Shannon diversity indices in EstimateS version 9.10 (Colwell 2013).

Ethics

Following the Code of Ethics of the International Society of Ethnobiology (International Society of Ethnobiology 2006), we followed all protocols with partner institutions and universities, including the acquisition of formal invitations, research permits, and plant export permits. At each market setting, we carefully explained the nature of our research and obtained prior informed consent from each participant. In addition to purchasing the market plants with which we made botanical vouchers, we also offered financial compensation, equivalent to local norms, for vendors' involvement in the research.

Results

Market characteristics

The 14 markets we visited during our quantitative market survey varied from the large metropolitan markets of Libreville with a variety of spice, herb, and Bwiti stalls to the small village market of Cocobeach with only two spice stalls (Table 1). Out of the 192 stalls we counted, the majority were spice stalls (n= 108), followed by herb stalls (56), Bwiti stalls (16), and Beninese vendors (11). We encountered only one ambulant seller on the main market in Mont Bouët, which was left out of Table 1. The Libreville stalls, with a combined total of 5045 kg of medicinal plant stock, comprised nearly 75% of the total weight of medicine plant products available daily for sale in Gabon (out of the total 192 stalls). Although spice stalls are fairly evenly distributed across the country, Libreville housed the main trade in herbal medicine. Marché Bornave in Port-Gentil housed the most Bwiti stalls out of all the markets we visited. The medicinal plant vendors were largely part of the main markets containing food, fish, clothes, and small sundry items and sold products six or seven days a week. The marketplaces were dominated by female vendors; 90% of the surveyed stalls were managed by women.

Table 1 Characteristics of 14 marketplaces visited during 2012 Gabon herbal market survey.

Location (Market)	Sales frequency (days / wk)	Description	Spice stalls	Herb stalls	Bwiti stalls	Benin stalls	No. of sampled stalls (% of total)	Est. % of total floristic diversity	Total daily stock (kg)
Cocobeach	7	Small village market, border with Equatorial Guinea	2	0	0	0	0	6	17
Fougamou	7	Canned food, sandals, plastic buckets, smoked fish	4	0	0	0	0	6	33
Franceville (Grand Marché Poto-Poto)	7	Fruits, vegetables, bush meat, clothes	7	2	0	0	0	8	135
Lambaréné (Marché Issac)	7	Mainly fish, food	8	0	0	0	0	7	73
Libreville (La Peyrie)	6	Medicinal plants, herbs fresh, sellers harvest on Mondays	0	13	0	0	4 (31)	36	1623
Libreville (Mont Bouët Main Market)	6	Food, clothes	16	0	9	8	4 (12)	13	1030
Libreville (Mont Bouët)	6	Medicinal plants, herbs fresh, sellers harvest on Mondays	0	38	0	0	5 (13)	39	1987
Libreville (Nkembo)	6	Food, fish, clothes	49	0	0	0	4 (8)	6	404
Oyem (Marché Akouokam)	7	Vegetables, fruits, and food	5	0	0	0	1 (20)	6	41
Oyem (Marché Ngouema)	7	Vegetables, fruits, and food	12	1	0	0	2 (15)	15	138
Port-Gentil (Marché Balise)	7	Vegetables, fruit, clothes	0	0	0	3	0	3	19
Port-Gentil (Marché Bornave)	7	Ritual plants	0	0	7	0	1 (14)	11	1050
Port-Gentil (Marché Grand Village)	7	Vegetables, fruit, clothes,	4	0	0	0	0	6	33
Tchibanga (Marché de la Gare Routière)	6	Fresh vegetables, dry fish	1	2	0	0	0	7	86
TOTAL			**108**	**56**	**16**	**11**	**21* (11)**	**100%**	**6807**

*including one ambulant seller

Although 81% of the sampled market stalls were headed by vendors of Gabonese nationality, we also encountered several vendors from other Western African countries, including Benin, Cameroon, Niger, Nigeria, and Togo. Beninese vendors were the most frequently encountered migrants selling herbal medicine. Migrant sellers sold distinct species not marketed by the Gabonese vendors. For example, large quantities of *Afrostyrax* sp. (DQ 1106) fruits reported to be imported from Cameroon were found on a spice stall of a Cameroonian vendor, and imported savanna barks such as *Lannea barteri* and *Pteleopsis suberosa* were observed on the Beninese herbal stalls. In Fig. 2, the 21 stalls are arranged by similarity of species composition. Points that are closely clustered have many species in common. Points that are farther apart have less botanical similarity. Gabonese herb and spice stalls, as well as the migrant spice and Bwiti stalls, were similar in floristic composition. The Togolese spice stall was unique in that it contained only one species, the bark of *Scorodophloeus zenkeri*, which was also found on one herb stall and one additional spice stall. The outlying herb and spice stalls clustered near the x axis have unique species not recorded on other Gabonese stalls. The species and weights counted on each stall are reported in full detail in Appendix 2.The Beninese herbal stall that we surveyed clearly stood out as an outlier among the sampled herb stalls. The Beninese stall sold common species from the Beninese herbal medicine market (Quiroz et al. 2014) not present on Gabonese herb stalls. The ambulant seller was selling only two species, *Annickia affinis*, which was found abundantly on herb stalls, and *Cymbopogon citratus*, which was also commonly sold on the market but not present on the stalls we surveyed.

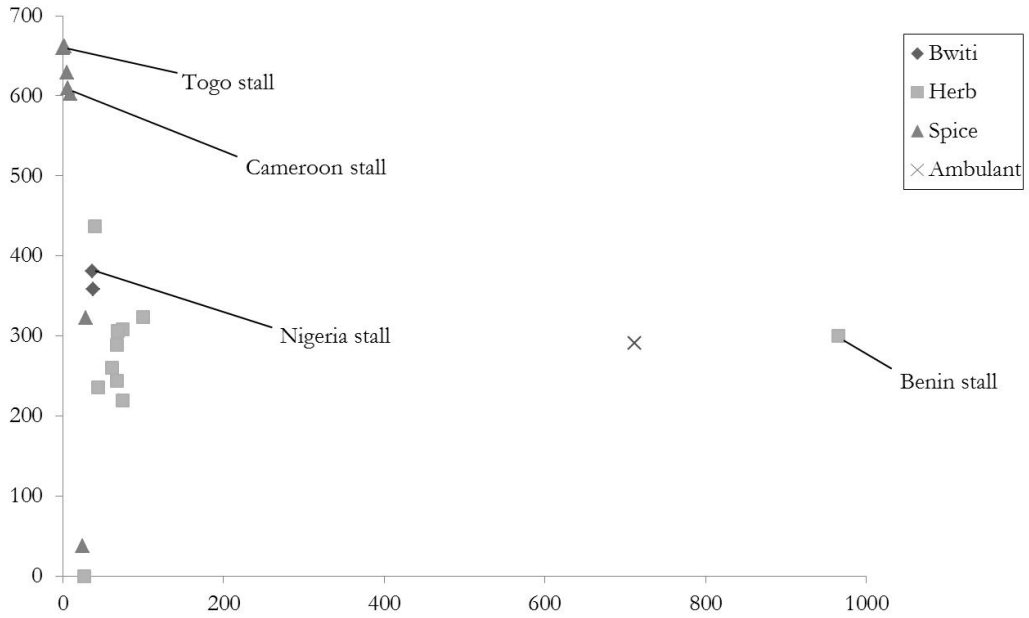


Fig.2. Detrended Correspondance Analysis indicating the similarity in floristic diversity among the four main stall types surveyed in Gabon [Herb (n=11); Spice (n=7); Bwiti (n=2) and Ambulant (n=1)]

Floristic diversity

Over the course of our six month study, we encountered 263 medicinal plant products, belonging to 217 individual species, of which 160 were identified to species level, 36 to genus level, and three to family level (Appendix 1). The remaining 18 remain unidentified to family level due to insufficient sample material. We encountered more plant products than species since many plant parts sold individually were from the same species (for example the resin and bark of *Aucoumea klaineana*). The plant families with the most number of species for sale on the market were Leguminosae (33 spp.),

Rubiaceae (16 spp.), Euphorbiaceae (12 spp.), Annonaceae (11 spp.), Apocynaceae and Malvaceae (10 spp. each), Zingiberaceae (8 spp.), and Asteraceae and Solanaceae (7 spp. each). After sampling 21 stalls, we encountered 66 % (174 out of 263) of the total plant products and 71% of the existing botanical variation (155 out of 217 species). Plant mixtures were excluded from this calculation since they combined many species, most of which were also sold separately. Our sampling represented approximately 10% of the total number of medicine stalls on the 14 marketplaces we visited. Although our accumulation curves (Fig. 3) do not level off completely, the flattening of the line suggests that our sample size was adequate to give a representative overview of the diversity of medicinal plant species and products sold on the marketplaces in 2012.

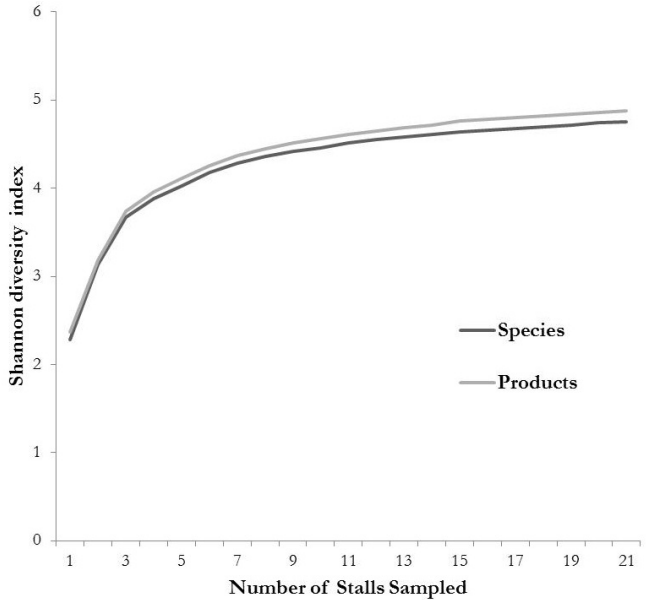
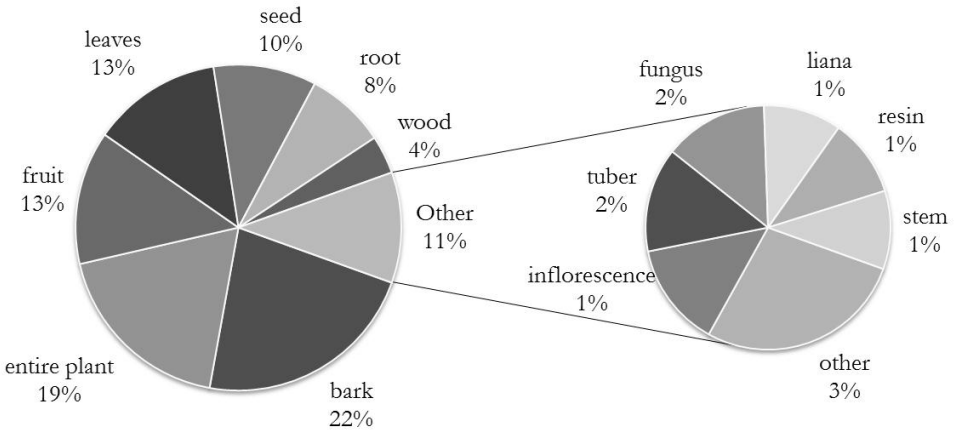


Fig.3. Shannon diversity index cumulative curve for species and products sold on the 21 markets stalls sampled in Gabon (2012).

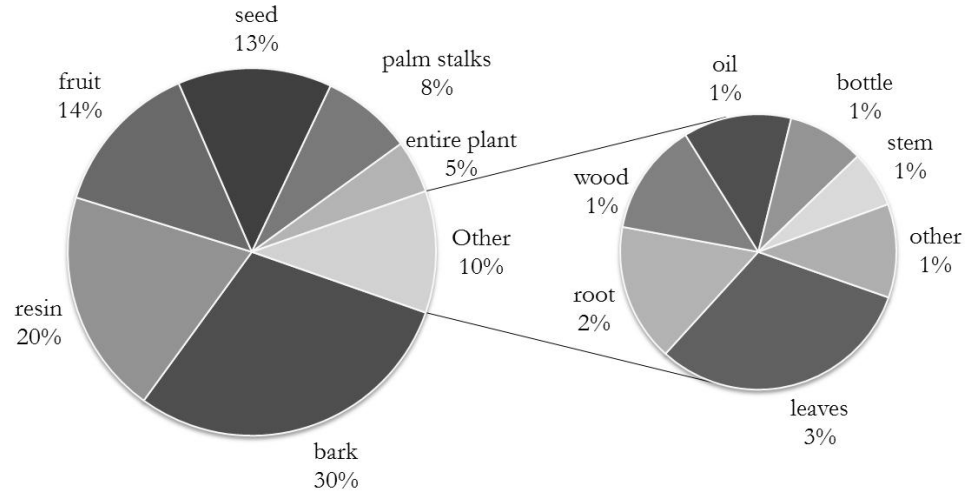
Barks comprised the largest percentage of plant diversity (22%), followed closely by the entire plant (19%), fruits (13%), and leaves (13%) (Fig. 4a). Those plant parts that made up less than 1% of the total (rhizome, branch, oil, palm stalks, fibers) were combined under the heading "other." Bark was also sold in the greatest volume (in kg) on the marketplaces that we visited (30%) (Fig. 4b), followed by resin (20%), fruits (14%), and seeds (13%).

Prices, Frequencies, and Volumes

The average price per sales unit of medicinal plant products in Gabon did not vary greatly (bark US$ 1.85, leaves US$ 1.76, entire plant US$ 1.64, fruit US$ 1.60, seed US$ 1.03, and fungus US$0.93), except for wood and roots that were US$ 4.67 and US$ 3.74 respectively. The most expensive species were found on a Bwiti stall at Marché Bornave in Port-Gentil: the inflorescences of *Streptogyna crinita*, which were sold in very small quantities (1 gram) at the rate of US$ 1869 per kilo, unidentified seed "kandrina" (Bapounou) (AMT 1354), which was sold by piece at the rate of US$ 623 per kilo, and unidentified fruit "kiliguu" (Mitsogho) (AMT 1041), which was sold by piece at the rate of US$ 748 per kilo. It should be taken into account that these products are always sold in very small quantities. The remaining prices of plant products ranged from US$ 359 per kilo for the wood of *Nauclea diderrichii* to US$ 1.25 per kilo for the leaves of *Cymbopogon citratus* (Appendix 1). We calculated the average price of all medicinal plant species sold on the 21 surveyed stalls to be US$ 56 per kilo.



(a)



(b)

Fig. 4. Plant parts sold on herbal markets sampled in Gabon 2012, (a) percentage of the total number of products (n=263), and (b) percentage of daily stock (excluding stock stored behind stalls).

The reported weekly sales varied greatly by market vendors with whom we spoke. The estimated weekly sales figures represented the value of products sold per week but it did not include transportation and collection costs. Therefore, the average income of each market vendor is likely lower than the reported sales. On average, Bwiti stalls reported sales of US$ 327 a week, herb stalls reported sales of US$ 197 a week (with a range of US$ 654 by a wholesale vendor selling mainly barks to US$ 22 a week for a small herb stand), spice stalls reported sales of US$ 131 a week, Beninese vendors reports sales of US$ 56 a week and ambulant sellers reported sales of US$ 6 a week. The relatively higher reported weekly sales of Bwiti stalls may be reflective of the higher price of ritual plants, the possibility that this figure included the sale of animal products (which were generally more expensive than plant products), and/or the basis of the Bwiti calculation on only one vendor (which may not reflect the weekly sales of an average Bwiti vendor). Based on these reported average sales, we estimated the annual value of medicinal plant trade in Gabon to be US$ 1,538,936 in 2012.

The species encountered most frequently in the 21 surveyed market stalls were the fruits of *Tetrapleura tetraptera*, the seeds of *Monodora myristica,* and the resin of *Aucoumea klaineana* (Table 2). Although *A. klaineana* resin was sometimes found to be sold alone, it was typically wrapped in the bark of *Xylopia aethiopica* to form the interior of an indigenous torch used in ceremonies.

Table 2 Species encountered in more than one third (29%) of the 21 surveyed stalls in Gabon 2012.

Species	Freq (%)	Total volume on 21 stalls (kg)	Traditional Use	Habit	IUCN Threat Status
Tetrapleura tetraptera	52	14.42	ritual, spice	tree	
Monodora myristica	52	18.29	ritual, spice, women's health	tree	
Aucoumea klaineana	45	134.10	ritual, skin infections, good luck	tree	VU[1]
Pterocarpus soyauxii	38	9.50	ritual, skin ointment, red kaolin	tree	
Capsicum annuum	38	2.83	childcare, digestive, ritual, women's health, spice	herb	
Annickia affinis	38	25.94	malaria	tree	
Aframomum melegueta	38	0.40	childcare, spice	herb	
Xylopia aethiopica	36	13.62	digestive, ritual, spice	tree	
Massularia acuminata	33	10.07	sprained limbs, ritual, women's health	shrub	
AMT 787	29	0.41	ritual	fungus	
Tabernanthe iboga	29	6.09	ritual	shrub	
Pentaclethra macrophylla	29	17.46	ritual, women's health	tree	
Cymbopogon densiflorus	29	2.18	ritual, mourning	herb	

[1]vulnerable

The majority of the species that we frequently encountered on the market stalls were also sold in the greatest bulk (Table 3). Eighteen species made up almost 50% of the total volume of products available daily on the Gabonese market. *Aucoumea klaineana* was sold in the highest quantity, with an estimated daily available stock of nearly 950 kg. Although the resin of this species represents only 1% of the diversity of plant products sold (Fig 4a), it represents 20% of the daily stock (Fig 4b). Dual purpose species that are used both as food additives and medicine were also well represented in the daily available stock, such as the barks of *Garcinia kola*, seeds of *Monodora myristica*, and the fruits of *Afrostyrax* sp. The seeds of *Irvingia gabonensis* were not included in our market calculations since they were only used as a food additive, but due to their prevalence on the market, we estimated ca. 118 kg to be sold at the main Mont Bouët market in Libreville and ca. 20 kg on the market in Lambaréné.

We calculated the total volume of medicinal plants available for sale on the Gabonese market to be 6807 kg per day (Table 1). Vendors acknowledged discarding stock regularly, yet absolute numbers of discarded plant material were not reported. This material should be recognized as contributing to the entire volume harvested (available stock) but not sold on the market. By dividing the estimated annual value of the medicinal plant trade (US$ 1,538,936) by the average per kilo price (US$ 56), we estimated the annual volume of medicinal plants available on the entire Gabonese market in 2012 to be approximately 27,481 kg.

Table 3 Species representing 50% of total daily volume, extrapolated to the entire Gabonese market.

Species	Part	Traditional uses	Daily market stock (kg)	Habit	IUCN Threat status
Aucoumea klaineana	resin, bark, leaves, wood	ritual, skin infections	948.35	tree	VU[1]
Raphia sp.	palm stalks	ritual	378.40	tree	
Monodora myristica	seed	ritual, women's health	312.70	tree	
Garcinia kola	bark	ritual, palm wine	242.26	tree	VU[1]
Tetrapleura tetraptera	fruit	ritual	224.94	tree	
Ricinodendron heudelotii	seed	medicinal oil, spice	155.92	tree	
Afrostyrax sp. (DQ 1106)	fruit	ritual, spice	155.57	tree	*
Xylopia aethiopica	bark, fruit	digestive, ritual, spice	148.70	tree	
Annickia affinis	bark	malaria	140.65	tree	
Pentaclethra macrophylla	fruit, bark	ritual, women's health	124.59	tree	
Copaifera religiosa	bark	anemia, ritual	121.48	tree	
Daniellia klainei	bark	ritual, sore body	92.85	tree	LR/NT[2]
Garcinia lucida	bark	anti-poison	92.41	tree	
Distemonanthus benthamianus	bark	good luck	76.09	tree	
Croton oligandrus	bark	ritual, women's health	67.78	tree	
Terminalia catappa	oil from seeds	childcare	64.72	tree	
Erythrophleum ivorense	bark	ritual, swollen limbs/feet	62.34	tree	
Massularia acuminata	fruit	ritual, sprained limbs, women's health	59.92	shrub	

[1]Vulnerable; [2] Low risk/Near threatened; *Some species vulnerable

Vulnerable species

Out of the 18 species sold in the highest quantity on the Gabonese marketplace (Table 3), we found two species that were considered vulnerable by the IUCN, *Aucoumea klaineana* and *Garcinia kola*. *A. klaineana* was encountered on nearly half of the market stalls we surveyed. Another possibly vulnerable species was *Afrostyrax* sp. (Table 3), but our plant material was only identified to the genus level and we were unable to confirm whether it was the vulnerable species *Afrostyrax lepidophyllus* Mildbr. *Daniellia klainei* was considered lower risk/near threatened by the IUCN. None of the species encountered most frequently or sold in the highest volume were listed as restricted for international trade by the Convention on Trade in Endangered Species (CITES). Out of the 217 total species encountered at the Gabonese market (Appendix 1), three additional species were listed as vulnerable by the IUCN: *Nauclea diderrichii*, *Brillantaisia lancifolia*, and *Baillonella toxisperma*.

Most salient health issues and traditional uses

Over one-third of the 263 medicinal plant products documented for sale were reported to be used in rituals, which we defined as those plants used in spiritual ceremonies, as good luck charms, as protection against bad spirits or sorcery, and for attracting or keeping a spouse (Fig. 5). The use of

medicinal herbs for good luck baths, such as *Emilia coccinea,* was one of the most common uses of market plants. Women's health ailments comprised 13% of the total number of uses, including plant remedies for vaginal cleanses, fertility, pregnancy, childbirth, postpartum recovery, and increasing breastmilk production. Childcare was the third most common health category of medicinal plants encountered on the market, and included infant health ailments such as diarrhea, cough, and diaper rash, but also local cultural bound concepts such as encouraging children to walk early, closing the fontanels, and treatment of "la rate" (in French), an illness characterized by low body weight and pain on the left side of the body. The category "other" included those health ailments that were only mentioned once or twice by a vendor such as toothache, muscle pain, and jaundice.

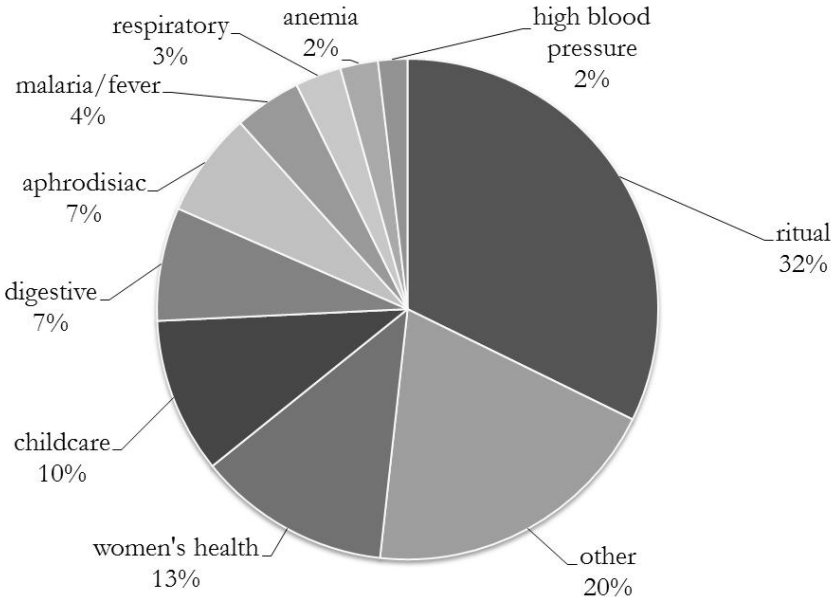


Fig. 5. Most salient health ailments treated by plants sold on the Gabon herbal market in 2012.

Plant vendor concerns

The vendors reported four main obstacles to the domestic medicinal plant trade: high middleman prices, demolishing of medicinal plant markets, negative societal reputation, and loss of collection habitat. Although most of the women from Libreville reported self-collection of medicinal plants, barks were often purchased from a specialized bark harvester. According to the vendors, the selling price of the barks was often lower than their purchase price, resulting in a loss of profit. Secondly, vendors reported that the medicinal herb stalls of Libreville were once joined under one roof, but the former building was demolished, forcing the herbal medicine market to become divided between the La Peyrie and Mont Bouët annex markets (Table 1). The Bwiti medicine sellers in Port-Gentil reported a similar situation in which they were once part of the larger market Marché Grand Village, but have since been moved farther away to a separate market, Marché Bornave. These changes resulted in difficulties securing a fixed place to sell. Several vendors explained that this situation was linked to a tension with some members of the general public against traditional medicine, stigmatizing the vendors in a negative way. Lastly, many of the harvesters we accompanied to collect fresh material reported that the rapid expansion of Libreville has resulted in a loss of habitat to collect medicinal plants, causing further travel in search of material and increased collection costs.

Discussion

Comparison with other African medicinal markets

We calculated Gabon's domestic annual herbal medicine trade to contain 27 tons worth of medicinal plant products with a value of approximately US$ 1.5 million. This volume and economic value was generally smaller than other markets in Africa, including the Eastern Cape Province of South Africa with a total of 525 tons worth US$ 3 million (Dold and Cocks 2002) Ghana with 951 tons worth US$ 7.8 million (van Andel, Myren, and van Onselen 2012), and Benin with 655 tons worth US$ 2.7 million (Quiroz et al. 2014). Gabon's annual herbal trade was more valuable than Sierra Leone, estimated to be worth US$ 64,000 (Jusu and Sanchez 2013).

The average price of herbal medicine in Gabon was $56 per kg, more expensive than in Ghana (US$ 8.2/kg) or Benin (US$ 21/kg), resulting in a fairly high value for a low volume of plant material for sale. The pattern of products sold in low quantities at high prices, such as the most expensive products sold only at Bwiti stalls, has also been documented for markets in South Africa (Williams et al., 2009). The lower value and volume of the Gabonese market could also be attributed to Gabon's relatively low population, 1.6 million, compared to other African countries. The high reported weekly salaries of the herbal vendors may be reflective of Gabon's per capita income, US$19,200 a year, which is four times higher than most sub-Saharan African countries (CIA 2013b). The migrant Beninese vendors reported sales of around US$ 56 a week, which was only slightly higher than the estimated US$ 45 weekly sales reported by market vendors in Benin (Quiroz et al. 2014). The presence of medicinal plants on the market stresses the role of herbal medicine in relatively wealthy African countries with heavily urbanized populations.

The bulk of the daily stock of plant parts in Gabon was sold as bark (30%), followed by resin (20%). In comparison with West African markets, Ghana's daily stock was dominated by fruits and seeds, Benin was mainly leaves and whole plants, and Sierra Leone was mainly barks and leaves. In South Africa (Dold and Cocks 2002), bulbs, tubers and roots represented over 60% of the most frequently traded plant species, where roots represented only 2% of the daily stock in Gabon. In Tanzania, barks and roots were most prevalent on the market (McMillen 2008). Given that 80% of Gabon's surface is covered in forest, the dominance of rainforest barks on the market is not surprising.

Although the rainforest vegetation in Central Africa varies greatly with the savanna-mosaic vegetation of Benin and Ghana, the three countries had some commercialized medicinal plants species in common, such as the seeds and fruits that doubled as food additives and medicine (*Xylopia aethiopica*, *Monodora myristica*, *Aframomum melegueta*). Like the markets in Benin and Ghana, Gabon's most salient health products included those used in ritual and for women's health. Although the volume and value of the herbal material sold in Gabon was much lower than other African markets, the floristic diversity of the market (217 spp.) was higher than in Cameroon (35 spp.)(Betti 2002), Sierra Leone (43 spp.), South Africa (166spp.), and Ghana (209 spp.), and slightly lower than in Benin (283 spp.) and Tanzania (250 ethnospp). Since our market survey captured only six months out of the year and did not include some smaller markets across the country, the total plant diversity of Gabon's markets is likely to be higher than our estimates.

Migrant sellers and imported plants

A notable attribute of the herbal medicinal plant trade in Gabon is the presence of market vendors from neighboring African countries, e.g. Benin, Cameroon, Nigeria, Niger, Togo, who sold medicinal plant products imported into Gabon. From our previous work on Beninese herbal markets (Quiroz et al. 2014), we were able to recognize and identify many Beninese plant products. Previous work on

sub-Saharan African markets has documented the presence of non-African vendors, including Chinese herbal medicine in Tanzania (Hsu 2002) and the sale of Indian herbs in South Africa (Williams, Witkowski, and Balkwill, 2005; Wojtasik, 2013), but also migrants from other African countries, such as Beninese vendors in Ghana (van Andel, Myren, and van Onselen 2012). Since nearly 20% of the Gabonese population is made up of immigrants, and Beninese migrants are the third largest immigrant group (The World Bank 2011) it is possible that Beninese medicinal plant sellers are catering to the demand of Beninese migrants in Gabon. However, the market women that we accompanied in the field mentioned collecting species such as *Cassytha filiformis* specifically for West African immigrants, suggesting that the Gabonese vendors also cater to immigrant healthcare needs. The presence of imported products and vendors at major medicinal plant markets in Gabon may suggest that there is a demand for diverse medicinal products from non-forest vegetation types. The trade of imported herbal medicine has further implications for the sustainability of the national, regional, and continent-wide herbal medicine trade and is an area for future research.

It is likely that Gabonese medicinal plants are exported outside of the country, especially *Tabernanthe iboga* (Neuwinger 1996). The Gabonese branch of the Wildlife Conservation Society in Libreville expressed concern about the unsustainable export-oriented harvest of *T. iboga* (R. Starkey, personal communication July 2012), a concern echoed by the antipoaching canine unit implemented by the Agence Nationale des Parcs Nationaux (ANPN)(Wagtail UK 2013), but no official data on exported species or volumes were available.

Comparison with other Gabonese industries

Although US$ 1.5 million is a substantial value for this informal economy, it is dwarfed by the major natural resource industries of Gabon, namely the US$ 15 billion oil industry (CIA 2013b) and the US$ 1.8 billion timber industry (Forest Legality Alliance 2014). Nevertheless, the income derived from the medicinal plant trade makes substantial contributions to the economic well-being of the plant vendors in Gabon, the majority of whom are women. This pattern has been documented in other countries in Africa (Dold and Cocks, 2002; Jusu and Sanchez, 2013; Quiroz et al., 2014; van Andel et al., 2012; Williams et al., 2009), highlighting the necessity of understanding gender dynamics in the trade of NTFPs (Shackleton and Paumgarten, 2011).

Potential species of concern

Out of the five IUCN red-listed species, only the resin of *Aucoumea klaineana* and bark of *Garcinia kola* were found in high quantities on the market stalls. *A. klaineana* is historically the most popular tree exported from Gabon by the timber industry (Forest Legality Alliance 2014; Global Forest Watch 2000), suggesting that the timber industry has had a large role in the overharvesting of this rainforest tree. In neighboring Cameroon *G. kola* is commonly cultivated, highlighting local responses to managing commercially important resources (Fondoun and Manga 2000). Further investigation is needed to make more substantial claims about the sustainability of these rainforest trees' harvest for medicinal use- including harvesting methods and frequency, natural distribution, population assessments, impact studies and measurements on the rate of extraction versus the rate of natural regeneration (Guinee 2013; Ticktin 2004). Our results can contribute to improved resource management strategies, securing not only the survival of these species, but also the availability of these resources to people who rely on them for their physical, spiritual, and economic well-being (Dold and Cocks 2002). It should also be noted that most of the species that we encountered on the market were not yet assessed by the IUCN, which opens the possibility for additional threatened species.

Salient traditional uses

Plants used in rituals comprised the majority of the medicinal plants sold on the market in Gabon, reflecting the importance of Bwiti practices to modern urban culture in Gabon. Although Bwiti customs are closely associated with the use of *Tabernanthe iboga* (Pope 1969), the indigenous torches represent the greatest volumes of all plant products for sale. *T. iboga* was sold in much smaller volumes, suggesting that the many other ritual plants are commercialized and sold in larger volumes. Women's health issues and childcare comprised the next two largest health domains of commercialized plant products. Medicinal plants are used widely in Gabonese women's healthcare, especially for vaginal cleanses (Towns and van Andel 2014).

Conclusion

This market survey contributes to the literature on the Central African medicinal plant trade, shedding light on the current trade of species in the region, salient health needs and traditional uses met by the market, and the monetary value of this informal economy. With an estimated annual volume of 27 tons of medicinal plant material worth US$ 1.5 million, Gabon's market is smaller than herbal markets in other parts of Africa but generally higher in floristic diversity. Dominated by barks, the Gabon market also offers large quantities of IUCN vulnerable *Aucoumea klaineana* resin for sale. Including this highly valued timber species, only 2% of the 217 species encountered on the market have conservation concerns.

The herbal markets in Libreville housed 75% of the total stock of medicine plant products available for sale daily. The markets in Libreville also featured many migrant vendors, the majority of whom were Beninese, selling imported species not for sale at herbal stalls of Gabonese vendors. Bwiti stalls were concentrated mainly in Port-Gentil while spice stalls selling dual purpose food and medicine products were common throughout the 14 markets we visited. Over 30% of the medicinal plant products from the herbal market were used for ritual purposes, highlighting the role of traditional spiritual practices and ceremonies in urban life in Gabon. Our results serve to fill the gaps in knowledge of a major medicinal market in a conservation-priority country of Central Africa, stress the role of herbal medicine in a relatively wealthy African country, and contribute to the overall understanding of the complexity of the African herbal medicine trade.

Acknowledgements

Most of all, we thank the market vendors who shared their time, patience, and knowledge with us during the survey. The Netherlands Organization for Scientific Research (NWO) provided funding for this research, (ALW-Vidi grant nr. 864.09.007), but had no additional involvement in the study. The fieldwork was supported by the research staff at L'Institut de Pharmacopée et de Médecine Traditionnelles (IPHAMETRA), the National Herbarium of Gabon (LBV), Henri Bourobou, le Centre National de la Recherche Scientifique et Technologique (CENAREST), and the Agence Nationale des Parcs Nationaux (ANPN). A special thanks to Sofie Ruysschaert and Esther van Vliet for assistance with the fieldwork. In the Netherlands, we would like to thank Marc Sosef for logistical support, Pieter Baas for assistance with the wood anatomy analysis, Barbara Gravendeel for DNA barcoding, and the botanists at the former Wageningen Branch of the National Herbarium of the Netherlands for their assistance with plant identification.

Appendix 1

Plant products recorded for sale on Gabon markets in 2012

Coll. Location	Local name[1]	Plant part	Coll. #	Family	Botanical Name	Use	average weight per sales unit [kg]	price per kg (US$)	IUCN status
Gabon	unknown "twisted liana"	liana			*(any species)*	ceremony	0.382	4.89	
Gabon	bed of gorilla	branch			*(any species)*	ritual	1.000	9.35	
Gabon	bukul (P), nzi (Fa)	fruit with seeds	DQ 1807	Malvaceae	*Abelmoschus moschatus* Medik.	ritual	0.017	275.61	
Gabon	sucre-sucre (Fr)	leaves	AMT 688	Leguminosae	*Abrus precatorius* L.	calm heart, ritual	0.027	65.14	
Gabon	munyenyegi (M)	seed	DQ 1004	Leguminosae	*Abrus precatorius* L.	anti-sorcery, ritual	0.041	24.78	
Benin	boni (F)	fruit	AMT 338	Leguminosae	*Acacia nilotica* (L.) Delile	women's health	0.002	292.94	
Gabon	mangbagabrello (M)	entire plant	AMT 771	Acanthaceae	*Acanthus montanus* (Nees) T.Anderson	childcare	0.157	5.96	
Benin	gbangina (F)	root	AMT 355	Malphigiaceae	*Acridocarpus smeathmanii* (DC.) Guill. & Perr.	anemia	0.285	13.12	
Gabon	mobulo (M)	liana	DQ 1047	Passifloraceae	*Adenia* sp. cf.	ceremony	0.125	14.95	
Gabon	potu (N), l'huile de saison, matimamanga (B)	entire plant	AMT 1021, DQ 1031, DQ 1179	Asteraceae	*Adenostemma viscosum* J.R.Forst. & G.Forst.	childcare, luck, women's health	0.200	9.35	
Gabon	mungunu (Fa)	fruit	AMT 1007, DQ 979	Zingiberaceae	*Aframomum* cf. *alboviolaceum* (Ridl.) K.Schum.	luck, ritual	0.020	46.73	
Gabon	petite piment round, lumbu tsitsi (P)	fruit	AMT 780	Zingiberaceae	*Aframomum melegueta* K.Schum.cf.	childcare, spice	0.006	155.76	
Gabon	noung tistchis (P)	seed	DQ 1808	Zingiberaceae	Aframomum sp.	hemorrhoids	0.041	24.78	
Gabon	nzombe (N), madjombu (P)	leaves	DQ 968	Zingiberaceae	*Aframomum giganteum* (Oliv. & D.Hanb.) K.Schum.	luck, swollen limbs	0.145	12.93	
Gabon	assom (Fa)	stem	DQ 1052	Zingiberaceae	*Aframomum giganteum* (Oliv. & D.Hanb.) K.Schum.	ritual, women's health	0.145	12.17	

Coll. Location	Local name[1]	Plant part	Coll. #	Family	Botanical Name	Use	average weight per sales unit [kg]	price per kg (US$)	IUCN status
Gabon	ditundudimukue (M)	fruit	DQ 997	Zingiberaceae	*Aframomum longipetiolatum* Koechlin	ritual	0.025	63.36	
Benin	atakoun (F)	seed	AMT 309	Zingiberaceae	*Afromomum* sp.	women's health	0.018	57.11	
Gabon	l'ail indigène (Fr)	fruit	DQ 1106	Huaceae	*Afrostyrax* sp.	ritual, spice	0.017	94.92	
Gabon	munyenbi (M)	seed	DQ 1014	Huaceae	*Afrostyrax kamerunensis* G.Perkins & Gilg	ritual	0.041	24.78	
Gabon	mambimatabe (P)	entire plant	AMT 1023	Asteraceae	*Ageratum conyzoides* (L.) L.	childcare	0.299	6.25	
Gabon	aloe	leaves	AMT 784	Asphodeliaceae	*Aloe buettneri* A.Berger	general health	0.068	25.87	
Gabon	mukuka (M)	bark	AMT 667	Apocynaceae	*Alstonia* sp.	malaria, women's health	0.052	17.97	
Gabon	mtsongo (N), mokuka (P)	bark	DQ 964	Apocynaceae	*Alstonia boonei* De Wild.	luck, malaria	0.117	15.98	
Gabon	folo (P)	inflorescence with seeds	DQ 1809	Amaranthaceae	*Amaranthus blitum* L.	tumors	0.041	24.78	
Gabon	odjanmingan nfu (Fa)	entire plant	DQ 1039	Commelinaceae	*Aneilema beniniense* (P.Beauv.) Kunth	ritual	0.105	15.64	
Gabon	onong (Fa), mumbundu (P), mbundu (P)	root	AMT 749, DQ 1111	Anisophylleaceae	*Anisophyllea* sp.	ritual	0.028	50.07	
Gabon	boire jeune, mfo (Fa), la mbamba bengue (Fr)	bark	AMT 743, DQ 963	Annonaceae	*Annickia affinis* (Exell) Versteegh & Sosef	malaria	0.166	1.87	
Benin	atahe (F)	bark	AMT 661	Annonaceae	*Annickia polycarpa* (DC.) Setten & Maas ex I.M.Turner	jaundice	0.073	25.30	
Gabon	muyoha (P)	bark	AMT 1013	Annonaceae	Annona sp.	unknown	0.048	19.47	
Gabon	yinda (P)	bark	AMT 739	Annonaceae	*Anonidium* cf. *mannii* (Oliv.) Engl. & Diels	women's health	0.058	31.84	
Gabon	ayindo (Fa)	bark	AMT 765	Gentianaceae	*Anthocleista* sp.	high blood pressure, diabetes	0.076	24.30	
Gabon	angokon (M), angokon (Fa)	bark	AMT 746, AMT 767	Anacardiaceae	*Antrocaryon klaineanum* Pierre	women's health	0.568	1.65	

Coll. Location	Local name[1]	Plant part	Coll. #	Family	Botanical Name	Use	average weight per sales unit [kg]	price per kg (US$)	IUCN status
Gabon	benzinzao (P), l'arbre de l'éléphant/boire de la estomac (Fr)	bark	AMT 1014, AMT 751	Rubiaceae	*Aoranthe cladantha* (K.Schum.) Somers	aphrodisiac, digestive	0.066	21.24	
Gabon	ibanzao (M)	wood	DQ 990	Rubiaceae	*Aoranthe cladantha* (K.Schum.) Somers	aphrodisiac	0.067	69.31	
Gabon	l'apelle (Fr), rugo (M)	leaves	DQ 1114	Asparagaceae	*Asparagus* cf. *warneckei* (Engl.) Hutch.	ritual	0.100	37.38	
Gabon	okume (P)	bark	AMT 1016	Burseraceae	*Aucoumea klaineana* Pierre	general health	0.111	8.42	VU
Gabon	okume (M)	resin	AMT 1050	Burseraceae	*Aucoumea klaineana* Pierre	ceremony	0.408	4.58	VU
Gabon	torche indigine (small) (Fr)	resin	AMT 750	Burseraceae	*Aucoumea klaineana* Pierre	ritual	0.609	3.07	VU
Gabon	torche indigine (big) (Fr)	resin	AMT 750	Burseraceae	*Aucoumea klaineana* Pierre	ritual	3.292	4.54	VU
Gabon	okume (Fa)	wood	AMT 939	Burseraceae	*Aucoumea klaineana* Pierre	handicapped/ paralyzed	0.059	79.20	VU
Gabon	l'okume (Fr)	leaves	DQ 969	Burseraceae	*Aucoumea klaineana* Pierre	luck, skin infections	0.145	12.93	VU
Gabon	moabi (M), adjab (Fa)	bark	AMT 745, DQ 1009	Sapotaceae	*Baillonella toxisperma* Pierre	aphrodisiac, women's health, ritual	0.077	12.14	VU
Gabon	moabi (M), adjab (Fa)	seed	DQ 1012	Sapotaceae	*Baillonella toxisperma* Pierre	medicinal oil	0.041	24.78	VU
Gabon	moabi (M)	seed		Sapotaceae	*Baillonella toxisperma* Pierre	food for ill	0.200	32.71	VU
Gabon	musinda, porosa, wengui (Eshira Commerial)	wood	DQ 987	Leguminosae	*Bobgunnia fistuloides* (Harms) J.H.Kirkbr. & Wiersema	aphrodisiac	0.067	69.31	
Benin	èponge traditionnel (Fr)	root fiber	DQ 854	Arecaceae	*Borassus aethiopum* Mart.	ceremony	0.138	27.17	
Gabon	dimuenu (P), kri tanguimina (N), tangamina (M, P), nzibilor (Fa), pense tous (Fr), tangemina dibagte (B)	entire plant	AMT 1042, DQ 1033, AMT 1026	Acanthaceae	*Brillantaisia lancifolia* Lindau	anemia, childcare, ritual	0.160	17.52	VU
Gabon	dilemto dikala (M)	leaves	AMT 1038	Acanthaceae	*Brillantaisia* cf. *owariensis* P.Beauv.	flu, heart	0.326	5.73	
Gabon	cola de gorille (Fr)	fruit	AMT 1036	Capparaceae	*Buchholzia coriacea* Engl.	aphrodisiac	0.039	48.55	

Coll. Location	Local name[1]	Plant part	Coll. #	Family	Botanical Name	Use	average weight per sales unit [kg]	price per kg (US$)	IUCN status
Gabon	lembandre (N)	seed	DQ 1000	Capparaceae	*Buchholzia coriacea* Engl.	aphrodisiac, High blood pressure	0.041	24.78	
Gabon	digudimumbu (M)	seed	DQ 1007	Leguminosae	*Caesalpinia bonduc* (L.) Roxb.	women's health	0.010	93.46	
Gabon	mungungu (N), la feuille de l'haricot (Fr)	leaves	DQ 1030	Leguminosae	*Cajanus cajan* (L.) Millsp.	childcare	0.145	12.17	
Gabon	musimina (M)	seed	DQ 998	Leguminosae	*Canavalia ensiformis* (L.) DC.	luck, ritual	0.041	24.78	
Gabon	petite piment, tzoli (M)	fruit	AMT 672, DQ 1002	Solanaceae	*Capsicum annuum* L.	ritual, spice, women's health	0.026	61.90	
Gabon	feuilles de piment (Fr)	entire plant	AMT 684	Solanaceae	*Capsicum annuum* L.	childcare	0.157	5.96	
Gabon	kuta (P)	root		Polygalaceae	*Carpolobia* sp.	aphrodisiac	0.071	26.51	
Gabon	onong (Fa), kara (Fa)	leaves	AMT 1255	Polygalaceae	*Carpolobia alba* G.Don	women's health	0.177	9.93	
Gabon	anong (Fa)	root	AMT 752, AMT 779	Polygalaceae	*Carpolobia alba* G.Don	aphrodisiac	0.071	26.51	
Gabon	kuta (M)	wood	DQ 985	Polygalaceae	*Carpolobia alba* G.Don	aphrodisiac	0.076	61.49	
Gabon	kota (M)	leaves	DQ 1049	Polygalaceae	*Carpolobia lutea* G.Don	aphrodisiac, childcare	0.145	12.17	
Gabon	munziji mangueb (P), la cord de pitier (Fr)	entire plant	DQ 1037	Lauraceae	*Cassytha filiformis* L.	luck, malaria, respiratory	0.105	15.64	
Gabon	mufuma (P), fromagier (Fr)	bark	AMT 1037	Malvaceae	*Ceiba pentandra* (L.) Gaertn.	childcare	0.494	3.78	
Gabon	abam (Fa)	fruit	AMT 1052	Sapotaceae	*Chrysophyllum lacourtianum* De Wild.	digestive	0.378	4.26	
Gabon	colatier (Fr), mbonatzu (P)	bark	AMT 1015	Malvaceae	*Cola acuminata* (P.Beauv.) Schott & Endl.	women's health	0.046	20.32	
Gabon	cola de gorille (Fr), yiel (M)	fruit	DQ 1010	Malvaceae	*Cola acuminata* (P.Beauv.) Schott & Endl.	birth facilitation, cermony	0.090	17.88	
Gabon	abe (Fa	bark	AMT 664	Malvaceae	*Cola* sp. cf.	women's health	0.062	15.07	
Gabon	unknown	leaves	AMT 1020	Combretaceae	*Combretum* sp.	luck	0.183	10.21	

Coll. Location	Local name[1]	Plant part	Coll. #	Family	Botanical Name	Use	average weight per sales unit [kg]	price per kg (US$)	IUCN status
Gabon	mutombi (Maongo), lendem (N), motombi (P)	bark	AMT 755, DQ 956	Leguminosae	*Copaifera religiosa* J.Leonard	anemia, luck	0.247	7.58	
Gabon	anzem	root		Leguminosae	*Copaifera* cf. *religiosa* J.Leonard	anti-worms	0.077	121.54	
Gabon	unknown	leaves		Costaceae	*Costus* cf. *afer* Ker Gawl.	ritual	0.177	9.93	
Gabon	unknown	inflorescence		Costaceae	*Costus* cf. *afer* Ker Gawl.	ritual	0.500	3.74	
Gabon	canne sauvage	stem		Costaceae	*Costus* sp.	ceremony	0.177	9.93	
Gabon	canne sauvage (Fr), mikuis (N)	leaves, stem	AMT 693, DQ 1029	Costaceae	*Costus lucanusianus* J.Braun & K.Schum.	luck	0.177	9.93	
Gabon	feuilles obamba (N)	leaves	AMT 692	Costaceae	*Costus maboumiensis* Pellegr.	luck	0.177	9.93	
Gabon	mikwisa benga (M), okossa mbumba (Om)	entire plant	DQ 1079	Costaceae	*Costus phyllocephalus* K.Schum.	ritual	0.157	11.92	
Gabon	ewome-ele (Fa)	bark	AMT 741	Olacaceae	*Coula edulis* Baill.	digestive	0.058	31.84	
Gabon	ewome-ele (Fa), kme (Fa)	fruit	AMT 742, DQ 982	Olacaceae	*Coula edulis* Baill.	ritual	0.017	55.12	
Gabon	nyundubalosi (M), onion de sorcier (Fr)	entire plant	AMT 799	Amarylliadaceae	*Crinum* sp.	ritual	0.161	23.22	
Gabon	mokek (N)	bark	AMT 677	Euphorbiaceae	*Croton* sp.	childcare	0.098	19.07	
Gabon	mbamba (N), misembe (Fa)	bark	DQ 965	Euphorbiaceae	*Croton* sp.	luck	0.179	10.47	
Gabon	mizembe (Fa)	bark	DQ 981	Euphorbiaceae	*Croton* sp.	ritual, women's health	0.116	15.92	
Gabon	mubanga (M), le bois de jemeaux (Fr)	bark	DQ 1050	Euphorbiaceae	*Croton* sp.	childcare, ritual	0.134	6.97	

Coll. Location	Local name[1]	Plant part	Coll. #	Family	Botanical Name	Use	average weight per sales unit [kg]	price per kg (US$)	IUCN status
Gabon	misembe (Fa), oyop (Fa), ongen (Fa)	bark	AMT 666, AMT 941	Euphorbiaceae	*Croton oligandrus* Pierre ex Hutch.	ritual, women's health	0.202	27.80	
Gabon	unknown	seed	DQ 1008	Euphorbiaceae	*Croton tiglium* L.	digestive	0.150	6.85	
Gabon	ingone (Fa)	seed	AMT 798	Cucurbitaceae	*Cucumeropsis mannii* Naudin	multiple	0.056	10.01	
Gabon	bater (M)	seed	DQ 1013	Cucurbitaceae	*Cucurbita* sp.	childcare, women's health	0.041	24.78	
Gabon	mdum (P, N)	bark	DQ 960	Leguminosae	*Cylicodiscus gabunensis* Harms	luck	0.221	8.46	
Benin	tisane (Fr)	leaves	DQ 318	Poaceae	*Cymbopogon citratus* (DC.) Stapf	digestive	0.300	1.25	
Gabon	izazango/nitsatsagu (P)	inflorescence	DQ 1036	Poaceae	*Cymbopogon densiflorus* (Steud.) Stapf	ceremony, mourning, ritual	0.042	44.50	
Gabon	sasao (M)	entire plant	AMT 788	Cyperaceae	*Cyperus articulatus* L.	ritual, women's health	0.066	28.32	
Gabon	batsasu (M)	rhizome	AMT 790, DQ 1051	Cyperaceae	*Cyperus articulatus* L.	ceremony, ritual	0.005	350.47	
Gabon	paungu (P), mutanghani (M)	bark	AMT 1029, AMT 757	Leguminosae	*Daniellia klainei* A.Chev.	luck, sore body	0.225	6.24	LR/NT
Gabon	mipipingi (P), le faux arachide qu'on ne mange pas (Fr)	entire plant	DQ 1027	Leguminosae	*Desmodium adscendens* (Sw.) DC.	women's health	0.105	15.64	
Gabon	enouk (Fa)	bark	AMT 785	Leguminosae	*Detarium macrocarpum* Harms	ritual	0.025	74.87	
Gabon	padouk (Fa)	bark	AMT 946	Leguminosae	*Dialium* cf. *guineense* Willd.	anemia	0.205	22.79	
Gabon	lemasses (B)	entire plant	DQ 1120	Melastomataceae	*Dinophora spenneroides* Benth.	increase appetitie, anemia	0.209	7.83	
Gabon	mgongula (P), ngugulansali (P), torgniungui (M), mussimene (M)	seed	DQ 1006, DQ 996	Leguminosae	*Dioclea* cf. *reflexa* Hook.f.	ritual	0.006	155.76	

Coll. Location	Local name[1]	Plant part	Coll. #	Family	Botanical Name	Use	average weight per sales unit [kg]	price per kg (US$)	IUCN status
Gabon	ngogolo (M), le mille pats de la rivière (Fr)	seed	DQ 1042	Leguminosae	*Dioclea hexandra* (Ralph) Mabb.	muscle pain	0.006	155.76	
Gabon	mbanda (P)	tuber (aerial)	AMT 769	Dioscoreaceae	*Dioscorea* sp.	aphrodisiac	0.043	36.21	
Gabon	nyam de diable (Fr)	tuber	AMT 770	Dioscoreaceae	*Dioscorea* sp.	women's health	0.069	13.64	
Gabon	L'igname sauvage (Fr), Lindi (N)	tuber (aerial)	DQ 975	Dioscoreaceae	*Dioscorea bulbifera* L.	ritual	0.043	21.73	
Gabon	muvengi (M), mbongi (N), eiyeni (Fa)	bark	AMT 756, DQ 961	Leguminosae	*Distemonanthus benthamianus* Baill.	luck	0.158	8.87	
Gabon	petite racine rouge, milundulu, demarreur rouge, bundu (N)	root	AMT 754, DQ 1062	Moraceae	*Dorstenia psilurus* Welw.	aphrodisiac	0.019	75.78	
Gabon	muyunguo (M)	bark	DQ 1061	Euphorbiaceae	*Drypetes gossweileri* S.Moore	protection against snakes	0.765	2.44	
Gabon	aka (Fa)	fruit	DQ 978	Malvaceae	*Duboscia macrocarpa* Bocq.	ceremony	0.012	134.11	
Gabon	lipital (N)	entire plant	DQ 1068	Amaranthaceae	*Dysphania ambrosioides* (L.) Mosyakin & Clemants	digestive, sprained joints	0.068	13.74	
Gabon	muwidich (N), santan (Fa)	entire plant	AMT 680, DQ 1064	Asteraceae	*Eclipta prostrata* (L.) L.	childcare, ritual	0.157	10.43	
Gabon	ngazti (P), pulpe d' palm (Fr), drafu (M)	fruit kernel	AMT 1031	Arecaceae	*Elaeis guineensis* Jacq.	medicinal oil	0.006	93.46	
Gabon	la tirance (Fr), mkoub (P)	entire plant	AMT 687, DQ 971	Acanthaceae	*Elytraria marginata* Vahl	ritual	0.157	8.94	
Gabon	feuilles de brousse/ l'oreille du chien (Fr), mibeles (N), alomyu (Fa)	entire plant	AMT 695, DQ 970	Asteraceae	*Emilia coccinea* (Sims) G.Don	luck, HBP	0.253	7.39	
Benin	gbagbada (F)	seed	DQ 412	Leguminosae	*Entada gigas* (L.) Fawc. & Rendle	ceremony	0.030	34.27	
Gabon	mbaka (P), boire de lune (Fr), mkas (N)	bark	AMT 1010, DQ 959	Leguminosae	*Erythrophleum ivorense* A.Chev.	foot soother, swollen limbs, luck	0.242	5.79	

Coll. Location	Local name[1]	Plant part	Coll. #	Family	Botanical Name	Use	average weight per sales unit [kg]	price per kg (US$)	IUCN status
Benin	gbokoka (F)	rope	DQ 689	Moraceae	*Ficus thonningii* Blume	ritual	0.200	9.35	
Gabon	tobu (M), Tobu (P), mbudi (N)	bark	AMT 747, DQ 955	Rubiaceae	*Fleroya ledermannii* (K.Krause) Y.F.Deng	digestive, luck, women's health	0.074	18.94	
Gabon	esok, onyeng (Fa), bois amere (Fr)	bark	AMT 777	Clusiaceae	*Garcinia kola* Heckel	palm wine	0.134	13.91	VU
Gabon	mukoka (M)	wood	DQ 992	Clusiaceae	*Garcinia kola* Heckel	aphrodisiac	0.067	69.31	VU
Gabon	esop (Fa)	bark	AMT 786	Clusiaceae	*Garcinia lucida* Vesque	anti-poison	0.127	29.45	
Gabon	matchumangui (N), le coeur de cuchon (Fr)	entire plant	DQ 1056	Rubiaceae	*Geophila afzelii* Hiern	digestive, ritual	0.105	15.64	
Gabon	duba (B)	entire plant	DQ 1020	Rubiaceae	*Geophila* sp.	ritual, women's health	0.105	15.64	
Gabon	inuka (M)	entire plant	AMT 1049	Asteraceae	*Gnaphalium* sp.	anti-poison	0.070	13.35	
Gabon	feuilles de coton (Fr)	entire plant	AMT 681	Malvaceae	*Gossypium barbadense* L.	childcare	0.157	10.43	
Gabon	unknown	seed		Malvaceae	*Gossypium* cf. *barbadense* L.	women's health	0.041	24.78	
Gabon	otunga (Fa)	root	AMT 942	Annonaceae	*Greenwayodendron* cf. *suaveolens* (Engl. & Diels) Verdc.	women's health	0.026	215.67	
Gabon	kevasingo (Fa), obaka (M)	bark	AMT 764, AMT 668	Leguminosae	*Guibourtia tessmannii* (Harms) J.Leonard	high blood pressure, diabetes, aphrodisiac, luck, women's health	0.191	4.90	
Gabon	musasa (N)	leaves	AMT 685	Clusiaceae	*Harungana madagascariensis* Lam. ex Poir.	women's health	0.177	5.28	
Gabon	atuin (Fa)	bark	AMT 778	Hypericaceae	*Harungana madagascariensis* Lam. ex Poir.	childcare	0.139	13.29	
Gabon	madulegele/rumuenu (P), biringele (B), le mirroir (Fr)	leaves	AMT 1024, DQ 1121	Rubiaceae	*Heinsia crinita* (Afzel.) G.Taylor	luck	0.306	6.11	
Gabon	djelewende (Om)	entire plant	DQ 967	Rubiaceae	*Heinsia* sp.	luck	0.105	17.88	
Gabon	kulu (B)	leaves	DQ 1119	Malvaceae	*Hibiscus surattensis* L.	anemia	0.356	4.94	

Coll. Location	Local name[1]	Plant part	Coll. #	Family	Botanical Name	Use	average weight per sales unit [kg]	price per kg (US$)	IUCN status
Gabon	chocolatier (Fr), odika (P), muebe (P)	bark	AMT 1017	Iriviginaceae	*Irvingia gabonensis* (Aubry-Lecomte ex O'Rorke) Baill.	digestive	0.087	10.74	LR/NT
Gabon	leleoh (N), madjudjuga (P)	entire plant	AMT 679, DQ 1035	Crassulaceae	*Kalanchoe crenata* (Andrews) Haw.	respiratory	0.157	11.92	
Gabon	rata (N, Fa)	bark	AMT 690, AMT 766	Rubiaceae	*Keetia* sp.[3]	women's health	0.058	31.84	
Gabon	mulunda (P), le fruit que l'elefant avale (Fr)	fruit	DQ 1038	Cucurbitaceae	*Lagenaria breviflora* (Benth.) Roberty	childcare, ritual	0.136	6.87	
Benin	ado (F)	fruit	DQ 396	Cucurbitaceae	*Lagenaria siceraria* (Molina) Standl.	ritual	0.017	94.92	
Benin	hounmansi (F)	bark	DQ 408	Anacardiaceae	*Lannea barteri* (Oliv.) Engl.	malaria, anemia	0.166	11.12	
Gabon	letchok (N)	bark	DQ 962	Anacardiaceae	*Lannea welwitschii* (Hiern) Engl	luck, women's health	0.184	10.16	
Gabon	feuilles de brousse (Fr), mundji (P), munju (N)	leaves	AMT 696, DQ 1028	Icacinaceae	*Lasianthera africana* P.Beauv.	luck	0.180	10.38	
Gabon	murlona (N)	fruit	DQ 1046	Icacinaceae	*Lavigeria* sp.	general health	0.102	15.86	
Gabon	l'appele (Fr)	entire plant	AMT 1040	Asparagaceae	*Ledebouria cameroonianа* (Baker) Speta	ritual	0.009	207.68	
Gabon	mbala, lalilmiu (P)	leaves	AMT 1003, DQ 1025	Vitaceae	*Leea guineensis* G. Don	luck	0.186	5.02	
Gabon	ntitsjantsitsikumbu (P), gombalonga (N), djanzukun (P), afing (Fa), gumbalunga (P)	entire plant	AMT 671, DQ 973, AMT 760	Verbenaceae	*Lippia rugosa* A.Chev.	luck, women's health	0.174	10.74	
Gabon	insaha la muele (B)	leaves	DQ 1024	Euphorbiaceae	*Macaranga monandra* Müll.Arg.	ritual	0.145	12.17	
Gabon	melange (Fr)	bottle			many species	ceremony	0.200	18.69	
Gabon	inja la muele (B)	leaves	AMT 1044, DQ 1022	Euphorbiaceae	*Maprounea membranacea* Pax & K.Hoffm.	ritual	0.190	9.26	

Coll. Location	Local name[1]	Plant part	Coll. #	Family	Botanical Name	Use	average weight per sales unit [kg]	price per kg (US$)	IUCN status
Gabon	namey (P), muendi (N), morendoc (N)	fruit	AMT 1005, DQ 1001	Rubiaceae	*Massularia acuminata* (G.Don) Bullock ex Hoyle	ritual, sprained limbs, women's health	0.073	25.60	
Gabon	depeyrie (M)	bark	AMT 748	Annonaceae	*Meiocarpidium lepidotum* (Oliv.) Engl. & Diels	childcare	0.023	40.63	
Gabon	ovandava (P)	leaves	AMT 1018	Pandaceae	*Microdesmis* cf. *puberula* Hook.f. ex Planch.	general health	0.134	13.95	
Gabon	pongogo (P)	entire plant	DQ 1258	Asteraceae	*Mikania chenopodifolia* Willd.	women's health	0.300	5.45	
Gabon	mabumbolu (P), mtsutsulu (N)	entire plant	AMT 678, DQ 972	Cucurbitaceae	*Momordica charantia* L.	childcare, high blood pressure, malaria, diabetes, luck	0.177	10.56	
Gabon	aboubou, bater bama bulu (M)	seed	DQ 1005	Cucurbitaceae	*Momordica charantia* L.	malaria, typhoid fever, women's health, yellow fever	0.100	10.28	
Gabon	nzin (Fa), nzingu (M)	seed	DQ 977, DQ 1043	Annonaceae	*Monodora myristica* (Gaertn.) Dunal	luck, ritual, spice, women's health	0.100	9.35	
Gabon	fep (Fa)	bark	DQ 980	Annonaceae	*Monodora myristica* (Gaertn.) Dunal	ritual	0.183	10.19	
Gabon	mwenda (P)	root	AMT 1011	Loganiaceae	*Mostuea hirsuta* (T.Anderson ex Benth.) Baill.	aphrodisiac	0.024	77.88	
Benin	ahohoroma (F)	root	DQ 428	Rubiaceae	*Mostuea hirsuta* (T.Anderson ex Benth.) Baill.	ceremony	0.100	37.38	
Gabon	museynga (M)	entire plant	AMT 1045	Urticaceae	*Musanga cecropioides* R.Br. ex Tedlie	internal sores	0.213	4.39	
Gabon	musinga (M)	bark	AMT 1309	Urticaceae	*Musanga* cf. *cecropioides* R.Br. ex Tedlie	respiratory, toothaches	0.240	7.70	
Gabon	afuluem (Fa)	leaves	DQ 1099	Rubiaceae	*Mussaenda* sp.	ritual	0.177	9.93	
Gabon	afulem (Fa)	entire plant	AMT 1034	Moraceae	*Myrianthus* sp.	luck	0.020	46.73	
Gabon	afunlum (Fa)	leaves	AMT 762	Moraceae	*Myrianthus serratus* (Trécul) Benth.	luck	0.177	9.93	
Gabon	mbilinga (M)	bark	AMT 901	Rubiaceae	*Nauclea diderrichii* (De Wild.) Merr.	aphrodisiac	0.127	14.55	VU
Gabon	mbilinga (M)	wood	DQ 986	Rubiaceae	*Nauclea diderrichii* (De Wild.) Merr.	aphrodisiac	0.013	359.45	VU

Coll. Location	Local name[1]	Plant part	Coll. #	Family	Botanical Name	Use	average weight per sales unit [kg]	price per kg (US$)	IUCN status
Gabon	mopintiti (P), onvup-ele (Fa)	bark	AMT 1009, AMT 740	Bignoniaceae	*Newbouldia laevis* (P.Beauv.) Seem.	respiratory	0.119	15.71	
Gabon	hyssop (Fr)	leaves	AMT 1187	Bignoniaceae	*Newbouldia laevis* (P.Beauv.) Seem.	ritual	0.177	9.93	
Benin	tabac (Fr)	leaves	DQ 379	Solanaceae	*Nicotiana tabacum* L.	luck	0.181	9.72	
Gabon	nzianzi (P), OsingFa (Fa), ocim (P, Fa), nsiansi sigeh (P)	entire plant	AMT 789, DQ 1041, DQ 1113	Lamiaceae	*Ocimum americanum* L.	luck, respiratory, ritual, women's health	0.044	42.97	
Gabon	nsiansi zineyhey (Puna), ntzianzi (P), madumbaduma (N)	entire plant	AMT 669, AMT 772	Lamiaceae	*Ocimum gratissimum* L.	childcare, malaria, women's health	0.157	5.96	
Gabon	racine du Cameroun (Fr)	root	AMT 782	Araliaceae	*Panax* sp.	aphrodisiac	0.016	59.34	
Gabon	mubogo (P	bark	AMT 1012	Pandaceae	*Panda oleosa* Pierre	women's health	0.047	19.88	
Gabon	ando (Fa)	seed	DQ 984	Pandaceae	*Panda oleosa* Pierre	ritual	0.041	24.78	
Gabon	lufumbu (P)	leaves	AMT 1027	Pandanaceae	*Pandanus* sp.	sores	0.032	116.82	
Gabon	unknown	stem		Passifloraceae	*Passiflora quadrangularis* L.	unknown	1.000	1.76	
Gabon	cinq feuilles (Fr)	leaves	AMT 1022	Sapindaceae	*Paullinia pinnata* L.	luck	0.130	14.38	
Gabon	mupanzi (M), inhansa (B)	leaves	AMT 1046, DQ 1023	Leguminosae	*Pentaclethra macrophylla* Benth.	luck, ritual	0.072	12.98	
Gabon	ebeig (Fa), mupanji (N), mankenun (P)	bark	AMT 663, DQ 995	Leguminosae	*Pentaclethra macrophylla* Benth.	ritual, women's health	0.112	8.34	
Gabon	mupanji (N), mankenun (P)	fruit	DQ 993	Leguminosae	*Pentaclethra macrophylla* Benth.	ritual	0.102	9.21	
Gabon	mupanji (N), mankenun (P), movanti (P)	seed	DQ 994	Leguminosae	*Pentaclethra macrophylla* Benth.	ritual	0.041	24.78	

Coll. Location	Local name[1]	Plant part	Coll. #	Family	Botanical Name	Use	average weight per sales unit [kg]	price per kg (US$)	IUCN status
Gabon	ngovi (P), njovi polu (P)	entire plant	AMT 1019, AMT 697	Apocynaceae	*Periploca nigrescens* Afzel	luck	0.098	19.07	
Gabon	abian (Fa), arbre de genie (Fr)	bark	DQ 1018	Lecythidaceae	*Petersianthus macrocarpus* (P.Beauv.) Liben	women's health	0.127	14.54	
Gabon	dighoundou (M)	fruit	DQ 1117	Apocynaceae	*Picralima nitida* (Stapf) T.Durand & H.Durand	typhoid fever	1.794	3.13	
Gabon	dighoundou (M), duhundu (P), ebame (Fa)	bark	DQ 1118, AMT 689	Apocynaceae	*Picralima nitida* (Stapf) T.Durand & H.Durand	diabetes, high blood pressure, malaria	0.046	41.08	
Benin	injaiye (T)	seed	AMT 658	Piperaceae	*Piper guineense* Schumach. & Thonn.	women's health	0.001	10.43	
Gabon	fouketou (P)	liana	AMT 791	Piperaceae	*Piper guineense* Schumach. & Thonn.	respiratory	0.382	4.89	
Gabon	abonza (Fa), malemto (N)	entire plant	AMT 761, DQ 1032	Piperaceae	*Piper umbellatum* L.	ceremony, hemorrhoids	0.157	10.43	
Gabon	ntoum/debema (Fa)	bark	AMT 904	Leguminosae	*Piptadeniastrum africanum* (Hook.f.) Brenan	women's health	0.127	14.55	
Gabon	humbu (M)	entire plant	DQ 1065	Araceae	*Pistia stratiotes* L.	internal sores	0.024	78.98	
Gabon	feuilles de brousse (Fr)	entire plant	AMT 691	Pteridaceae	*Pityrogramma calomelanos* (L.) Link	luck	0.157	10.43	
Gabon	isula (Fa)	bark	DQ 958	Euphorbiaceae	*Plagiostyles africana* (Müll.Arg.) Prain	childcare, luck	0.180	10.38	
Gabon	intabi (B)	entire plant	DQ 1021	Lamiaceae	*Plectranthus occidentalis* B.J.Pollard	ritual	0.105	15.64	
Gabon	aye (Fa)	fruit	DQ 983	Anisophylleaceae	*Poga oleosa* Pierre	childcare, epilepsy	0.102	15.86	
Gabon	ouamanta (M)	entire plant	DQ 1044	Portulaceae	*Portulaca quadrifida* L.	ritual	0.105	15.64	
Benin	kakey (F)	wood	AMT 208	Leguminosae	*Prosopis africana* (Guill. & Perr.) Taub.	childcare	0.132	35.40	
Gabon	mazunaunbali (Puna)	bark	AMT 738	Anacardiaceae	*Pseudospondias* cf. *longifolia* Engl.	anemia, women's health	0.092	10.16	
Gabon	guave (Fr)	leaves	AMT 1270	Myrtaceae	*Psidium guajava* L.	digestive	0.177	9.93	
Gabon	coller-coller (Fr)	leaves	AMT 1039, AMT 686	Rubiaceae	*Psydrax palma* (K.Schum.) Bridson	ritual	0.131	10.70	

Coll. Location	Local name[1]	Plant part	Coll. #	Family	Botanical Name	Use	average weight per sales unit [kg]	price per kg (US$)	IUCN status
Benin	kuli-kuli goto (F)	bark	AMT 74, DQ 415	Combretaceae	*Pteleopsis suberosa* Engl. & Diels	childcare	0.273	6.78	
Gabon	kaolin rouge (Fr), inzingue (M)	wood	AMT 781, DQ 1017	Leguminosae	*Pterocarpus soyauxii* Taub.	ritual	0.091	51.63	
Gabon	issoumbu	bark	DQ 966, AMT 792	Myristicaceae	*Pycnanthus angolensis* (Welw.) Warb.	respiratory, luck	0.185	10.10	
Gabon	bohubobang (M)	fungus	AMT 676	Polyporaceae	*Pycnoporus sanguineus* (L.) Murrill	childcare	0.005	186.92	
Gabon	issindigal (P)	wood	DQ 989	Simaroubaceae	*Quassia africana* (Baill.) Baill.	aphrodisiac, women's health	0.067	69.31	
Gabon	zinderal, sindu gala	root	AMT 763	Simaroubaceae	*Quassia* cf. *africana* (Baill.) Baill.	high blood pressure	0.028	133.51	
Gabon	ngangji (Fa)	seed	DQ 976	Arecaceae	*Raphia* sp.	ritual	0.017	54.98	
Gabon	flambout (Fr)	palm stalks		Arecaceae	*Raphia* sp.	ceremony	1.000	1.87	
Benin	dekwin (F)	seed	DQ 253	Arecaceae	*Raphia hookeri* G.Mann & H.Wendl.	childcare	0.016	65.07	
Gabon	nzezan (Fa)	seed	DQ 1105	Euphorbiaceae	*Ricinodendron heudelotii* (Baill.) Heckel	medicinal oil, spice	0.041	24.78	
Benin	fefekuba (T)	seed	DQ 564	Euphorbiaceae	*Ricinus communis* L.	fever	0.041	24.78	
Gabon	akoha (Fa), igamu (P)	root	AMT 665	Violaceae	*Rinorea* sp. cf.[2]	digestive, women's health	0.100	37.38	
Benin	kudo (F)	root	AMT 25	Rubiaceae	*Sarcocephalus latifolius* (Sm.) E.A.Bruce	women's health	0.063	59.81	
Gabon	kenkisi (P)	entire plant	AMT 1030	Cyperaceae	*Scleria boivinii* Steud.	heart pain	0.044	42.48	
Gabon	orandara (Puna), maduey duey (P), ugandala (N)	entire plant	AMT 699, AMT 674	Scrophulariaceae	*Scoparia dulcis* L.	luck, respiratory	0.134	12.21	
Gabon	l'ail indigine pour le riz (Fr), munyenbi (M), essun (Fa)	bark	DQ 1107, DQ 1019	Leguminosae	*Scorodophloeus zenkeri* Harms[2]	ritual, spice	0.023	20.62	

Coll. Location	Local name[1]	Plant part	Coll. #	Family	Botanical Name	Use	average weight per sales unit [kg]	price per kg (US$)	IUCN status
Gabon	njovi yango (P)	entire plant	AMT 698	Apocynaceae	*Secamone afzelii* (Roem. & Schult.) K.Schum.	luck	0.157	10.43	
Gabon	ahroyhroy (Om), meroilli (P, Fr), magoyiu (M)	entire plant	AMT 683, DQ 1016	Selaginellaceae	*Selaginella myosurus* Alston	ceremony, luck, women's health	0.157	5.96	
Gabon	itsiamuna amba (P)	entire plant	AMT 675	Leguminosae	*Senna alata* (L.) Roxb.	typhoid fever	0.017	109.95	
Gabon	bakanbit (M)	entire plant	DQ 1115	Malvaceae	*Sida acuta* Burm.f.	women's health	0.187	10.02	
Gabon	unknown	fruit		Solanaceae	*Solanum* sp.	unknown	0.285	5.64	
Gabon	mukier (M)	fruit	DQ 1116	Solanaceae	*Solanum* cf. *macrocarpon* L.	childcare	0.040	4.67	
Gabon	mineka (P)	fruit	AMT 673	Solanaceae	*Solanum anguivi* Lam.	women's health	0.017	55.12	
Gabon	bambo lungo (M), l'aubergine sauvage (Fr)	fruit	DQ 1067	Solanaceae	*Solanum* cf. *anguivi* Lam.	ceremony	0.017	55.14	
Benin	akaono (T)	leaves	AMT 247	Poaceae	*Sorghum bicolor* (L.) Moench	anemia	0.083	21.19	
Gabon	amban (Fa)	entire plant	AMT 1035	Araceae	sp.	ritual	0.003	311.53	
Gabon	odjanmingan ovoel (Fa)	entire plant	DQ 1040	Acanthaceae	sp.	ritual	0.105	15.64	
Gabon	njumu (P)	fruit	AMT 1028	Humiriaceae	sp. cf.	heart pain	0.009	207.68	
Gabon	feuilles de poison (Fr)	entire plant	AMT 1043	Rubiaceae	*Spermacoce* sp.	anti-poison	0.185	5.05	
Gabon	bongi (P)	inflorescence with seeds	AMT 1355	Poaceae	*Streptogyna crinita* P.Beauv	ritual	0.001	1869.16	
Gabon	dirembi (P)	fruit	DQ 1110	Loganiaceae	*Strychnos aculeata* Soler.	fish poison, ritual	0.102	15.86	
Gabon	dirembi (P)	fruit	DQ 1109	Loganiaceae	*Strychnos icaja* Baill.	fish poison, ritual	0.102	15.86	
Gabon	demarreur noir (Fr)	root	AMT 783, AMT 753	Menispermiaceae	*Synclisia scabrida* Miers	aphrodisiac	0.019	48.34	
Gabon	graines de bois sacree (Fr)	fruit	AMT 1048	Apocynaceae	*Tabernanthe iboga* Baill.	ceremony	0.003	311.53	
Gabon	iboga (Fr, Fa, N)	root	DQ 974	Apocynaceae	*Tabernanthe iboga* Baill.	ceremony	0.151	61.89	

Coll. Location	Local name[1]	Plant part	Coll. #	Family	Botanical Name	Use	average weight per sales unit [kg]	price per kg (US$)	IUCN status
Gabon	bois sacree (Fr)	bottle (small)		Apocynaceae	*Tabernanthe iboga* Baill.	ceremony	0.200	46.73	
Gabon	bois sacree (Fr)	bottle (large)		Apocynaceae	*Tabernanthe iboga* Baill.	ceremony	0.850	21.99	
Gabon	mbraha (N), muburg (M)	entire plant	AMT 694, DQ 1015	Leguminosae	*Tephrosia vogelii* Hook.f.	fish poison, luck	0.039	42.48	
Gabon	tsamu (M)	fruit	DQ 1123	Leguminosae	*Tephrosia vogelii* Hook.f.	luck, fish posion	0.014	133.51	
Gabon	huile d'almond (Fr)	bottle		Combretaceae	*Terminalia catappa* L.	childcare	0.200	32.71	
Gabon	ya ramponu (N)	fruit	DQ 954	Leguminosae	*Tetrapleura tetraptera* (Schum. & Thonn.) Taub.	luck, spice	0.044	8.50	
Gabon	tsele (N)	bark	DQ 957	Leguminosae	*Tetrapleura tetraptera* (Schum. & Thonn.) Taub.	luck	0.251	7.45	
Gabon	unknown	leaves	AMT 1025	Thomandersiaceae	*Thomandersia* sp.	fish poison, luck	0.107	17.47	
Gabon	mubindisa (M)	entire plant	DQ 1066	Commelinaceae	*Tradescantia zebrina* Bosse	burns	0.222	8.42	
Gabon	mboa (P)	fungus	AMT 1006		unidentified	ceremony	0.003	311.53	
Gabon	mbanda (P)	fruit	AMT 1008		unidentified	aphrodisiac	0.149	12.54	
Gabon	kiliguu (M)	fruit	AMT 1041		unidentified	women's health	0.003	747.66	
Gabon	seviki (M)	bark	AMT 1047		unidentified	ritual	0.213	8.78	
Gabon	kilinga (P)	tuber	AMT 1353		unidentified	ceremony	0.006	311.53	
Gabon	kandrina (P)	seed	AMT 1354		unidentified	ceremony	0.003	623.05	
Gabon	abunku (Fa)	fungus	AMT 787		unidentified	ceremony	0.007	133.51	
Gabon	mabaman (Fa)	bark	AMT 940		unidentified	multiple	0.143	65.36	
Gabon	lukanga (P)	wood	DQ 988		unidentified	aphrodisiac	0.034	137.44	
Gabon	digundu (M)	fruit	DQ 1011		unidentified	typhoid fever	0.102	15.86	
Gabon	nimu (M)	fruit	DQ 1048		unidentified	childcare	0.102	15.86	
Gabon	esok (Fa)	root	DQ 1063		unidentified	poison antidote	0.093	20.10	
Gabon	lit de jumeaux (Fr)	bark			unidentified	aphrodisiac	0.127	14.55	

Coll. Location	Local name[1]	Plant part	Coll. #	Family	Botanical Name	Use	average weight per sales unit [kg]	price per kg (US$)	IUCN status
Gabon	setembwand	root			unidentified	aphrodisiac	0.077	48.62	
Gabon	milangi (P), langue de peroquet (Fr)	leaves			unidentified	women's health	0.145	6.47	
Gabon	kandila (M)	fungus			unidentified	ritual	0.005	186.92	
Gabon	unknown	bottle (large)			unidentified mixture	childcare	1.500	12.46	
Gabon	unknown	root			unidentified- very large root, yellowish inside	unknown	0.077	48.62	
Gabon	mongongo (N)	entire plant	DQ 1034	Orchidaceae	*Vanilla sp.*	childcare	0.105	15.64	
Gabon	bikambilar (Fa)	entire plant	AMT 807	Asteraceae	*Vernonia amygdalina* Delile	digestive	0.157	10.43	
Gabon	milumnemugan (P), kala (M)	fruit	DQ 1003	Annonaceae	*Xylopia aethiopica* (Dunal) A.Rich.	digestive, ritual, spice	0.048	33.53	
Gabon	torche indigine (small) (Fr)	bark	AMT 750	Annonaceae	*Xylopia aethiopica* (Dunal) A.Rich.	ritual	0.057	32.40	
Gabon	torche indigine (big) (Fr)	bark	AMT 750	Annonaceae	*Xylopia aethiopica* (Dunal) A.Rich.	ritual	0.308	32.40	
Gabon	olong (Fa)	bark	AMT 1033	Rutaceae	*Zanthoxylum* cf. *heitzii* (Aubrév. & Pellegr.) P.G.Waterman	sexually transmitted infections	0.262	7.13	
Gabon	graine mais (Fr)	seed		Poaceae	*Zea mays L.*	aphrodisiac	0.041	24.78	
Gabon	gingembre (Fr)	rhizome		Zingiberaceae	*Zingiber officinale* Roscoe	digestive	0.113	12.41	

[1]Language abbreviations are as follows: B (Bateke), F (Fon), Fa (Fang), Fr (French), P (Bapounou), M (Mitsogho), N (Nzebi), Om (Omiene), T (Tcha)
[2]Identified by wood anatomist
[3]Identified by DNA barcoding

Appendix 2

Weight of plant species recorded for sale in Gabon in 2012 per market stall

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Type of stall	Herb	Spice	Togo Spice	Spice	Spice	Herb	Herb	Herb	Herb	Herb	Herb	Herb	Cameroon Spice	Ambulant	Benin Herb	Nigeria Bwiti	Herb	Spice	Herb	Spice	Bwiti
	Location	Mont Bouët	Nkembo	Nkembo	Nkembo	Nkembo	La Peyrie	La Peyrie	La Peyrie	La Peyrie	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Ngouema	Ngouema	Akouokam	Port Gentil
Species	**TOTAL 21 stalls (kg)**																					
Abelmoschus cf. *moschatus* Medik.	0.03																			0.03		
Abrus precatorius L.	0.05						0.05															
Acanthus montanus (Nees) T.Anderson	0.16																	0.16				
Adenia cf. sp. (DQ 1047)	0.50						0.50															
Adenostemma viscosum J.R.Forst. & G.Forst.	1.20						1.00											0.20				
Aframomum cf. *alboviolaceum* (Ridl.) K.Schum.	0.74						0.12	0.06	0.12	0.24			0.20									
Aframomum cf. *melegueta* K.Schum.	0.40	0.16			0.02		0.01		0.02								0.04		0.04		0.01	0.10
Afrostyrax sp. (DQ 1106)	10.15				0.15									10.00								
Ageratum conyzoides (L.) L.	1.79						0.30					1.50										
Aloe buettneri A.Berger	4.35	4.35																				
Alstonia sp. cf. (AMT 667)	0.73						0.42	0.31														
Anisophyllea sp. (AMT 749)	1.71	0.62					0.53			0.28												0.28
Annickia affinis (Exell) Versteegh & Sosef	25.94	7.98					2.66		0.50	6.65		0.33	1.00		1.00					5.82		
Annona sp. (AMT 1013)	0.24						0.24															

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Type of stall	Herb	Spice	Togo Spice	Spice	Spice	Herb	Herb	Herb	Herb	Herb	Herb	Herb	Cameroon Spice	Ambulant	Benin Herb	Nigeria Bwiti	Herb	Spice	Herb	Spice	Bwiti
	Location	Mont Bouët	Nkembo	Nkembo	Nkembo	Nkembo	La Peyrie	La Peyrie	La Peyrie	La Peyrie	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Ngouema	Ngouema	Akouokam	Port Gentil
Species	**TOTAL 21 stalls (kg)**																					
Anonidium cf. *mannii* (Oliv.) Engl. & Diels	0.29											0.29										
Aoranthe cladantha (K.Schum.) Somers	0.46						0.46															
Asparagus cf. *warneckei* (Engl.) Hutch.	0.10																	0.10				
Aucoumea klaineana Pierre	134.10	14.50					0.33		6.95	12.68	12.19		0.29				68.24			4.51		14.01
Baillonella toxisperma Pierre	2.40	0.70					0.15			0.39										1.16		
Brillantaisia cf. *owariensis* P.Beauv.	0.98											0.98										
Brillantaisia lancifolia Lindau	4.00								1.12			0.32	0.96				0.64	0.96				
Buchholzia coriacea Engl.	1.27	0.92								0.23								0.12				
Caesalpinia bonduc (L.) Roxb.	0.01								0.01													
Canavalia ensiformis (L.) DC.	0.37											0.29	0.08									
Capsicum annuum L.	2.83	0.68					0.13	0.05	0.36	0.31			0.68					0.52				0.10
Carpolobia sp. ("kuta")	0.42	0.42																				
Carpolobia alba G.Don	0.50	0.14																0.35				
Carpolobia lutea G.Don	0.22																					0.22
Ceiba pentandra (L.) Gaertn.	3.46										3.46											
Cola acuminata (P.Beauv.) Schott & Endl.	2.76	0.72					0.60						1.44									
Combretum sp.	0.92						0.73						0.18									
Copaifera religiosa J.Leonard	21.69	2.47					1.73	3.94		9.86										3.70		

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Type of stall	Herb	Spice	Togo Spice	Spice	Spice	Herb	Herb	Herb	Herb	Herb	Herb	Herb	Cameroon Spice	Ambulant	Benin Herb	Nigeria Bwiti	Herb	Spice	Herb	Spice	Bwiti
	Location	Mont Bouët	Nkembo	Nkembo	Nkembo	Nkembo	La Peyrie	La Peyrie	La Peyrie	La Peyrie	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Ngouema	Ngouema	Akouokam	Port Gentil
Species	**TOTAL 21 stalls (kg)**																					
Costus cf. *afer* Ker Gawl.	0.68																	0.68				
Costus lucanusianus J.Braun & K.Schum.	0.89												0.71					0.18				
Costus phyllocephalus K.Schum.	0.31																	0.31				
Coula edulis Baill.	0.02									0.02												
Croton oligandrus Pierre ex Hutch.	12.10									6.05			1.41							4.64		
Croton tiglium L.	0.20	0.20																				
Cucumeropsis mannii Naudin	0.90																		0.84		0.06	
Cylicodiscus gabunensis Harms	8.18						1.77													0.88		5.53
Cymbopogon citratus (DC.) Stapf	5.40														2.40	3.00						
Cymbopogon densiflorus (Steud.) Stapf	2.18	0.50							0.29	0.21		0.08	0.08				1.00					
Cyperus articulatus L.	0.15												0.07					0.09				
Daniellia klainei A.Chev.	13.69								6.74				0.22									6.74
Desmodium adscendens (Sw.) DC.	0.73												0.52					0.21				
Detarium macrocarpum Harms	0.30	0.25																		0.05		
Dialium cf. *guineense* Willd.	2.05																			2.05		
Dinophora spenneroides Benth.	0.21																	0.21				
Dioclea cf. *reflexa* Hook.f.	0.05								0.01	0.04												
Dioscorea sp. cf.	0.15						0.15															

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Type of stall	Herb	Spice	Togo Spice	Spice	Spice	Herb	Herb	Herb	Herb	Herb	Herb	Herb	Cameroon Spice	Ambulant	Benin Herb	Nigeria Bwiti	Herb	Spice	Herb	Spice	Bwiti
	Location	Mont Bouët	Nkembo	Nkembo	Nkembo	Nkembo	La Peyrie	La Peyrie	La Peyrie	La Peyrie	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Ngouema	Ngouema	Akouokam	Port Gentil
Species	**TOTAL 21 stalls (kg)**																					
Distemonanthus benthamianus Baill.	11.22								0.63	1.58		3.48										5.53
Dorstenia psilurus Welw.	1.35	0.56					0.54		0.07	0.19												
Drypetes gossweileri S.Moore	9.95									3.06										6.89		
Duboscia macrocarpa Bocq.	0.83		0.05							0.18							0.60					
Elaeis guineensis Jacq.	0.75								0.60			0.15										
Elytraria marginata Vahl	2.51						0.31		0.47	0.94								0.78				
Emilia coccinea (Sims) G.Don	0.25						0.25															
Entada gigas (L.) Fawc. & Rendle	0.42	0.24								0.18												
Erythrophleum ivorense A.Chev.	11.13	1.45					4.84					1.94								2.90		
Ficus thonningii Blume	0.20																0.20					
Fleroya ledermannii (K.Krause) Y.F.Deng	2.59																					2.59
Garcinia kola Heckel	8.73																		4.70		4.03	
Garcinia lucida Vesque	16.50	12.69																		3.81		
Geophila afzelii Hiern	0.31						0.31															
Gnaphalium sp.	0.07												0.07									
Greenwayodendron cf. *suaveolens* (Engl. & Diels) Verdc.	0.03																			0.03		
Guibourtia tessmannii (Harms) J.Leonard	8.20						1.14			0.76		1.91	2.10							2.29		
Harungana madagascariensis Lam. ex Poir.	7.80	1.39					1.39			2.78		0.56	1.68									

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Type of stall	Herb	Spice	Togo Spice	Spice	Spice	Herb	Herb	Herb	Herb	Herb	Herb	Herb	Cameroon Spice	Ambulant	Benin Herb	Nigeria Bwiti	Herb	Spice	Herb	Spice	Bwiti
	Location	Mont Bouët	Nkembo	Nkembo	Nkembo	Nkembo	La Peyrie	La Peyrie	La Peyrie	La Peyrie	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Ngouema	Ngouema	Akouokam	Port Gentil
Species	**TOTAL 21 stalls (kg)**																					
Heinsia crinita (Afzel.) G.Taylor	2.75						0.92											1.84				
Hibiscus surattensis L.	0.36																	0.36				
Irvingia gabonensis (Aubry-Lecomte ex O'Rorke) Baill.	5.44					5.00	0.44															
Kalanchoe crenata (Andrews) Haw.	1.88							0.16	1.57			0.16										
Keetia sp. (AMT 690)	0.70							0.46														0.23
Lagenaria breviflora (Benth.) Roberty	0.14								0.14													
Lagenaria siceraria (Molina) Standl.	0.34																0.34					
Lannea barteri (Oliv.) Engl.	0.17															0.17						
Lasianthera africana P.Beauv.	4.86						0.54	0.54				0.18	3.60									
*Ledebouria cameroonian*a (Baker) Speta	0.18											0.18										
Leea guineensis G. Don	0.74												0.74									
Lippia rugosa A.Chev.	3.65	0.52					0.35		1.91			0.52						0.35				
Macaranga monandra Müll.Arg.	0.14																	0.14				
Massularia acuminata (G.Don) Bullock ex Hoyle	10.07						0.95	1.53	0.44	2.34		2.92	0.44									1.46
Meiocarpidium lepidotum (Oliv.) Engl. & Diels	0.35																			0.35		
Microdesmis cf. *puberula* Hook.f. ex Planch.	0.94						0.54						0.40									
Mikania chenopodifolia Willd.	0.30																	0.30				

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Type of stall	Herb	Spice	Togo Spice	Spice	Spice	Herb	Herb	Herb	Herb	Herb	Herb	Herb	Cameroon Spice	Ambulant	Benin Herb	Nigeria Bwiti	Herb	Spice	Herb	Spice	Bwiti
	Location	Mont Bouët	Nkembo	Nkembo	Nkembo	Nkembo	La Peyrie	La Peyrie	La Peyrie	La Peyrie	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Ngouema	Ngouema	Akouokam	Port Gentil
Species	**TOTAL 21 stalls (kg)**																					
Momordica charantia L.	1.13	0.10					0.63															0.40
Monodora myristica (Gaertn.) Dunal	18.29	1.69			1.00		1.00		0.60	0.40			1.10	10.00			2.00		0.30		0.10	0.10
Morinda lucida Benth.	0.50															0.50						
Mostuea hirsuta (T.Anderson ex Benth.) Baill.	0.65						0.29		0.17	0.19												
Musanga cecropioides R.Br. ex Tedlie	0.43												0.43									
Mussaenda sp. (DQ 1099)	0.35																	0.35				
Myrianthus serratus (Trécul) Benth.	2.12									0.53		0.18	0.53					0.89				
Nauclea diderrichii (De Wild.) Merr.	0.42											0.04	0.05							0.33		
Newbouldia laevis (P.Beauv.) Seem.	4.05						1.67			2.38												
Nicotiana tabacum L.	0.72	0.18								0.36							0.18					
Ocimum americanum L.	1.61							0.48	0.22	0.52		0.39										
Ocimum gratissimum L.	0.31																	0.31				
Panax sp. (AMT 782)	0.06	0.06																				
Panda oleosa Pierre	0.38						0.38															
Pandanus sp. (AMT 1027)	0.03								0.03													
Passiflora quadrangularis L.	6.00																	6.00				
Paullinia pinnata L.	1.17						0.26						0.91									
Pentaclethra macrophylla Benth.	17.46						1.93		0.10	2.03			0.42							1.82		11.17

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Type of stall	Herb	Spice	Togo Spice	Spice	Spice	Herb	Herb	Herb	Herb	Herb	Herb	Herb	Cameroon Spice	Ambulant	Benin Herb	Nigeria Bwiti	Herb	Spice	Herb	Spice	Bwiti
	Location	Mont Bouët	Nkembo	Nkembo	Nkembo	Nkembo	La Peyrie	La Peyrie	La Peyrie	La Peyrie	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Ngouema	Ngouema	Akouokam	Port Gentil
Species	**TOTAL 21 stalls (kg)**																					
Periploca nigrescens Afzel	0.10						0.10															
Piptadeniastrum africanum (Hook.f.) Brenan	1.02											0.51								0.51		
Pityrogramma calomelanos (L.) Link	0.31																	0.31				
Plagiostyles africana (Müll.Arg.) Prain	1.44											1.44										
Prosopis africana (Guill. & Perr.) Taub.	0.66															0.66						
Pseudospondias cf. *longifolia* Engl.	0.18						0.18															
Psidium guajava L.	0.71											0.18	0.53									
Psydrax palma (K.Schum.) Bridson	0.79											0.26	0.52									
Pteleopsis suberosa Engl. & Diels	1.36															1.36						
Pterocarpus soyauxii Taub.	9.50	0.63					1.81	0.81		2.44		1.81	0.81				1.00					0.18
Pycnoporus sanguineus (L.) Murrill	0.07							0.07														
Quassia africana (Baill.) Baill.	1.51	1.06						0.25				0.20										
Raphia sp. ("flambout")	54.00						6.00		21.00	1.00							6.00					20.00
Raphia sp. (DQ 976)	0.17	0.17																				
Ricinodendron heudelotii (Baill.) Heckel	10.12				0.12									10.00								
Rinorea sp. cf. (AMT 665)	6.10						2.30	0.60	2.20	1.00												
Sarcocephalus latifolius (Sm.) E.A.Bruce	0.31															0.31						
Scleria boivinii Steud.	0.09								0.09													

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Type of stall	Herb	Spice	Togo Spice	Spice	Spice	Herb	Herb	Herb	Herb	Herb	Herb	Herb	Cameroon Spice	Ambulant	Benin Herb	Nigeria Bwiti	Herb	Spice	Herb	Spice	Bwiti
	Location	Mont Bouët	Nkembo	Nkembo	Nkembo	Nkembo	La Peyrie	La Peyrie	La Peyrie	La Peyrie	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Ngouema	Ngouema	Akouokam	Port Gentil
Species	**TOTAL 21 stalls (kg)**																					
Scoparia dulcis L.	4.56						0.54															4.02
Scorodophloeus zenkeri Harms	0.45			0.23	0.14								0.09									
Secamone afzelii (Roem. & Schult.) K.Schum.	1.25							0.78					0.16					0.31				
Selaginella myosurus Alston	1.88											0.31	1.41					0.16				
Senna alata (L.) Roxb.	0.12											0.05						0.07				
Solanum anguivi Lam.	0.12							0.12														
Sorghum bicolor (L.) Moench	0.33															0.33						
sp. Araceae (AMT 1035)	0.06									0.03		0.03										
sp. cf. Humiriaceae (AMT 1028)	0.33								0.02			0.14								0.18		
Spermacoce sp.	0.37												0.37									
Streptogyna crinita P.Beauv.	0.01																					0.01
Strychnos icaja Baill.	0.30											0.30										
Synclisia scabrida Miers	0.60	0.04							0.06	0.39		0.12										
Tabernanthe iboga Baill.	7.16						3.40	0.30		1.00		0.80	0.66									1.00
Tephrosia vogelii Hook.f.	0.46						0.08	0.19	0.08			0.04						0.08				
Terminalia catappa L.	7.95		2.00				0.50			5.20												0.25
Tetrapleura tetraptera (Schum. & Thonn.) Taub.	14.42	1.14					0.57	0.75	1.00	2.00		0.53	1.67	5.00			0.44			0.44		0.88
Thomandersia sp.	0.32						0.32															

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Type of stall	Herb	Spice	Togo Spice	Spice	Spice	Herb	Herb	Herb	Herb	Herb	Herb	Herb	Cameroon Spice	Ambulant	Benin Herb	Nigeria Bwiti	Herb	Spice	Herb	Spice	Bwiti
	Location	Mont Bouët	Nkembo	Nkembo	Nkembo	Nkembo	La Peyrie	La Peyrie	La Peyrie	La Peyrie	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Mont Bouët	Ngouema	Ngouema	Akouokam	Port Gentil
Species	**TOTAL 21 stalls (kg)**																					
unidentified ("kandila")	0.01											0.01										
unidentified ("milangi")	0.87												0.87									
unidentified (AMT 1006)	0.01						0.01															
unidentified (AMT 1041)	0.03											0.03										
unidentified (AMT 1047)	1.28												1.28									
unidentified (AMT 1353)	0.30																					0.30
unidentified (AMT 1354)	0.03																					0.03
unidentified (AMT 787)	0.41	0.04						0.14		0.06		0.02	0.01							0.14		
unidentified (AMT 940)	1.43																			1.43		
Vernonia amygdalina Delile	0.78																	0.78				
Xylopia aethiopica (Dunal) A.Rich.	13.62	1.84							0.94	1.57	1.14						6.38		0.10	0.34		1.31
Zanthoxylum cf. *heitzii* (Aubrév. & Pellegr.) P.G.Waterman	1.31									1.31												
Zingiber officinale Roscoe	1.58								0.34												1.24	
TOTAL kilograms on all stalls	595.28	58.43	2.05	0.23	1.43	5.00	46.36	11.56	48.79	71.37	16.78	23.14	28.70	35.00	3.40	6.33	87.06	17.12	5.98	44.28	5.43	76.43

Chapter Six

Summary

Summary and Conclusions

The four chapters presented in this thesis describe the medicinal plant knowledge, plant harvest patterns, reproductive health perspectives, and infant treatment preferences of Beninese and Gabonese women, as well as the value, volume, and diversity of Gabon's medicinal plant trade. The major research questions from each chapter are outlined below, with a detailed explanation of the results, hypotheses, and conclusions. This summary concludes with methodological considerations, implications for public health and education programs, and suggestions for future research.

Research Questions

Which vegetation types are major sources of herbal medicine for women and children in Bénin and Gabon?

The results in **Chapter 2** support secondary vegetation as a crucial asset in both savanna-dominated and forest-dominated landscapes. More than 80% of the 335 species cited in Bénin and 272 species in Gabon came from disturbance vegetation and home gardens, supporting our first hypothesis that women harvest predominantly from secondary forest and disturbance vegetation. Beninese and Gabonese women from our study care for their children and their own well-being by growing domesticated species, transplanting forest species to their gardens, and managing the vegetation in their immediate surroundings. The women have overcome the vulnerability of having access to a limited space and few resources to meet their families' healthcare needs. Western African women's medicinal plant harvesting can be considered generally sustainable due to the heavy reliance on human-altered habitats, but additional research is needed on the ecology and regeneration of medicinal plant species in order to make specific conclusions on the sustainability of their harvest.

What are the differences in plant use patterns between herbal medicine vendors and urban and rural women who harvest for personal use?

Like women in urban and rural areas, the majority of species cited by market vendors in **Chapter 2** came from human-altered habitats. In Bénin, women who worked in large metropolitan markets, far removed from the primary forest, were the most likely to cite vulnerable species due to their access to primary forest products through trade. In a forested country like Gabon, primary forest products were still widely available, including for women who did not have access to trade networks, resulting in no relationship between vulnerable plant use and informant type. Thus, we reject our second hypothesis that rural women use more vulnerable and primary forest species than urban and market women.

Among all plants used for women's health, how many are used to treat the statistical causes of maternal morbidity and mortality?

As discussed in **Chapter 3**, women were knowledgeable on treating the major causes of maternal mortality, but the majority of plants species in both countries were used for pregnancy-related conditions, menstrual-related conditions, and vaginal cleanses. Thus, we rejected our hypothesis that local perspectives, knowledge, and practices closely parallel African maternal mortality statistics. Beninese informants cited 248 plant species in total for women's reproductive health, in which 39 species (16%) were used to treat high blood pressure and 28 species (11%) were used in remedies for postpartum hemorrhage. Out of the 46 informants in Bénin, 87% cited at least one herbal remedy for high blood pressure, and 73% cited a remedy for postpartum hemorrhage. In Gabon, women cited a total of 189 species, in which 35 species (18%) were used to treat high blood pressure, and 12 (6%) were used to treat postpartum hemorrhage. 63% of the 41 women in Gabon were knowledgeable on

an herbal remedy for high blood pressure, and 41% knew treatments for postpartum hemorrhage. One-half of the citations for postpartum hemorrhage, however, only involved the use of hot water and thus were not plant-based in nature. Sepsis was not mentioned specifically by women in either country, but the high number of plants reported to treat sexually transmitted infections and vaginal and uterine cleanses may be reflective of local responses to treating infections.

What percentage of plants is used to treat locally-determined reproductive health concerns not addressed by international health organizations?

Menstrual-related conditions and infertility were two of the most salient health concerns according to the free-listing exercises, citation counts, and cited species presented in **Chapter 3**. These ailments were not found to be prioritized in most international health programs. In Bénin, 83% of women knew at least one treatment for a menstrual-related condition, and in Gabon, 76% of women knew an herbal remedy. A total of 79 species (32%) were used for menstrual-related conditions in Bénin, with 28 species (15%) used in Gabon. 67% of the Beninese informants and 46% of Gabonese informants knew herbal treatments for infertility. A total of 58 species (23%) were cited by Beninese women for infertility, and 13 species (7%) were cited in Gabon.

How do local biomedical healthcare providers perceive the use of traditional plant-based medicines for women's health?

The biomedical staff interviewed in **Chapter 3** recognized the role of plant-based medicine in women's reproductive health in both countries where we worked. They reported positive outcomes, such as postpartum recovery through the use of a hot water massage and the successful delivery of difficult births in private clinics through consultations with traditional healers, as well as negative outcomes such as uterine rupture due to the use of herbal medicine to accelerate contractions. We did not find a strong opinion among biomedical healthcare providers about plant-based medicines, yet both sets of practitioners cited government policies did not authorize the use of traditional medicine in national hospitals. These restrictions limited the amount of information practitioners were able to share with their patients and discouraged patients to discuss plant use practices with their doctors.

Which children's illnesses do Beninese and Gabonese mothers treat with medicinal plants?

Chapter 4 showed that mothers were most knowledge on plants to treat respiratory illnesses, malaria, and intestinal ailments, highlighting the similarity of mothers' experiences of infant health and the statistical causes of infant mortality. To a lesser extent, the women were also knowledgeable on plants for folk illnesses. Our results conclude that plant-based medicine, and more specifically mothers' knowledge of plants, is a major factor in the management of common childhood health ailments.

What are the major children's folk illnesses in each country?

In Bénin, mothers frequently cited the skin rash illnesses *atita* (Fon) and *ka* (Fon). Gabonese mothers commonly reported folk illnesses *la rate* (French) and *les fesses rouges* (French). Mothers from both countries shared the cultural concepts of encouraging children to walk early, monitoring the closure of the fontanels, and applying herbal enemas. As discussed in **Chapter 4**, these folk illnesses give insight into local treatments and health perspectives and are of interest to biomedicine since they may reveal important neglected diseases, such as the correlating symptoms of *la rate* and sickle cell disease.

For which ailments do mothers seek treatment from biomedical doctors or traditional healers?

The mothers involved in the study described in **Chapter 4** largely saw the three African systems of healthcare as complementary. The women generally self-treated with plants first, sought biomedical care for advanced stages of malaria, anemia, or fever or as a second source of healthcare and consulted the spiritual realm to treat folk illnesses or those ailments with a superhuman cause. Biomedicine was perceived to have the advantage of advanced technology and materials, especially for treatments related to blood transfusions. Some mothers in Bénin reported a preference of using self-collected herbal medicine over biomedical care due to the expensive of modern treatment.

What are the species, volume, and value of medicinal plant products sold domestically on major markets in Gabon?

The market study described in **Chapter 5** resulted in 263 medicinal plant products corresponding with at least 217 species. We estimated that 27 tons of medicinal plant products with a value of US$ 1.5 million are sold annually on the major Gabonese markets. We encountered 13 species on one-third of the surveyed stalls and found that 18 species made up almost 50% of the total volume of products available daily, including the fruits of *Tetrapleura tetraptera* and seeds of *Monodora myristica*.

What are the most frequently sold species and plant parts and the most salient health concerns treated by plants sold at the market?

Bark represented the majority of the Gabon market's floristic diversity (22%) as well as the highest percentage of daily stock (30%) in **Chapter 5**. The resin of IUCN red-listed rain forest tree species *Aucoumea klaineana* represented 20% of the daily volume of the entire market. The most salient uses of plants sold on the market were ritual purposes (32%), followed by women's health (13%), and childcare (10%). The strong presence of ritual plants on the marketplace highlights the role of spirituality and local belief systems in present-day Gabon, particularly in its urban centers.

How does Gabon's herbal medicine trade compare with markets in West Africa, Tanzania and South Africa?

Chapter 5 showed that the herbal market in Gabon was smaller in volume and value than markets in the Eastern Cape Province of South Africa, Ghana, and Bénin, and larger than the market in Sierra Leone. Gabon's floristic diversity on the market was higher than in Cameroon, Sierra Leone, South Africa, and Ghana, and slightly lower than in Bénin and Tanzania. These results support the first part of our hypothesis that Gabonese medicinal plant markets are smaller in volume than those in other African countries, but reject the second part, that Gabon's trade is smaller in floristic diversity. Herbal medicine in Gabon was more expensive than in Ghana or Bénin resulting in a fairly high value for a low volume of plant material for sale, and higher reported vendor salaries. In Gabon the most commonly traded plant parts were sold in the form of bark and resin, where Ghana was dominated by fruits and seeds, Bénin was mainly leaves and whole plants, and Sierra Leone was mainly barks and leaves. Bulbs, tubers and roots were most commonly traded in South Africa, with barks and roots most prevalent on Tanzania's market. Markets in Ghana, Gabon and Bénin all sold the seeds and fruits that doubled as food additives and medicine (*Xylopia aethiopica*, *Monodora myristica*, *Aframomum melegueta*) with ritual and women's health as top salient health concerns. The rank of women's health plants among the top two most salient health domains addressed by markets in Bénin, Gabon, and Ghana illustrate that women's health is a major concern treated by herbal medicine markets in Western Africa. The presence of medicinal plants on markets throughout Gabon stresses the role of herbal medicine in relatively wealthy African countries with heavily urbanized populations.

Methodological Considerations

Our methodology of utilizing ethnobotanical questionnaires with the corresponding collection of cited plant species resulted in a large database of plant names and uses. Although we were able to match 98% of the Beninese database and 93% of the Gabonese database with scientific nomenclature, several plants that were cited in questionnaires were unable to be matched with scientific literature, purchased on the market, or collected in the field. While some of the plants simply were unavailable due to season, location, or particular day on the market, many of the errors could be avoided in future studies. One explanation to this shortcoming can be attributed to the challenge of working with an international team of researchers with a variety of linguistic backgrounds (English, Spanish, Flemish, French, Dutch, Fon, Yoruba, Fang). Some of the unmatched names may be a result of the multiple phonetic interpretations of African plant names. Including special consideration for linguistics, including training in phonetic spelling of African languages, in future ethnobotanical studies may help to avoid similar database errors. Our data-collection methods could have been improved by follow-up focus group sessions with women who participated in the questionnaires. These sessions could serve to reiterate the data gathered in the questionnaires and confirm plant names with associated botanical collections. Future studies by ethnobotanists should continue the methodology of combining questionnaires with plant collection with these shortcomings in mind.

The largest critique of the methodology utilized in our study would be to spend more time in the individual communities where we worked. Although the six months spent in each country was a reasonable time frame for conducting doctoral fieldwork of this nature, field visits typically lasted from a few hours to several days. Spending more time with each woman and her broader community could result not only in more thorough understandings of local treatments from an anthropological perspective, more complete collection of medicinal plant vouchers from a botanical perspective, but also benefit sharing from an ethical perspective. In only one community from our study, a village in Bénin, were we able to contribute to a community-driven project directly from the results of our research. We sent the database of all herbal remedies cited by the community to the school director, complete with scientific identifications. The director plans to work with the school children to create and distribute booklets on medicinal plants for childcare directly from the knowledge generated in our study. Theoretically, our work can be applied to stimulate health care and conservation decisions from a policy viewpoint, but future research should seek to work closer with local people, health clinics, and conservation organizations to strengthen the direct outcome of ethnobotanical research for African communities.

In addition to creating stronger links with the communities where we worked, spending additional time with students at the universities and with research institutes could improve future research cooperation. Local African students are incredibly well-versed in the local languages and cultures but often have not had the same training as their peers outside of Africa. Foreign researchers have the possibility to expand the skillset of local students through offering opportunities to work on research studies and to build their anthropological, botanical, and logistical research skills.

Implications for public health and education programs

The local doctors, midwives, and gynecologists are uniquely positioned at the intersection of the two medical systems, situated between cultural practices and the biomedical science promoted in government hospitals and clinics. Although research on the effects of medicinal plants is sorely needed, in the meantime, educators and healthcare providers should familiarize themselves with common practices and herbal treatments in order to facilitate fruitful discussions with their patients and avoid

the negative effects of combined healthcare systems. Biomedical research is still inconclusive on the role of vaginal cleanses in either preventing or increasing vaginal infections (Myer et al. 2005; Low et al. 2011), yet anthropological research has shown that these practices are deeply embedded in a woman's agency over her own fertility and relationships (Martin Hilber et al. 2012). Dismissing local treatments or discouraging their use will further distance women from the treatment options available through biomedicine. Educational efforts can also focus on the link between sexually transmitted infections (STIs) and infertility, as infertility is a frequent concern of the women involved in our study, and STIs are considered one of its major causes (Collet et al. 1988).

Future research

In order to further the discussion on the sustainability of harvesting in secondary vegetation from **Chapter 2** and the commercialized species highlighted in **Chapter 5**, future studies should carry out population assessments, impact studies and natural regeneration measurements of species indicated as having conservation concerns such as *Baillonella toxisperma, Garcinia kola* and *Pterocarpus soyauxii* in Gabon and *Xylopia aethiopica*, *Khaya senegalensis*, *Monodora myristica*, and *Caesalpinia bonduc* in Bénin. Additionally, future research on male knowledge domains (e.g. ritual plants and aphrodisiacs) and associated plant harvesting patterns can help illustrate the gendered differences of medicinal plant use and its variable impacts on surrounding vegetation.

Echoing the biomedical healthcare providers interviewed in **Chapter 3**, additional information is needed on the role of plants in women's gynecological healthcare, including the specific benefits and risks of plant-based medicines in the long and short-term. Research should go beyond the goal of substantiating efficacy, instead focusing on improving biomedical healthcare providers' abilities to provide relevant information and practical advice to their patients.

Unlike the biomedical providers interviewed on women's health, the mothers in **Chapter 4** largely saw the three African healthcare systems as complementary. This dissonance creates fertile ground for politically-focused research on African governments' provision of biomedical care services, policies on herbal medicine, and local women's practices of managing reproductive and pediatric health.

Finally, in **Chapter 4**, we concluded that mothers' knowledge of herbal medicine is a major factor in the provision of infant healthcare. However, we did not take into account differences in ethnicity or age. In our study, we defined "mother" as any woman who had at least one child, which resulted in the participation of mothers and grandmothers. Future ethnobotanical research in Africa can assess the human behavior theory surrounding "grandmothering" (Hawkes et al. 1997; Bezner Kerr et al. 2008), focusing on the medicinal plant knowledge of women of the third age. This highly debated theory suggests that the presence of women in the post-fertile period of life is an evolutionary advantage, contributing to the wellbeing and survival of subsequent generations (O'Connell et al. 1999).

It is my hope that this study serves to give a voice to women from Bénin and Gabon on gynecological and pediatric health issues. May it contribute to an honest discussion between all stakeholders, followed with tangible action in improving the healthcare options and overall well-being of women and children in Beninese and Gabonese communities.

Samenvatting

Samenvatting en conclusies

Dit proefschrift beschrijft de kennis van Béninese en Gabonese vrouwen over medicinale planten, de manier waarop zij ze oogsten, hun visie op reproductieve gezondheid, en de wijze waarop zij hun kinderen behandelen bij ziekte. Het laatste hoofdstuk gaat over de omvang, diversiteit en economische waarde van de medicinale plantenhandel in Gabon. De belangrijkste onderzoeksvragen uit elk hoofdstuk worden hieronder uitgelicht met een korte beschrijving van de resultaten en conclusies. Deze samenvatting eindigt met enkele methodologische overwegingen, aanbevelingen voor voorlichtingsprogramma's en toekomstig onderzoek.

Onderzoeksvragen

Welke vegetatietypes leveren de meeste geneeskrachtige planten voor vrouwen en kinderen? **Hoofdstuk 2** Secondaire vegetatie is de belangrijkste bron voor medicinale planten, zowel in de savanne (Benin) als in het boslandschap van Gabon. Van de 335 medicinale planten in Bénin en 272 in Gabon kwam meer dan 80% uit door de mens verstoorde vegetatie en tuinen. Vrouwen verzamelen dus vooral planten in secundair bos, struikgewas en cultuurlandschap en niet zozeer uit primair regenwoud. De oogst van medicinale planten door vrouwen in Westelijk Afrika kan dus over het algemeen als duurzaam worden beschouwd.

Wat zijn de verschillen in plantgebruik tussen marktverkoopsters van kruidenmedicijnen, vrouwen uit de stad en vrouwen op het platteland die slechts voor persoonlijk gebruik oogsten? Ver verwijderd van het regenwoud, kenden marktverkoopsters in het sterk ontboste Bénin veel meer kwetsbare bossoorten dan de andere vrouwen, vanwege hun contacten met de commerciële handel (**Hoofdstuk 2)**. In het bosrijke Gabon waren bosproducten nog rijkelijk beschikbaar, ook voor vrouwen zonder toegang tot de markt. Daarom verwerpen we onze hypothese dat plattelandsvrouwen meer bosplanten gebruiken dan vrouwen in steden en marktverkoopsters.

Welk percentage van alle planten die vrouwen voor hun gezondheid gebruiken wordt aangewend voor de belangrijkste oorzaken van moedersterfte en morbiditeit? Uit **Hoofdstuk 3** blijkt dat vrouwen weliswaar bekend waren met de belangrijkste oorzaken van moedersterfte, maar in beide landen werden de meeste planten gebruikt voor zwangerschap gerelateerde aandoeningen, menstruatieproblemen en vaginale hygiëne. Lokaal medicinaal plantgebruik volgt dus niet de Afrikaanse statistieken over moedersterfte. Béninese informanten citeerden slechts 39 van de 248 soorten tegen hoge bloeddruk en 28 soorten tegen postpartumbloedingen. In Gabon gebruikten vrouwen slechts 35 van de 189 soorten tegen hypertensie en 12 bij postpartumbloedingen. Bloedvergiftiging werd niet specifiek genoemd door de ondervraagde vrouwen, maar het grote aantal planten dat werd vermeld voor het behandelen van Soa's en het reinigen van vagina en baarmoeder wijst op lokale kennis over het behandelen van bacteriële infecties.

Hoeveel planten gebruikt men voor cultuurgebonden aspecten van de reproductieve gezondheid? Menstruatieproblemen en onvruchtbaarheid kwamen als de twee belangrijkste gezondheidsaspecten naar voren uit interviews (**Hoofdstuk 3**). Deze onderwerpen staan niet in de moedersterftestatistieken van de internationale gezondheidsorganisaties. Hieruit blijkt dat de gezondheidsprioriteiten van de Afrikaanse vrouwen afwijken van de officiële statistieken.

Wat is de mening van lokale artsen en verplegend personeel over het gebruik van traditionele kruidengeneeskunde voor reproductieve gezondheid? Artsen en verplegend personeel in Bénin en Gabon waren op de hoogte van het gebruik van medicinale planten door vrouwen (**Hoofdstuk 3**). Zij hadden een positieve mening over aspecten als het voorspoedige herstel na de bevalling door het gebruik van warmwater

massages en de kundigheid van traditionele vroedvrouwen bij gecompliceerde bevallingen. Een negatief oordeel hadden ze over het gebruik van medicinale planten om de bevalling te bespoedigen, omdat dit vaak leidde tot het scheuren van de baarmoeder door het te sterk opwekken van de barensweeën. Het overheidsbeleid stond het gebruik van traditionele geneeswijzen in ziekenhuizen niet toe. Dit belemmerde medische personeel bij de communicatie over plantgebruik met hun patiënten.

Welke kinderziekten behandelen Béninese en Gabonese moeders met planten? Uit **Hoofdstuk 4** komt naar voren dat moeders de meeste ervaring hadden met het behandelen van luchtwegaandoeningen, malaria en maag-darmklachten met medicinale planten. Plantgebruik lijkt dus sterk gerelateerd te zijn aan de meest voorkomende oorzaken van kindersterfte in Sub-Sahara Afrika. Cultuurgebonden aandoeningen speelden een kleinere, maar niet onbelangrijke rol in het gebruik van traditionele geneesmiddelen. De kennis van planten onder (groot-) moeders speelt een belangrijke rol in het behandelen van veel voorkomende kinderziekten.

Wat zijn de belangrijkste cultuurgebonden kinderziekten in de twee landen? Béninese moeders gebruikten veel planten voor de huidziekten *atita* en *ka* bij kinderen (**Hoofdstuk 4**). Gabonese moeders spraken vaak over de ziektes *la rate* en *les fesses rouges*. Moeders in beide landen wilden hun kinderen snel leren lopen, wat zij stimuleerden met massages en kruidenbaden. Zij smeerden kruidenpasta op de fontanel van hun kinderen en gaven hen veelvuldig klysma's met plantenextracten. Hoewel niet door de Westerse geneeskunst gedefinieerd, verdienen cultuurgebonden aandoeningen aandacht van de medische wereld omdat zij aanwijzingen kunnen zijn voor onbehandelde of chronische ziektes, zoals sikkelcelanemie in het geval van *la rate*.

Bij welke kinderziekten gaan moeders naar de dokter en wanneer naar de traditionele genezer? Béninese en Gabonese moeders zagen de drie systemen van gezondheidszorg in Afrika (moderne geneeskunde, traditionele genezers en zelfzorgmiddelen met medicinale planten) grotendeels als complementair (**Hoofdstuk 4**). Kinderziektes behandelden ze meestal eerst met geneeskruiden. Bij ernstige vormen van malaria, bloedarmoede of hevige koorts, of als de kruiden niet hielpen, raadpleegden zij een arts of verpleger. Bij cultuurgebonden aandoeningen of ziekten met een bovennatuurlijke oorzaak zochten zij hulp bij een lokale (spirituele) kruidendokter. Hoewel de moderne geneeskunde goede medicijnen en geavanceerde apparaten had, was het eigen gebruik van kruiden veruit het goedkoopste.

Hoe omvangrijk is de medicinale plantenhandel op de binnenlandse markt van Gabon? Het marktonderzoek van **Hoofdstuk 5** leverde 263 medicinale producten op die correspondeerden met tenminste 217 plantensoorten. Een geschatte 27 ton aan geneeskruiden (US$ 1,5 miljoen) wordt jaarlijks omgezet op de binnenlandse Gabonese markt. Bestsellers zijn vruchten van *Tetrapleura tetraptera* en de zaden van *Monodora myristica*.

Welke gezondheidsproblemen behandelen de inwoners van Gabon met planten van de markt?

Op de Gabonese markt lag vooral boombast en hars van *Aucoumea klaineana*, gebruikt in *Bwiti* fakkels (**Hoofdstuk 5**). De meeste planten op de markt werden ritueel gebruikt (32%), gevolgd door vrouwengezondheid (13%), en het behandelen van kinderen (10%).

Lijkt de medicinale plantenhandel in Gabon op die van andere Afrikaanse landen? De handel in medicinale planten in Gabon is kleiner is qua volume en economische waarde dan die in Zuid-Afrika, Ghana en Bénin en groter dan die in Sierra Leone (**Hoofdstuk 5**). De botanische diversiteit van de Gabonese markt was hoger dan die van Kameroen, Sierra Leone, Zuid-Afrika en Ghana, maar iets lager dan die van Bénin en Tanzania. Geneeskruiden waren duurder in Gabon, wat resulteerde in een grotere opbrengst per kilo plantmateriaal en hogere salarissen van marktverkopers. Het feit dat reproductieve gezondheid telkens bovenaan de lijst stond van toepassingen in Bénin, Gabon en Ghana benadrukt de belangrijke rol die medicinale planten spelen in het welzijn van Afrikaanse vrouwen. Ook in relatief rijke, sterk verstedelijkte Afrikaanse landen als Gabon zijn medicinale planten nog steeds erg populair.

Methodologische overwegingen

Onze methodes (vragenlijsten en het verzamelen van tijdens het interview genoemde planten) resulteerden in een grote database met plantennamen en gebruiken. Zo'n 5% van de genoemde planten konden we niet koppelen aan een wetenschappelijke. Sommige van deze soorten waren misschien niet aanwezig of de lokale namen waren door ons internationale team anders gedocumenteerd dan in de literatuur. Toekomstig etnobotanisch onderzoek moet meer aandacht besteden aan linguïstische vaardigheden en officiële fonetische spellingstechnieken gebruiken. Groepsdiscussies achteraf kunnen dienen om verzamelde gegevens te controleren en lokale plantennamen te confirmeren. Als we de mogelijkheid hadden gehad langere tijd door te brengen in elke gemeenschap hadden we een beter begrip kunnen krijgen van de lokale gebruiken vanuit een antropologisch perspectief en een completere verzameling planten. Slechts in één Béninees dorp kon ons onderzoek direct tot ondersteuning dienen van een project opgezet door de lokale bevolking waarbij medicinale bomen en struiken werden aangeplant. Directere en langdurigere samenwerking met de lokale bevolking, gezondheidszorg en natuurbeschermingsorganisaties en Afrikaanse onderzoekers en studenten zou etnobotanisch onderzoek in Afrika effectiever maken.

Implicaties voor de volksgezondheid en voorlichtingsprogramma's

Onderzoek naar de werking van medicinale planten is hard nodig, maar Afrikaanse (vrouwen-) artsen, verplegers en gezondheidsvoorlichters moeten zich ook verdiepen in lokaal medicinaal plantgebruik en hierover met hun patiënten communiceren en de nadelen ervan voorkomen. Medici weten nog niet of vaginale reiniging van het risico op infectie verhoogt of verlaagt. Deze praktijken zijn sterk cultuurgebonden en geven de vrouw zeggenschap over haar eigen vruchtbaarheid en seksuele relaties. Verbieden van dit soort plantgebruik kan ertoe leiden dat men de moderne geneeskunde nog minder vertrouwt. Voorlichting moet zich richten op de relatie tussen Soa's en onvruchtbaarheid, gezien het laatste als groot probleem wordt erkend.

Toekomstig onderzoek

De duurzaamheid van de oogst van medicinale planten in Bénin en Gabon (**Hoofdstukken 2 en 5**) kan pas echt vastgesteld worden door onderzoek naar de populaties, de impact van de extractie, en de natuurlijke regeneratie van commercieel geoogste soorten als *Baillonella toxisperma, Garcinia kola* en *Pterocarpus soyauxii* in Gabon en *Xylopia aethiopica*, *Khaya senegalensis* en *Monodora myristica* in Bénin. Documentatie van vooral door mannen gebruikte planten (zoals rituele planten en afrodisiaca) en hun oogstwijze zou een gebalanceerde vergelijking tussen het medicinaal plantgebruik door mannen en vrouwen en de impact hiervan op de omringende vegetatie mogelijk maken.

Zoals aangegeven in **Hoofdstuk 3** is er meer onderzoek nodig op het gebied van medicinale planten en gynaecologische zorg, en vooral de specifieke voor- en nadelen van het gebruik van traditionele geneeskruiden op de korte en lange termijn. In tegenstelling tot het medisch personeel in **Hoofdstuk 4**, zagen de geïnterviewde vrouwen de drie Afrikaanse gezondheidszorgsystemen grotendeels als complementair. Dit zou een stimulans moeten zijn voor politiek-georiënteerd onderzoek naar het beleid van Afrikaanse overheden op het gebied van moderne gezondheidszorg en traditionele geneeswijzen voor vrouwen en kinderen.

Tenslotte concluderen wij in **Hoofdstuk 4** dat de kennis van moeders op het gebied van kruidenmedicijnen een belangrijke factor is in het leveren van zorg aan hun (klein-) kinderen. We namen zowel bij oma's als bij moeders een vragenlijst af. Toekomstige etnobotanische onderzoekers van medicinale plantenkennis van (oudere) vrouwen zouden de "grootmoederhypothese", bekend van de sociale wetenschappen en de evolutiebiologie in acht moeten nemen. Deze omstreden theorie suggereert

dat de aanwezigheid van post-menopauzale vrouwen positief bijdraagt tot het welzijn en de overleving van hun kleinkinderen en daaropvolgende generaties (O'Connell et al. 1999). Grootmoeders die de gezondheid van hun kleinkinderen verbeteren met geneeskruiden, zoals in Afrika, zouden een positieve invloed hebben op het welzijn van de volgende generaties.

Wij hopen dat dit onderzoek een stem geeft aan Béninese en Gabonese vrouwen op het gebied van reproductieve en kindergezondheid en bijdraagt aan concrete maatregelen om de gezondheid en het algemene welzijn van vrouwen en kinderen in West en Centraal Afrika te verbeteren.

References

Abdillahi, H.S. and J. Van Staden. 2013. Application of Medicinal Plants in Maternal Healthcare and Infertility: A South African Perspective. *Planta Medica* 230 (7): 591–599.

Adjanohoun, E.J., V. Adjakidje, and S. de Souza. 1989. Contribution Aux Études Ethnobotaniques et Floristiques du Bénin. Paris: Agence de Coopération Culturelle et Technique.

A**koègninou, A.,W.J. van der Burg, and L.I.G. van der Maesen. 2006.** Flore analytique du Bénin. Cotonou et Wageningen: Backhuys Pub., 329-330.

Alexiades, M.N., and J.W. Sheldon. 1996. Selected Guidelines for Ethnobotanical Research: A Field Manual. New York: New York Botanical Garden.

Anyinam, C. 1995. Ecology and Ethnomedicine: Exploring Links between Current Environmental Crisis and Indigenous Medical Practices. *Social Science & Medicine* 40 (3): 321-329.

Bakshi, S.S., S. McMahon, and A. George. 2013. The Role of Traditional Treatment on Health Care Seeking by Caregivers for Sick Children in Sierra Leone: Results of a Baseline Survey. *Acta Tropica* 127: 46–52.

Beiersmann, C. and Aboubakary S. 2007. Malaria in Rural Burkina Faso: Local Illness Concepts, Patterns of Traditional Treatment and Influence on Health-Seeking Behaviour. *Malaria Journal* 9: 1–9.

Belcher, B. and K. Schreckenberg. 2007. Commercialisation of Non Timber Forest Products: A Reality Check. *Development Policy Review* 25 (3): 355–377.

Betti, J.L. 2002. Medicinal Plants Sold in Yaoundé Markets, Cameroon. *African Study Monographs* 23 (2): 47-64.

Bezner Kerr, R., L. Dakishoni, L. Shumba, R. Msachi, and M. Chirwa. 2008. 'We Grandmothers Know Plenty': Breastfeeding, Complementary Feeding and the Multifaceted Role of Grandmothers in Malawi. *Social Science & Medicine* 66 (5): 1095–105.

Bhatia, J.C., J. Cleland, L. Bhagavan, and N.S.N. Rao. 1997. Levels and Determinants of Gynecological Morbidity in a District of South India. *Studies in Family Planning* 28 (2): 95–103.

Bhutta, Z.M. Chopra, H. Axelson, P. Berman, T. Boerma, J. Bryce, F. Bustreo, E. Cavagnero, G. Cometto, B. Daelmans, A. de Francisco, H. Fogstad, N. Gupta, L. Laski, J. Lawn, B. Maliqi, E. Mason, C. Pitt, J. Requejo, A. Starrs, C.G. Victora, and T. Wardlaw. 2010. Countdown to 2015 Decade Report (2000-10): Taking Stock of Maternal, Newborn, and Child Survival. *Lancet* 375 (9730): 2032–2044.

Black, R.E., S. Cousens, H.L. Johnson, J.E. Lawn, I. Rudan, D.G. Bassani, P. Jha, H. Campbell, C.F.Walker, R. Cibulskis, T. Eisele, L. Liu, and C. Mathers. 2010. Global, Regional, and National Causes of Child Mortality in 2008: A Systematic Analysis. *Lancet* 375 (9730): 1969–1987.

Bland, R.M., N.C. Rollins, J.van den Broeck, and H.M. Coovadia. 2004. The Use of Non-Prescribed Medication in the First 3 Months of Life in Rural South Africa. *Tropical Medicine & International Health* 9 (1): 118–124.

Brown, J.E. and R.C. Brown. 2000. Traditional Intravaginal Practices and the Heterosexual Transmission of Disease: A Review. *Sexually Transmitted Diseases* 27(4): 183-187.

Brown, S. and A.E. Lugo. 1990. Tropical Secondary Forests. *Journal of Tropical Ecology* 6 (1): 1–32.

Bruijns, S., R. Green, and L. Wallis. 2012. Sepsis as a Cause of Rising Health Care Casualties in Africa. *African Journal of Emergency Medicine* 2 (2): 47–48.

Bryce, J., C. Boschi-Pinto, K. Shibuya, and R.E. Black. 2005. WHO Estimates of the Causes of Death in Children. *Lancet* 365 (9465): 1147–1152.

Caldwell, J.C. and P. Caldwell. 1987. The Cultural Context of High Fertility in Sub-Saharan Africa. *Population and Development Review* 13 (3): 409–437.

Camou-Guerrero, A., V. Reyes-García, M. Martínez-Ramos, and A. Casas. **2007.** Knowledge and Use Value of Plant Species in a Rarámuri Community: A Gender Perspective for Conservation. *Human Ecology* 36 (2): 259–272.

Caniago, I., and F.S. Stephen. 1998. Medicinal Plant Ecology, Knowledge and Conservation in Kalimantan, Indonesia. *Economic Botany* 52 (3): 229–250.

Cates, W., T.M.M. Farley, and P.J. Rowe. 1985. Worldwide Patterns of Infertility: Is Africa Different? *The Lancet* 5800: 596–598.

CIA. 2013a. CIA - The World Factbook: Benin. Available from https://www.cia.gov/library/publications/the-world-factbook/geos/bn.html. Accessed 29 April 2013.

CIA. 2013b. CIA - The World Factbook: Gabon. Available from https://www.cia.gov/library/publications/the-world-factbook/geos/gb.html. Accessed 29 April 2013.

CITES. 2013. CITES. Available from http://www.cites.org/. Accessed 20 September 2013.

Cocks, M.L. and A.P. Dold. 2006. Cultural Significance of Biodiversity: The Role of Medicinal Plants in Urban African Cultural Practices in the Eastern Cape, South Africa. *Journal of Ethnobiology* 26 (1): 60–81.

Coley, P.D., J.P. Bryant, and F.S. Chapin. 1985. Resource Availability and Plant Antiherbivore Defense. *Science* 230 (4728): 895–899.

Collet, M., J. Reniers, E. Frost, R. Gass, F. Yvert, A. Leclerc, C. Roth-Meyer, B. Ivanoff, and A. Meheus. 1988. Infertility in Central Africa: Infection Is the Cause. *International Journal of Gynaecology and Obstetrics* 26 (3): 423–428.

Colvin, C.J., H.J. Smith, A. Swartz, J.W. Ahs, J. de Heer, N. Opiyo, J.C. Kim, T. Marraccini, and A. George. 2013. Understanding Careseeking for Child Illness in Sub-Saharan Africa: A Systematic Review and Conceptual Framework Based on Qualitative Research of Household Recognition and Response to Child Diarrhoea, Pneumonia and Malaria. *Social Science & Medicine* 86: 66–78.

Colwell, R.K. 2013. EstimateS: Statistical Estimation of Species Richness and Shared Species from Samples. Version 9. User's Guide and application published at: http://purl.oclc.org/estimates.

Cui, W. 2010. Mother or Nothing: The Agony of Infertility. *Bulletin of the World Health Organization* 88 (12): 881–882.

Cunningham, A.B. 2001. Applied Ethnobotany: People, Wild Plant Use and Conservation. People and. London: Earthscan.

Cunningham, A.B. 1993. African Medicinal Plants: Setting Priorities at the Interface between Conservation and Primary Healthcare. People and Plants Working Paper no.1. Paris: UNESCO.

Daar, A.S., and Z. Merali. 2002. Infertility and Social Suffering: The Case of ART in Developing Countries. Current Practices and Controversies in Assisted Reproduction. Geneva, Switzerland: World Health Organization. 15-21.

Davies-Adetugbo, A.A. 1997. Sociocultural Factors and the Promotion of Exclusive Breastfeeding in Rural Yoruba Communities of Osun State, Nigeria. *Social Science & Medicine* 45 (1): 113–125.

De Albuquerque, U.P., and R.F.P. de Lucena. 2005. Can Apparency Affect the Use of Plants by Local People in Tropical Forests? *Interciencia* 30 (8).

de Boer, H., and V. Lamxay. 2009. Plants Used during Pregnancy, Childbirth and Postpartum Healthcare in Lao PDR: A Comparative Study of the Brou, Saek and Kry Ethnic Groups. *Journal of Ethnobiology and Ethnomedicine* 5: 25.

De Lucena, R.F.P., P.M. de Medeiros, E.D.L. Araújo, A.G.C. Alves, and U.P. Albuquerque. 2012. The Ecological Apparency Hypothesis and the Importance of Useful Plants in Rural Communities from Northeastern Brazil: An Assessment Based on Use Value. *Journal of Environmental Management* 96 (1): 106–115.

De Zoysa, I., D. Carson, R. Feachem, B. Kirkwood, E. Lindsay-Smith, and R. Loewenson. 1984. Perceptions of Childhood Diarrhoea and Its Treatment in Rural Zimbabwe. *Social Science & Medicine* 19 (7): 727–734.

Dold, A.P., and M.L. Cocks. 2002. The Trade in Medicinal Plants in the Eastern Cape Province, South Africa. *South African Journal of Science* 98 (11 & 12): 589–597.

Dyer, S.J., N. Abrahams, M. Hoffman, and Z.M. van der Spuy. 2002. 'Men Leave Me as I Cannot Have Children': Women's Experiences with Involuntary Childlessness. *Human Reproduction* 17 (6): 1663–1668.

Eisele, T.P., D.A. Larsen, P.A. Anglewicz, J. Keating, J. Yukich, A. Bennett, P. Hutchinson, and R.W. Steketee. 2012. Malaria Prevention in Pregnancy, Birthweight, and Neonatal Mortality: A Meta-Analysis of 32 National Cross-Sectional Datasets in Africa. *The Lancet Infectious Diseases* 12 (12): 942–949.

El-Hilaly, J., M. Hmammouchi, and B. Lyoussi. 2003. Ethnobotanical Studies and Economic Evaluation of Medicinal Plants in Taounate Province (Northern Morocco). *Journal of Ethnopharmacology* 86 (2-3): 149–158.

Etkin, N.L. 1988. Cultural constructions of efficacy. In Van der Geest S., Whyte S.R., eds. The context of medicines in developing countries. Dordrecht: Kluwer Academic, 299–326.

FAO. 2010a. Evaluation Des Ressources Forestieres Mondiales 2010 Rapport National Benin. Rome. Available from http://www.fao.org/docrep/013/al458f/al458f.pdf. Accessed 6 May 2013.

FAO. 2010b. Evaluation Des Ressources Forestieres Mondiales 2010 Rapport National Gabon. Rome. Available from http://www.fao.org/docrep/013/al509F/al509f.pdf. Accessed 11 October 2013.

FAO. 2010c. Global Forest Resources Assessment 2010. Rome. Available from http://www.fao.org/docrep/013/i1757e/i1757e.pdf. Accessed 11 October 2013.

Feeny, P. 1976. Plant Apparency and Chemical Defense. In Biochemical Interaction Between Plants and Insects. Eds. J.W. Wallace, and R.L. Mansell. Vol 10. NY: Springer, 1–40.

Fleming, A.F. 1989. Tropical Obstetrics and Gynaecology. 1. Anaemia in Pregnancy in Tropical Africa. *Transactions of the Royal Society of Tropical Medicine and Hygiene* 83 (4): 441–448.

Flore du Gabon. 1960–2008. Various editors, volume 1–38. Paris: Muséum National d'Histoire.

Folke, C. 2006. Resilience: The Emergence of a Perspective for Social–ecological Systems Analyses. *Global Environmental Change* 16 (3): 253–267.

Fondoun, J.M. and T.T. Manga. 2000. "Farmers Indigenous Practices for Conserving Garcinia Kola and Gnetum Africanum in Southern Cameroon." *Agroforestry Systems* (1990): 289–302.

Forest Legality Alliance. 2014. Gabon. Available from http://risk.forestlegality.org/countries/gabon. Accessed 14 April 2014.

Frank, O. 1983. Infertility in Sub-Saharan Africa: Estimates and Implications. *Population and Development Review* 9 (1): 137–144.

Frei, B., O. Sticher, and M. Heinrich. 2000. Zapotec and Mixe Use of Tropical Habitats for Securing Medicinal Plants in Mexico. *Economic Botany* 54 (1): 73–81.

Friend-du Preez, N., N. Cameron, and P. Griffiths. 2013. 'So They Believe That If the Baby Is Sick You Must Give Drugs…' The Importance of Medicines in Health-Seeking Behaviour for Childhood Illnesses in Urban South Africa. *Social Science & Medicine* 92: 43–52.

Gallopín, G.C. 2006. Linkages between Vulnerability, Resilience, and Adaptive Capacity."*Global Environmental Change* 16 (3): 293–303.

Gaoue, O.G., C.C. Horvitz, T. Ticktin, U.K. Steiner, and S. Tuljapurkar. 2013. Defoliation and Bark Harvesting Affect Life-History Traits of a Tropical Tree. *Journal of Ecology* 101(6): 1563-1571.

Gaoue, O.G., and T. Ticktin. 2007. Patterns of Harvesting Foliage and Bark from the Multipurpose Tree Khaya Senegalensis in Benin: Variation across Ecological Regions and Its Impacts on Population Structure. *Biological Conservation* 137 (3): 424–436.

Geissler, P.W., S.A.Harris, R.J. Prince, A. Olsen, R.A. Odhiambo, H. Oketch-Rabah, P.A. Madiega, A. Andersen, and P. Mølgaard. 2002. Medicinal Plants Used by Luo Mothers and Children in Bondo District, Kenya. *Journal of Ethnopharmacology* 83 (1-2): 39–54.

Global Forest Watch. 2000. A First Look at Logging in Gabon. Washington: World Resources Institute. Available from http://www.cabdirect.org/abstracts/20036792649.html. Accessed 22 April 2014.

Gottlieb, A. 2004. The Afterlife Is Where We Come from. London: University of Chicago Press.

Green, E.C. 1985. Traditional Healers, Mothers and Childhood Diarrheal Disease in Swaziland: The Interface of Anthropology and Health Education. *Social Science & Medicine* 20 (3): 277–285.

Grosse, S.D., I. Odame, H.K. Atrash, D.D. Amendah, F.B. Piel, and T.N. Williams. 2011. Sickle Cell Disease in Africa: A Neglected Cause of Early Childhood Mortality. *American Journal of Preventive Medicine* 41 (6 Suppl 4): S398–405.

Guinee, L. 2013. Sustainability Aspects of Medicinal Bark, Root and Wood Harvest in Gabon: A Rapid Assessment of Sustainability Issues Using Market Surveys and Species Distribution Models. MSc Thesis. Utrecht / Leiden University.

Gutman, J. and L. Slutsker. 2011. Malaria Control in Pregnancy: Still a Long Way to Go. *The Lancet Infectious Diseases* 11 (3): 157–159.

Hamilton, A.C. 2004. Medicinal Plants, Conservation and Livelihoods. *Biodiversity and Conservation* 13 (8): 1477–1517.

Harlow, S.D. and O.M.R. Campbell. 2000. Menstrual Dysfunction: A Missed Opportunity for Improving Reproductive Health in Developing Countries. *Reproductive Health Matters* 8 (15): 142–147.

Hawkes, K., J.F. O'Connell, and N.G. Blurton Jones. 1997. Hadza Women's Time Allocation, Offspring Provisioning, and the Evolution of Long Postmenopausal Life Spans. *Current Anthropology* 38 (4): 551–577.

Hawkes, K. 2004. Human Longevity: The Grandmother Effect. *Nature* 428: 128–129.

Hawthorne, W.D. and C.C.H. Jongkind. 2006. Woody Plants of Western African forests:A Guide to the Forest Trees, Shrubs and Lianes from Senegal to Ghana. Edited by R. Wise. Kew: Royal Botanic Gardens.

Helman, C.G. 2007. Culture, Health and Illness. Fifth Edition. London: Hodder Arnold.

Hofmann, J., M. de Allegri, M. Sarker, M. Sanon, and T. Böhler. 2009. Breast Milk as the 'Water That Supports and Preserves Life'--Socio-Cultural Constructions of Breastfeeding and Their Implications for the Prevention of Mother to Child Transmission of HIV in Sub-Saharan Africa. *Health Policy* 89 (3): 322–328.

Holm, L.1997. World Weeds: Natural Histories and Distribution. New York: John Wiley & Sons.

Horton, R. 2010. The Continuing Invisibility of Women and Children. *Lancet* 375 (9730): 1941–1943.

Howard, P.L. 2003. Women and the Plant World: An Exploration. In Women and Plants: Gender Relations in Biodiversity Management & Conservation. London: Zed, 1–48.

Hsu, E. 2002. 'The Medicine from China Has Rapid Effects': Chinese Medicine Patients in Tanzania. *Anthropology & Medicine* 9 (3): 51–53.

Huynh, B., N. Fievet, G. Gbaguidi, S. Dechavanne, S. Borgella, B. Guézo-Mévo, A. Massougbodji, N.T. Ndam, P. Deloron, and M. Cot. 2011. Influence of the Timing of Malaria Infection during Pregnancy on Birth Weight and on Maternal Anemia in Benin. *The American Journal of Tropical Medicine and Hygiene* 85 (2): 214–220.

InsideWood. 2004-onwards. Published on the Internet. Available from http://insidewood.lib.ncsu.edu. Accessed 20 April 2014.

International Society of Ethnobiology. 2006. http://ethnobiology.net/code-of-Ethics/. International Society of Ethnobiology Code of Ethics (with 2008 Additions). Available from http://ethnobiology.net/code-of-ethics/. Accessed 14 May 2013.

IUCN Red List of Threatened Species. 2013. IUCN 2013. Version 2013.1. Available from www.iucnredlist.org. Accessed 20 September 2013.

Iyam, D. 1996. "Full" Men and "Powerful" Women: The Reconstruction of Gender Status among the Biase of Southeastern Nigeria. *Canadian Journal of African Studies/La Revue canadienne des études africaines* 30(3): 387-408.

Jawad, I., I. Lukšić, and S.B. Rafnsson. 2012. Assessing Available Information on the Burden of Sepsis: Global Estimates of Incidence, Prevalence and Mortality. *Journal of Global Health* 2: 10404.

Jerven, M. 2009. The Relativity of Poverty and Income: How Reliable Are African Economic Statistics? *African Affairs* 109 (434): 77–96.

Jha, S. and K.S. Bawa. 2006. Population Growth, Human Development, and Deforestation in Biodiversity Hotspots. *Conservation Biology* 20 (3): 906–912.

Jusu, A. and A.C. Sanchez. 2013. Economic Importance of the Medicinal Plant Trade in Sierra Leone. *Economic Botany* 67 (4): 299–312.

Jusu, A. and A.C. Sanchez. 2014. Medicinal Plant Trade in Sierra Leone: Threats and Opportunities for Conservation. *Economic Botany* 68: 16–29.

Kamatenesi-Mugisha, M. and H. Oryem-Origa. 2007. Medicinal Plants Used in Some Gynaecological Morbidity Ailments in Western Uganda. *African Journal of Ecology* 45 (s1): 34–40.

Kay, M.A. 1993. Fallen Fontanelle: Culture Bound or Cross-Cultural? *Medical Anthropology* 15 (2): 137–156.

Khan, K.S., D. Wojdyla, L. Say, A.M, Gülmezoglu, and P.F.A. van Look. 2006. WHO Analysis of Causes of Maternal Death: A Systematic Review. *Lancet* 367 (9516): 1066–1074.

Kiesler, J. and R. Ricer. 2003. The Abnormal Fontanel. American Family Physician 67 (12): 2547–2452.

Kinney, M.V., K.J. Kerber, R.E. Black, B. Cohen, F. Nkrumah, H. Coovadia, P.M. Nampala, J.E. Lawn. 2010. Sub-Saharan Africa's Mothers, Newborns, and Children: Where and Why Do They Die? *PLoS Medicine* 7 (6).

Lahm, S.A. 2001. Hunting and Wildlife in Northeastern Gabon: Why Conservation Should Extend beyond Protected Areas. In African Rain Forest Ecology and Conservation: An Interdisciplinary Perspective, edited by W. Weber. New Haven, CT: Yale University Press, 344–354.

Langwick, S.A. 2011. Bodies, Politics, and African Healing: The Matter of Maladies in Tanzania. Bloomington: Indiana University Press.

Langwick, S.A. 2008. Articulate(d) Bodies: Traditional Medicine in a Tanzanian Hospital. *American Ethnologist* 35 (3): 428–439.

Larsen, U. 2000. Primary and Secondary Infertility in Sub-Saharan Africa. *International Journal of Epidemiology* 29 (2): 285–291.

Lawrence, A., O.L. Phillips, and A.R. Ismodes. 2005. Local Values for Harvested Forest Plants in Madre de Dios, Peru: Towards a More Contextualised Interpretation of Quantitative Ethnobotanical Data. *Biodiversity & Conservation* 14: 45–79.

Lekana-Douki, J.B., J.B. Bongui, S.L.O. Liabagui, S.E.Z. Edou, R. Zatra, U. Bisvigou, P. Druilhe, J. Lebibi, F.S.T. Ndouo, and M. Kombila. 2011. In Vitro Antiplasmodial Activity and Cytotoxicity of Nine Plants Traditionally Used in Gabon. *Journal of Ethnopharmacology* 133 (3): 1103–1108.

Levin, E. 2001. The Meaning of Menstrual Management in a High-Fertility Society: Guinea, West Africa. Regulating Menstruation: Beliefs, Practices, Interpretations. In Regulating Menstruation: Beliefs, Practices, Interpretations, edited by Etienne Van de Walle and Elisha P. Renne. London: The University of Chicago Press, 157–171.

Low, N., M.F. Chersich, K. Schmidlin, M.E. Egger, S.C. Francis, J.H.H.M. van de Wijgert, R.J. Hayes, J.M. Baeten, J. Brown, S. Delany-Moretlwe, R. Kaul, N. McGrath, C. Morrison, L. Myer, M. Temmerman, A. van der Straten, D. Watson-Jones, M. Zwahlen, and A. Martin Hilber. 2011. Intravaginal Practices, Bacterial Vaginosis, and HIV Infection in Women: Individual Participant Data Meta-Analysis. *PLoS Medicine* 8 (2).

Lyon, L.M. and L.H. Hardesty. 2012. Quantifying Medicinal Plant Knowledge among Non–Specialist Antanosy Villagers in Southern Madagascar. *Economic Botany* 66 (1): 1–11.

Makani, J., T.N. Williams, and K. Marsh. 2007. Sickle Cell Disease in Africa: Burden and Research Priorities. A*nnals of Tropical Medicine and Parasitology* 101 (1): 3–14.

Malan, D.F. and D.F.R. Neuba. 2011. Traditional Practices and Medicinal Plants Use during Pregnancy by Anyi-Ndenye Women (Eastern Côte d'Ivoire). A*frican Journal of Reproductive Health* 15: 85–94.

Martin, G.J. 2004. Ethnobotany: A Methods Manual. 1st ed. London: Earthscan.

Martin Hilber, A., E. Kenter, S. Redmond, S. Merten, B. Bagnol, N. Low, and R. Garside. 2012. Vaginal Practices as Women's Agency in Sub-Saharan Africa: A Synthesis of Meaning and Motivation through Meta-Ethnography. *Social Science & Medicine* 74 (9): 1311–1323.

Mathez-Stiefel, S., I. Vandebroek, and S. Rist. 2012. Can Andean Medicine Coexist with Biomedical Healthcare? A Comparison of Two Rural Communities in Peru and Bolivia. *Journal of Ethnobiology and Ethnomedicine* 8 (1): 26.

Mati, E. and H. de Boer. 2011. Ethnobotany and Trade of Medicinal Plants in the Qaysari Market, Kurdish Autonomous Region, Iraq. *Journal of Ethnopharmacology* 133 (2): 490–510.

McClain, C.S. 1989. Women as healers: Cross-cultural perspectives. New Brunswick: Rutgers University Press.

McCune, B. and M.J. Mefford. 2006. PC-ORD v5. Multivariate Analysis of Ecological Data. Glaneden Beach: MjM Software Design.

McDade, T.W., V. Reyes-García, P. Blackinton, S. Tanner, T. Huanca, and W.R. Leonard. 2007. Ethnobotanical Knowledge Is Associated with Indices of Child Health in the Bolivian Amazon. *Proceedings of the National Academy of Sciences of the United States of America* 104 (15): 6134–6139.

McGeoch, L., I. Gordon, and J. Schmitt. 2008. Impacts of Land Use, Anthropogenic Disturbance, and Harvesting on an African Medicinal Liana. *Biological Conservation* 141 (9): 2218–2229.

McMillen, H.L. 2008. Conserving the Roots of Trade: Local Ecological Knowledge of Ethnomedicines from Tanga, Tanzania Markets. PhD Thesis, University of Hawaii at Manoa, Honolulu.

Meier, E.R. and J.L. Miller. 2012. Sickle Cell Disease in Children. *Drugs* 72 (7): 895–906.

Miller, E.M. 2011. Maternal Health and Knowledge and Infant Health Outcomes in the Ariaal People of Northern Kenya. *Social Science & Medicine* 73 (8): 1266–1274.

Milliken, W. 1997. Traditional Anti-Malarial Medicine in Roraima, Brazil. *Economic Botany* 51 (3): 212–237.

Milliken, W. and B. Albert. 1997. The Use of Medicinal Plants by the Yanomami Indians of Brazil, Part II. *Economic Botany* 51 (3): 264–278.

Missouri Botanical Garden. 2013. Tropicos.org. Available at http://www.tropicos.org. Accessed 14 August 2013.

Mogensen, H.O. 2000. False Teeth and Real Suffering: The Social Course of 'Germectomy' in Eastern Uganda. *Culture, Medicine and Psychiatry* 24 (3): 331–351.

Montgomery, C.M., W. Mwengee, M. Kong'ong'o, and R. Pool. 2006. 'To Help Them Is to Educate Them': Power and Pedagogy in the Prevention and Treatment of Malaria in Tanzania. *Tropical Medicine & International Health* 11 (11): 1661–1669.

Myer, L., L. Kuhn, and Z.A. Stein. 2005. Intravaginal Practices, Bacterial Vaginosis, and Women's Susceptibility to HIV Infection: Epidemiological Evidence and Biological Mechanisms. *Lancet Infectious Diseases* 5: 786–794.

Naab, F., R. Brown, and S. Heidrich. 2013. Psychosocial Health of Infertile Ghanaian Women and Their Infertility Beliefs. *Journal of Nursing Scholarship* 45 (2): 1–9.

Neuenschwander, P., B. Sinsin, and G. Goergen. 2011. Protection de La Nature En Afrique de l'Ouest: Une Liste Rouge Pour Le Bénin Nature Conservation in West Africa: Red List for Benin. Ibadan: IITA, 21-46.

Neuwinger, H.D. 1996. African Ethnobotany: Poisons and Drugs: Chemistry, Pharmacology, Toxicology. Chapman and Hall, London, 207-212.

Newing, H. 2011. Conducting Research in Conservation: A Social Science Perspective. London: Routledge.

Newman, L. F. 1985. An introduction to population anthropology. In: Women's medicine: a cross cultural study of indigenous fertility regulation, edited by L.F. Newman and J.M. Nyce. New Brunswick, New Jersey: Rutgers University Press, 1-23.

Ngom, P. 2000. Stomach Washing: Menstrual Inducement among the Kassena-Nankana of Northern Ghana. *African Population Studies* 15: 109–116.

Nissani, M. (1997). Ten cheers for interdisciplinarity: The case for interdisciplinary knowledge and research. *The Social Science Journal* 34(2), 201-216.

Njamen, D. and M.A. Mvondo. 2013. Phytotherapy and Women's Reproductive Health: The Cameroonian Perspective. *Planta Medica* 79: 600–611.

Nsungwa-Sabiiti, J., K. Källander, X. Nsabagasani, K. Namusisi, G. Pariyo, A. Johansson, G. Tomson, and S. Peterson. 2004. Local Fever Illness Classifications: Implications for Home Management of Malaria Strategies. *Tropical Medicine & International Health* 9 (11): 1191–1199.

Nyamongo, I.K. 2002. Health Care Switching Behaviour of Malaria Patients in a Kenyan Rural Community. *Social Science & Medicine* 54 (3): 377–386.

O'Connell, J.F., K. Hawkes, and N.G. Blurton Jones. 1999. Grandmothering and the Evolution of Homo Erectus. J*ournal of Human Evolution* 36(5), 461-485.

Olson, D.M. and E. Dinerstein. 1998. The Global 200: A Representation Approach to Conserving the Earth's Most Biologically Valuable Ecoregions. *Conservation Biology* (12): 502–515.

Ondo, C.O. 2001. Estudio de Productos Forestables No Maderables En Tres Mercados de Guinea Ecuatorial. *Anales del Jardín Botánico de Madrid* 59 (2): 275–286.

Osamor, P.E. and B.E. Owumi. 2010. Complementary and Alternative Medicine in the Management of Hypertension in an Urban Nigerian Community. *BMC Complementary and Alternative Medicine* 10 (1): 36.

Pearce, T.O. 1993. Lay Medical Knowledge in an African Context. In Knowledge, Power and Practice: The Anthropology of Medicine and Everyday Life, edited by S. Lindenbaum and M. Lock. Berkeley: University of California Press, 150–165.

Pfeiffer, J.M. and R.J. Butz. 2005. Assessing Cultural and Ecological Variation in Ethnobiological Research: The Importance of Gender. *Journal of Ethnobiology* 25 (2): 240–278.

Phillips, O. and A.H. Gentry. 1993. The Useful Plants of Tambopata, Peru: I. Statistical Hypotheses Tests with a New Quantitative Technique. *Economic Botany* 47 (1): 15–32.

Phillips, O., Gentry, A.H., Reynel, C., Wilkin, P., and Galvez-Durand, B. 1994. Quantitative ethnobotany and Amazonian conservation. *Conservation biology* 8(1): 225-248.

Plant Resources of Tropical Africa. 2013. Plant Resources of Tropical Africa. Available at http://www.prota4u.org/. Accecssed 15 April 2013.

Pope, H.G. 1969. Tabernanthe Iboga: An African Narcotic Plant of Social Importance. *Economic Botany* 23 (2): 174–184.

Pouliot, M. 2011. Relying on Nature's Pharmacy in Rural Burkina Faso: Empirical Evidence of the Determinants of Traditional Medicine Consumption. *Social Science & Medicine* 73 (10): 1498–507.

Prata, N., G. Mbaruku, M. Campbell, M. Potts, and F. Vahidnia. 2005. Controlling Postpartum Hemorrhage after Home Births in Tanzania. *International Journal of Gynaecology and Obstetrics* 90 (1): 51–55.

Quinlan, M.B. 2010. Ethnomedicine and Ethnobotany of Fright, a Caribbean Culture-Bound Psychiatric Syndrome. *Journal of Ethnobiology and Ethnomedicine* 6: 9.

Quiroz, D., A.M. Towns, I.L. Sènan, J. Swier, S. Brière, M.D. Sosef, and T. van Andel. 2014. Quantifying the Domestic Market in Herbal Medicine in Benin, West Africa. *Journal of Ethnopharmacology* 151 (3): 1100–1108.

Ramharter, M., S.K. Chai, and A.A. Adegnika. 2004. Shared Breastfeeding in Central Africa. *AIDS* 18(13): 1845–1856.

Raponda-Walker, A. and R. Sillans. 1961. Les Plantes Utiles Du Gabon. Sepia. Paris: Fondation Raponda-Walker.

Reyes-García, V. 2010. The Relevance of Traditional Knowledge Systems for Ethnopharmacological Research: Theoretical and Methodological Contributions. *Journal of Ethnobiology and Ethnomedicine* 6 (1): 32.

Rocheleau, D. and D. Edmunds. 1997. Women, Men and Trees: Gender, Power and Property in Forest and Agrarian Landscapes. *World Development* 25 (8): 1351–1371.

Runganga, A.O. and J. Kasule. 1995. The Vaginal Use of Herbs/substances: An HIV Transmission Facilitatory Factor? *AIDS Care* 7 (5): 639–45.

Rutherford, M.E. 2010. How Access to Health Care Relates to under-Five Mortality in Sub-Saharan Africa: Systematic Review. *Tropical Medicine & International Health* 15 (5): 508–519.

Rutstein, S.O. and I.H. Shah. 2004. Infecundity Infertility and Childlessness in Developing Countries. DHS Comparative Reports 9.

Ruysschaert, S., T. van Andel, K. van de Putte, and P. van Damme. 2009. Bathe the Baby to Make It Strong and Healthy: Plant Use and Child Care among Saramaccan Maroons in Suriname. *Journal of Ethnopharmacology* 121 (1): 148–170.

Ryan, G.W. 1998. What Do Sequential Behavioral Patterns Suggest about the Medical Decision-Making Process?: Modeling Home Case Management of Acute Illnesses in a Rural Cameroonian Village. *Social Science & Medicine* 46 (2): 209–225.

Sabuni, L.P. 2007. Dilemma with the Local Perception of Causes of Illnesses in Central Africa: Muted Concept but Prevalent in Everyday Life. *Qualitative Health Research* 17 (9): 1280–1291.

Schiebinger, L.L. 2009. Plants and empire: Colonial Bioprospecting in the Atlantic World. Cambridge: Harvard University Press.

Schippmann, U., D.J. Leaman, and A.B. Cunningham. 2002. Impact of Cultivation and Gathering of Medicinal Plants on Biodiversity: Global Trends and Issues. Biodiversity and the Ecosystem Approach in Agriculture, Forestry and Fisheries. Food and Agriculture Organization of the United Nations (FAO) Proceedings, Rome, Italy: 12-13 October 2002, 140-167.

Seale, A.C., M. Mwaniki, C.R.J.C. Newton, and J.A. Berkley. 2009. Maternal and Early Onset Neonatal Bacterial Sepsis: Burden and Strategies for Prevention in Sub-Saharan Africa. *The Lancet Infectious Diseases* 9 (7): 428–438.

Shackleton, C. and S. Shackleton. 2004. The Importance of Non-Timber Forest Products in Rural Livelihood Security and as Safety Nets: A Review of Evidence from South Africa. *South African Journal of Science* 100(11 & 12): 658–664.

Shackleton, S. and F. Paumgarten. 2011. Opportunities for Enhancing Poor Women's Socioeconomic Empowerment in the Value Chains of Three African Non-Timber Forest Products (NTFPs). *International Forestry Review* 13 (2): 136–151.

Sommer, M. 2010. Where the Education System and Women's Bodies Collide: The Social and Health Impact of Girls' Experiences of Menstruation and Schooling in Tanzania. *Journal of Adolescence* 33 (4): 521–529.

Sosef, M.S.M., J.J. Wieringa, C.C.H. Jongkind, G. Achoundong, Y. Azizet Issembé, D. Bedigian, R.G. van den Berg, F.J. Breteler, M. Cheek, J. Degreef, R.B. Faden, P. Goldblatt, L.J.G. van der Maesen, L. Ngok Banak, R. Niangadouma, T. Nzabi, B. Nziengui, Z.S. Rogers, T. Stévart, J.L.C.H. van Valkenburg, G. Walters, and J.J.F.E. de Wilde. 2006. Check-list des plantes vasculaires du Gabon – Checklist of Gabonese vascular plants. Scripta Botanica Belgica 35: 1–438.

Stepp, J.R. and D.E. Moerman. 2001. The Importance of Weeds in Ethnopharmacology. *Journal of Ethnopharmacology* 75 (1): 19–23.

Stewart, K.M. 2003. The African Cherry (Prunus Africana): Can Lessons Be Learned from an over-Exploited Medicinal Tree? *Journal of Ethnopharmacology* 89 (1): 3–13.

Stewart, K. 2009. Effects of Bark Harvest and Other Human Activity on Populations of the African Cherry (Prunus Africana) on Mount Oku, Cameroon. *Forest Ecology and Management* 258 (7): 1121–1128.

Straus, L., K. Munguambe, Q. Bassat, S. Machevo, C. Pell, A. Roca, and R. Pool. 2011. Inherent Illnesses and Attacks: An Ethnographic Study of Interpretations of Childhood Acute Respiratory Infections (ARIs) in Manhiça, Southern Mozambique. *BMC Public Health* 11 (1): 556.

Tanner, S., M.E. Chuquimia-Choque, T. Huanca, T.W. McDade, W.R. Leonard, and V. Reyes-García. 2011. The Effects of Local Medicinal Knowledge and Hygiene on Helminth Infections in an Amazonian Society. *Social Science & Medicine* 72 (5): 701–709.

Telefo, P.B., L.L. Lienou, M.D. Yemele, M.C. Lemfack, C. Mouokeu, C.S. Goka, S.R. Tagne, and F.P. Moundipa. 2011. Ethnopharmacological Survey of Plants Used for the Treatment of Female Infertility in Baham, Cameroon. *Journal of Ethnopharmacology* 136 (1): 178–187.

Ten, V.T.A. 2007. Menstrual Hygiene: A Neglected Condition for the Achievement of Several Millennium Development Goals. Zoetermeer, The Netherlands: Europe External Policy.

Terashima, H. and M. Ichikawa. 2003. A Comparative Ethnobotany of the Mbuti and Efe Hunter-Gatherers in the Ituri Forest, Democratic Republic of Congo. *African Study Monographs* 24 (1-2): 1–128.

The World Bank. 2011. Migration and Remittances Factbook 2011. Available from http://data.worldbank.org/data-catalog/migration-and-remittances. Accessed 14 April 2014.

Thomas, E., I. Vandebroek, P. Van Damme, P. Goetghebeur, D. Douterlungne, S. Sanca, and S. Arrazola. 2009. The Relation between Accessibility, Diversity and Indigenous Valuation of Vegetation in the Bolivian Andes. *Journal of Arid Environments* 73 (9): 854–861.

Thomas, E., I. Vandebroek, S. Sanca, and P. van Damme. 2009. Cultural Significance of Medicinal Plant Families and Species among Quechua Farmers in Apillapampa, Bolivia. *Journal of Ethnopharmacology* 122 (1): 60–67.

Ticktin, T. 2004. The Ecological Implications of Harvesting Non-Timber Forest Products. *Journal of Applied Ecology* 41 (1): 11–21.

Ticktin, T. and S.P. Dalle. 2005. Medicinal Plant Use in the Practice of Midwifery in Rural Honduras. *Journal of Ethnopharmacology* 96 (1-2): 233–248.

Towns, A.M., S. Ruysschaert, E. van Vliet, and T.R. van Andel. 2014. Evidence in Support of the Role of Disturbance Vegetation for Women's Health and Childcare in Western Africa. *Journal of Ethnobiology and Ethnomedicine* 10 (1), 42.

Towns, A.M., and T.R. van Andel. 2014. Comparing Local Perspectives on Women's Health with Statistics on Maternal Mortality: An Ethnobotanical Study in Bénin and Gabon. *BMC Complementary and Alternative Medicine* 14 (113).

UNDP. 2012. MDG Report 2012: Assessing Progress in Africa toward the Millennium Development Goals. Available from http://www.uneca.org/sites/default/files/publications/mdgreport2012_eng.pdf . Accessed 29 April 2013.

UNDP 2013a. International Human Development Indicators - UNDP: Benin. Available from http://hdrstats.undp.org/en/countries/profiles/BEN.html. Accessed 29 April 2013.

UNDP. 2013b. International Human Development Indicators - UNDP: Gabon. Available from http://hdrstats.undp.org/en/countries/profiles/GAB.html. Accessed 29 April 2013.

UNFPA. 2013. Improving Reproductive Health. Available from http://www.unfpa.org/rh/index.htm. Accessed 26 April 2014.

United Nations. 2013. United Nations Millennium Development Goals. United Nations. Available from http://www.un.org/millenniumgoals/. Accessed 29 April 2013.

van Andel, T., B. Myren, and S. van Onselen. 2012. Ghana's Herbal Market. *Journal of Ethnopharmacology* 140 (2): 368–378.

van Andel, T., S. de Korte, D. Koopmans, J. Behari-Ramdas, and S. Ruysschaert. 2008. Dry Sex in Suriname. *Journal of Ethnopharmacology* 116 (1): 84–88.

van Andel, T. and R. Havinga. 2008. Sustainability Aspects of Commercial Medicinal Plant Harvesting in Suriname. *Forest Ecology and Management* 256 (8): 1540–1545.

van Andel, T., S. Mitchell, G. Volpato, I. Vandebroek, J. Swier, S. Ruysschaert, C.A.R. Jiménez, and N. Raes. 2012. In Search of the Perfect Aphrodisiac: Parallel Use of Bitter Tonics in West Africa and the Caribbean. *Journal of Ethnopharmacology* 143 (3): 840–850.

van Andel, TR. 2009. Plant Use from the Motherland: Linking Afro-Caribbean and West-African Ethnobotany. NWO ALW-Vidi. Leiden: Leiden University.

van Balen, F. and T. Gerrits. 2001. Quality of Infertility Care in Poor-Resource Areas and the Introduction of New Reproductive Technologies. *Human Reproduction* 16 (2): 215–219.

van der Geest, S. 1997. Is There a Role for Traditional Medicine in Basic Health Services in Africa? A Plea for a Community Perspective. *Tropical Medicine & International Health* 2 (9): 903–911.

van Dijk, J.F.W. and K.F. Wiersum. 1999. Non-Timber Forest Product Resources: Abundance, Distribution, and the Impact of Timber Exploitation. In Sustainable Management of African Rainforest, Part I: Workshops, 210-220.

Vandebroek, I. 2013. Intercultural Health and Ethnobotany: How to Improve Healthcare for Underserved and Minority Communities? *Journal of Ethnopharmacology* 148 (3): 746–754.

Veale, D.J, K.I. Furman, and D.W. Oliver. 1992. South African Traditional Herbal Medicines Used during Pregnancy and Childbirth. *Journal of Ethnopharmacology* 36 (3): 185–91.

Voeks, R.A. 1996. Tropical Forest Healers and Habitat Preference. *Economic Botany* 50 (4): 381–400.

Voeks, R.A. 2004. Disturbance Pharmacopoeias: Medicine and Myth from the Humid Tropics. *Annals of the Association of American Geographers* 94 (4): 868–888.

Voeks, R.A. 2007. Are Women Reservoirs of Traditional Plant Knowledge? Gender, Ethnobotany and Globalization in Northeast Brazil. *Singapore Journal of Tropical Geography* 28 (1): 7–20.

Wagtail UK. 2013. Gabon's Sniffing Detectives. Available from http://www.wagtailuk.com/gabons-sniffing-detectives/. Accessed 23 April 2014.

Water Supply and Sanitation Collaborative Council. 2013. Celebrating Womanhood: Menstruation Hygiene Management,. Available from http://www.wsscc.org/sites/default/files/wsscc_mhm_handout_4pp_2.pdf_final_23082013.pdf. Accessed 5 June 2013.

WHO. 2008. WHO Traditional Medicine. World Health Organization. Available from http://www.who.int/mediacentre/factsheets/fs134/en/. Accessed 29 April 2013.

WHO. 2012. WHO Maternal Mortality Country Profiles. World Health Organization. Available from http://www.who.int/gho/maternal_health/countries/en/. Accessed 13 June 2013.

WHO. 2013a. WHO Intermittent Preventive Treatment in Pregnancy (IPTp). World Health Organization. Available from http://www.who.int/malaria/areas/preventive_therapies/pregnancy/en/index.html. Accessed 18 June 2013.

WHO. 2013b. WHO MDG 6: Combat HIV/AIDS, Malaria and Other Diseases. World Health Organization. Available from http://www.who.int/topics/millennium_development_goals/diseases/en/. Accesed18 June 2013.

WHO. 2013c. WHO Breastfeeding. World Health Organization. Available from http://www.who.int/topics/breastfeeding/en/. Accessed 18 June 2013.

Williams, V.L., E.T.F. Witkowski, and K. Balkwill. 2005. Application of Diversity Indices to Appraise Plant Availability in the Traditional Medicinal Markets of Johannesburg, South Africa. *Biodiversity and Conservation* 14 (12): 2971–3001.

Williams, V.L., K. Balkwill, and E.T.F. Witkowski. 2000. Unraveling the Commercial Market for Medicinal Plants and Plant Parts on the Witwatersrand, South Africa. *Economic Botany* 43 (3): 310-327.

Williams, V.L., E.T.F. Witkowski, and K. Balkwill. 2009. Volume and Financial Value of Species Traded in the Medicinal Plant Markets of Gauteng, South Africa. *International Journal of Sustainable Development & World Ecology* 14 (6): 584–603.

Wojtasik, E.M. 2013. Richness and Diversity of Alien Ethnomedicinal Plant Taxa Used and Sold for Traditional Medicine in South Africa. PhD Thesis. University of the Witwatersrand, Johannesburg.

Yeo, E.A., L. Béquet, D.K. Ekouévi, and M. Krawinkel. 2005. Attitudes towards Exclusive Breastfeeding and Other Infant Feeding Options--a Study from Abidjan, Cote d'Ivoire. *Journal of Tropical Pediatrics* 51 (4): 223–226.

Yetein, M.H., L.G. Houessou, T.O. Lougbégnon, O. Teka, and B. Tente. 2013. Ethnobotanical Study of Medicinal Plants Used for the Treatment of Malaria in Plateau of Allada, Benin (West Africa). *Journal of Ethnopharmacology* 146 (1): 154–163.

Curriculum Vitae

Alexandra Maria Towns was born on the 23 of May 1983 in Watertown, New York, USA. She graduated from Francis Scott Key High School in Union Bridge, Maryland in 2001. Selecting a university program of study was particularly hard for her, as Alexandra was equally drawn to the natural and social sciences. She started her undergraduate degree in Education in August 2001 at La Salle University in Philadelphia, Pennsylvania. In 2002, realizing that she needed to learn much more about the world before she could teach about it, Ms. Towns transferred to Towson University in Baltimore, Maryland to begin a B.A. program in International Studies. She wrote an honors thesis entitled *The Continued Presence of NGOs in the International System* and studied abroad in Germany (2002), Mexico (2003), and Chile (2004).

Graduating *magna cum laude* from Towson University in May 2005, Alexandra joined the United States Peace Corps as an agricultural volunteer. She spent two and a half years living in a rural village in Niger, West Africa, supporting a women's sesame seed cooperative and working on multiple small farming and gardening projects. It was also at this time that Alexandra became fascinated with local knowledge systems. She spent many mornings collecting wild plants with village youth and afternoons preparing traditional dishes with female elders.

In September 2008, Alexandra started a M.Sc. degree in International Agricultural Development at the University of California, Davis. She acquired funding to return to Niger in 2009 to identify wild plants and fish and investigate their role in the local Nigerien food system. She presented the results at the Society for Economic Botany Conference in Xalapa, Mexico in May 2010, compiled them into the MSc thesis entitled *Ethnoecology and food sovereignty among the Songhai people of Niger: species, knowledge, and implications for rural development*, and graduated in September 2010.

In December 2010, Alexandra joined Naturalis Biodiversity Center, Leiden University as a PhD researcher. In addition to fieldwork, she also co-organized the *Tropical Plant Families* course at Naturalis in 2012, and gave lectures on plant families Lamiaceae and Melastomataceae in both 2013 and 2014. Ms. Towns supervised five students during her time at Naturalis. She also served on the board of the Society for Economic Botany as a student representative (2013-2014) and presented her research findings at international conferences in Bénin (2011), England (2013), Maryland (2013), Macau (2014), and North Carolina (2014). In the Netherlands, she presented at the Institute for Biodiversity and Ecosystem Dynamics (2011), the Catharina Schrader Foundation (2012), and NWO Bessensap (2013). Alexandra received the Fulling Award for *Best Contributed Oral Paper* at the Society for Economic Botany conference in 2013. Ms. Towns plans to apply for post-doctoral funding to continue conducting ethnobotanical research in the USA. One day she still intends to teach.

List of Publications

van Andel, T.R., Croft, S., van Loon, E., Quiroz, D., **Towns, A.M.**, and Raes, N. Prioritizing West African medicinal plants for conservation and sustainable extraction based on species distribution models and market surveys (submitted).

Andel, T.R. van, van 't Klooster, C.I.E.A., Quiroz, D., **Towns, A.M**., Ruysschaert, S. and M. van den Berg. Local plant names reveal that enslaved Africans recognized substantial parts of the New World flora (submitted).

Vossen, T.E., **Towns, A.M**., Ruysschaert, S., Quiroz, D. and T.R. van Andel. Consequences of the trans-Atlantic slave trade on medicinal plant selection: Plant use for cultural bound syndromes affecting children in Suriname and Western Africa. *PLOS One* (in review).

Andel, T.R. van, de Boer, H., **Towns, A.M.** Gynecological, andrological and urological problems: an ethnopharmacological perspective. In: Heinrich, M. and Jaeger, A. (eds.), Ethnopharmacaology - a reader. Wiley & Sons, Chichester. (accepted).

Towns, A.M., S.M. Eyi and T.R. van Andel. Traditional medicine and child care in Western Africa: mothers' knowledge, folk illnesses, and patterns of healthcare-seeking behavior. *PLoS ONE* 2014, 9(8): e105972.

Towns, A.M., Quiroz, D.K., Guinee, L., de Boer, H.J., and T.R. van Andel. Volume, value and floristic diversity of Gabon's medicinal plant markets. *Journal of Ethnopharmacology* 2014, 155: 1184-1193.

Towns, A.M., S. Ruysschaert, E. van Vliet and T. van Andel. Evidence in support of the role of disturbance vegetation for women's health and childcare in Western Africa. *Journal of Ethnobiology and Ethnomedicine* 2014, 10:42.

Towns, A.M. and T. van Andel. Comparing local perspectives on women's health with statistics on maternal mortality: an ethnobotanical study in Benin and Gabon. *BMC Complementary and Alternative Medicine* 2014, 14:113.

Quiroz, D., **Towns, A.M**., Legba, S.I., Swier, J., Briere, S., Sosef, M.S.M. and T.R. van Andel. Quantifying the domestic market in herbal medicine in Benin, West Africa. *Journal of Ethnopharmacology* 2014, 151: 1100-1108.

Towns, A.M., D. Potter, and S. Idrissa. Cultivated, Caught, and Collected: Defining Culturally-Appropriate Foods in Tallé, Niger. *Development in Practice* 2013, 23:2.

Towns, A.M. Ethnobotany and Food Sovereignty among the Songhai People of Niger: Species, Local Knowledge, and Implications for Sustainable Rural Development. Diss. University of California, Davis, 2010. Dissertations & Theses: A&I, ProQuest.

Acknowledgements

First and foremost, I would like to thank Tinde van Andel for the opportunity to work on the *Plant Use of the Motherland* project. From sharing an office for four years, encouraging me in the field, challenging me to become a better scientist, and being a role model of work–life balance, I am deeply thankful to have had the chance to work under her supervision.

I am especially grateful for my colleagues at Naturalis Biodiversity Center and Leiden and Wageningen Universities, including (but not limited to) Hugo de Boer, Mark Sosef, Johan Mols, Sofie Ruysschaert, Diana Quiroz, Paul and Hiltje Maas, Jos van der Maesen, Frans Breteler, Lieke Guinee, Esther van Vliet, Ivo Abraão, Marco Roos, Theo Damen, Sarina Veldman, József Geml, and Connie Baak. My gratitude goes to the botanists at the former Wageningen branch of Naturalis for their assistance with plant identification and to the collection staff at Naturalis.

Collaboration with research partners in Bénin and Gabon has been critical in the success of this dissertation. Foremost, I am deeply appreciative to the urban, rural, and market women who shared their time, knowledge, and patience with me during the questionnaires. I thank the professors at the University of Abomey-Calavi in Bénin, especially Akpovi Akoegninou and Brice Sinsin, along with the staff of the National Herbarium of Bénin (BEN) for their logistical support. I also thank Honorat Aguessy and l'Institut de Développement et d'Echanges Endogènes (IDEE), Association des Sages-Femmes du Bénin, Karin Ostertag, Lucrece Atindehou, and Raoudath Bouraima for their assistance in the Bénin fieldwork. The Gabon fieldwork was supported by the research staff at L'Institut de Pharmacopée et de Médecine Traditionnelles (IPHAMETRA), the National Herbarium of Gabon (LBV), Henri Bourobou, le Centre National de la Recherche Scientifique et Technologique (CENAREST), and the Agence Nationale des Parcs Nationaux (ANPN). A special thanks is extended to Hugues Eyi Ndong, Sandra Eyi, Jean Pierre Ongoda, the midwives, pediatricians, and gynecologists at the Centre Hôpital Universitaire de Libreville (CHUL), and the Grand Kami of Assiami for their assistance in the Gabonese fieldwork.

I would also like to acknowledge my friends at Naturalis, Leiden University, and within the Leiden community, who made the life of a PhD student a fun one. Many thanks to Annick Lang, Judith Aiglsperger, Luis Morgado, Nicolas Davin, Chiara Marchetti and Paolo Concari, Patrik Henriksson, Luisa Carvalheiro, Sylvia Mota de Oliveira, Rachel Schwallier, Coen van der Giesen, Stefano Cucurachi, Tatiana Semenova, Rob Hattinga, Camila Caram Deelder, Sheila Owen, Celeste Beran Bennekers, and Janelle Ward.

Completing this PhD would not have been possible without my family. To my husband Ibrahim, thank you for your infinite patience, encouragement, and support throughout this Dutch-Beninese-Gabonese adventure. To my parents Kenneth and Krista, brother Bryan, and extended family, I am grateful for your understanding for yet another four years away. I dedicate this dissertation to all of you.