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Trade of wild-harvested medicinal plant species in local markets of Tanzania and its implications for conservation

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ABSTRACT

In Tanzania, about 10% of the reported 12,000 species of higher plants are estimated to be used as medicine for treating different human health problems. Most of the medicinal plants are collected from wild populations, but their trade and quantities are not properly recorded. Monitoring of trade in wild-harvested medicinal plants is challenging as most materials are traded in various processed forms and most vendors practice informal trade. Yet, monitoring is important for conservation and sustainability. This study aims to assess the trade of wild-harvested medicinal plant species in local markets of Tanzania and its implications for conservation. Semi-structured interviews were used to record frequency, volume of trade and uses of wild-harvested medicinal plants in Arusha, Dodoma, Mbeya, Morogoro and Mwanza regions. Relative frequency of citation and informant consensus factor were calculated for each species and mentioned use category. Forty vendors were interviewed, and 400 out of 522 collected market samples were identified to 162 species from herbarium-deposited collections. Plant parts with the largest volume of trade were roots (3818 kg), bark (1163 kg) and leaves (492 kg). The most frequently traded species were *Zanthoxylum chalybaeum* Engl., *Albizia anthelmintica* Brongn., *Zanha africana* (Radlk.) Exell, *Warburgia stuhlmannii* and *Vachellia nilotica* (L.) P.J.H.Hurter & Mabb. The most popular medicinal plants in the markets are connected to local health problems including malaria, libido disorders or infertility. The high diversity of commercialized plants used for medicinal issues mainly relies on wild stock for local consumption and international trade, and this has significant implications for conservation concerns.

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1. Introduction

Medicinal plants have been used since ancient times to heal and cure diseases and to improve health and well-being of humans (Balick and Cox 1996). They form the basis of accessible and affordable health care and are an important source of livelihoods for indigenous and rural populations (Roberson, 2008). They are also the source of many active ingredients for modern pharmaceuticals (Ruffo et al., 2002). Between 50,000 and 80,000 flowering plants are used for medicine worldwide, many of them are collected from wild resources (Marinelli, 2005; Leamann, 2011). About 15,000 medicinal plant species are threatened with extinction worldwide because of overharvesting and habitat destruction (Chen et al. 2016). As the wild populations of medicinal plants remain the major sources of supply, concerns about sustainability of commercial harvests become more and more prominent (Schippmann

et al., 2006). It has been estimated that the earth is losing at least one potential major medicine every 2 years (Groombridge and Jenkins 2002).

In Tanzania, over 12,000 species of higher plants have been reported, and about 10% are estimated to be used as medicines to treat different human health conditions (Mahunnah et al., 2012). In Tanzania, most of the population depends on medicinal plants for their primary health care and there is a commercial trade of wild-harvested medicinal plants along with subsistence use. Wild-harvested medicinal plants play an important role in providing cures that are cheap, readily accessible and available to the vast rural population of Tanzania.

Globally, the bulk of medicinal plant materials traded are collected from the wild (Chen et al. 2016). Commercial trade of medicinal plants puts pressure on wild plant populations, and several medicinal plants species are at risk of extinction (Kuetze, 2013). Recent global data on the volume of wild-harvested medicinal plants are lacking (FAO, 2010). In Tanzania, commercial trade is the largest threat to medicinal plant populations (Ghimire et al., 2005). Monitoring of trade in wild-harvested medicinal plants is challenging, as most material is traded in various forms and the majority of vendors practice informal trade. Harvesting of medicinal plants is not monitored and collectors harvest

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plants non-sustainably imposing threats to natural populations and raising conservation issues regarding frequently collected medicinal plants (Augustino and Gillah 2005). Therefore, the first step in monitoring trade and addressing sustainability and conservation issues regarding medicinal plants is having comprehensive overview about the diversity of species in trade and their trade volumes. Trading of medicinal plants under vernacular names adds a challenge for proper monitoring of trade because sometimes the same vernacular name can be applied for different species vice versa the same species may be collected under different vernacular names. For example, the local name “*sokonoi*” is used for different species of *Warburgia* (Canellaceae), including *W. salutaris* (G.Bertol.) Chiov., *W. ugandensis* Sprague, and *W. stuhlmannii* Engl. (Otieno et al., 2015). Hence, proper identification of medicinal plants in the markets with the help of voucher specimens is important.

The objective of this study was to identify the diversity and origin of wild-harvested medicinal plant species in local markets of Tanzania and to assess the quantity of their trade. Furthermore, we aimed to address the following questions: (1) How many species are traded in the markets? (2) What is the origin of commercialized species? (3) What is the volume of traded plant species? and (4) What are the most frequent traded plant species? Based on the answers of these questions, we aimed to evaluate the potential ecological and sustainability impact of medicinal plant harvest and trade.

2. Materials and methods

2.1. Study sites

The study was conducted in Arusha, Morogoro, Mbeya, Mwanza and Dodoma districts (Fig. 1). These areas were selected according to their greatest market chain information and ecological diversity of medicinal plants. Mwanza is the largest population center and border city in the northwestern part of the country and is close to Lake Victoria where there is a wet and moist environment along the shore for wetland plants. Arusha represents the northeastern regions and export route to

Kenya, and is rich in protected areas (National Parks, wildlife corridors, wetlands, and includes the Rift valley). Mbeya represents the southern highland regions, and the exit route to Zambia and the southern African region. Mbeya region is close to Mount Rungwe catchment forest reserve, Kitulo National Park and extended Usungu plain. Dodoma and Morogoro are in the center of the country and they are close and accessible from other regions in which market information was assessed to cover the chain of medicinal plant trade between regions of Tanzania. Around Morogoro there are number of ecological hotspots for medicinal plants, game reserve (Selous), valleys (Kilombero and Rufiji), National Parks (Mikumi and Udzungwa) and Mountain ranges (Uluguru) (Myers, 1990).

2.2. Market surveys

Semi-structured interviews were conducted in the markets of Arusha, Morogoro, Mbeya, Mwanza, and Dodoma towns with medicinal plant vendors to document frequency, trade chain and quantity of wild-harvested medicinal plants. The research goals were explained before conducting interviews (Supplementary material S1) and free and prior informed consent was obtained from the participants. Information on marketed medicinal plants, their names and uses, their origin and harvest areas, trade amount per year, most popular medicinal plant species and their perceived availability by vendors were recorded (Supplementary material S2). The snowball method (Bernard 1995) was used among vendors to acquire further reliable vendors. The interviews were carried out from June to September 2016.

2.3. Field collection

The market survey was followed by field collections in which vendors were asked to join the research team in the field and assist in herbarium voucher specimen collection of traded medicinal plants. The collection of voucher specimens took place together with the participants in areas in which they collect medicinal plants for sale in the market. All plant materials were collected based on national legislation and

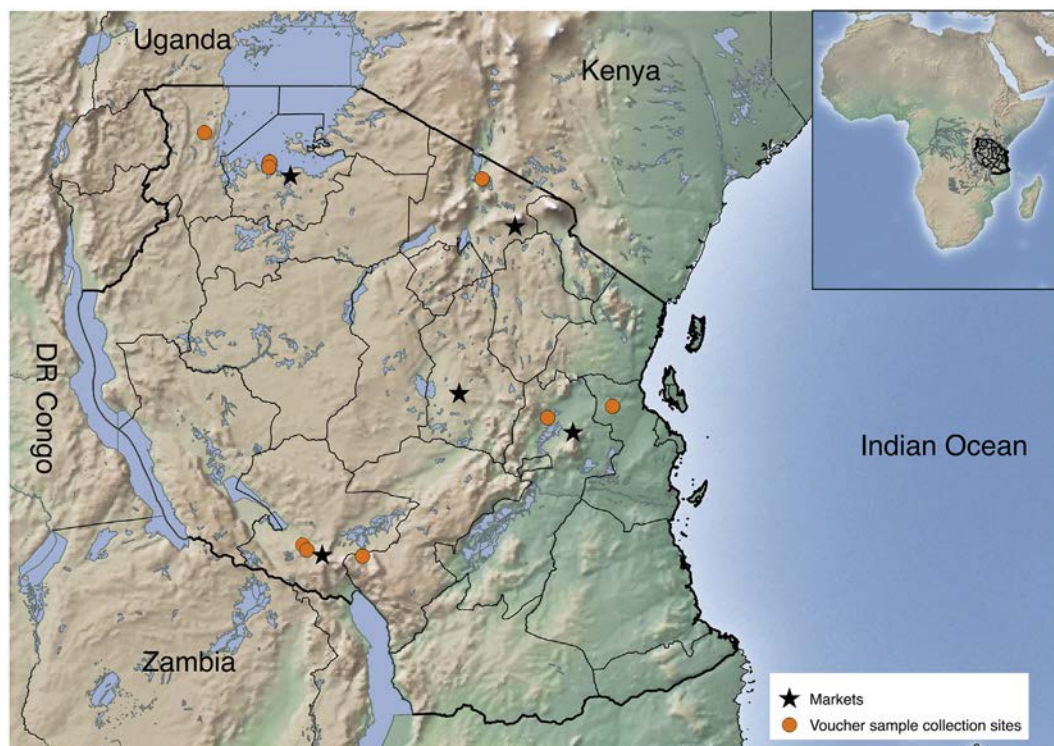


Fig. 1. Map of Tanzania showing the study sites where market samples and voucher specimens of traded medicinal plants were collected.

appropriate permits for collecting plant material were acquired from responsible organizations.

2.4. Identification of medicinal plants

Medicinal plants collected from the field were identified with the help of expert botanists and using the Flora of Tropical East Africa (FTEA, 1948–2012) as main reference and by comparing with herbarium specimens at the herbarium of the Institute of Traditional Medicine and the herbarium of the University of Dar es Salaam. Voucher specimens were deposited at the herbarium of the Institute of Traditional Medicine, Muhimbili University of Health and Allied Sciences (MUHAS).

2.5. Data analysis

To determine which plants are particularly frequent in local markets in Tanzania, the relative frequency of citation (RFC) was calculated for each species by dividing the number of vendors who sell species *i* (OS_i) by the total number of interviewed vendors (N) (Rossato et al., 1999; Tardío and Pardo-de Santayana, 2008; Ghorbani et al. 2011). In addition, the informant consensus factor ($ICF = n_{ur} - n_t / n_{ur} - 1$) (Trotter and Logan, 1986; Heinrich et al., 1998) was calculated to measure the consensus between informants concerning what plants are used for specific uses. The ICF product ranges from 0 to 1. A high value indicates that relatively few taxa are applied for that affliction, thus showing a high degree of agreement on the treatment of that affliction.

3. Results

3.1. Vendors demographics

From the 40 vendors interviewed in this study, 80% were men and 20% were women. Vendor age was distributed in six age categories as 21–30 (7.5%), 31–40 (15%), 41–50 (25%), 51–60 (27.5%), 61–70 (20%), 71–80 (5%). Among the interviewed vendors, 87.5% had no formal education, 10% had attended primary school only, and 2.5% had attended secondary school. A large proportion of vendors were of the Maasai

ethnic group (60%), followed by Sukuma (15%), Meru (10%), Kinga (7.5%), Haya (5%) and Gogo (2.5%) ethnic groups.

3.2. Diversity and frequency of traded plants and their uses

In total, 522 market samples were collected, of which 400 samples were successfully identified morphologically to 162 corresponding species, belonging to 135 genera and 52 families. Fabaceae was the dominant family with 38 (23.5%) species followed by Lamiaceae with 10 (6.2%), Asteraceae with 9 (5.5%) and Euphorbiaceae with 8 (4.9%) species. The most frequent species in the markets were *Zanthoxylum chalybaeum* Engl. (RFC = 0.6), *Albizia anthelmintica* Brongn. (RFC = 0.45), *Zanha africana* (Radlk.) Exell (RFC = 0.35), *Warburgia stuhlmannii* (RFC = 0.325) and *Vachellia nilotica* (L.) P.J.H.Hurter & Mabb (RFC = 0.3) (Fig. 2.)

According to vendors, most medicinal plants were used to treat malaria, libido disorders, infertility, dysmenorrhoea and for spiritual/psychosociological purposes. A total of 577 use reports were recorded, for 36 health conditions. The highest informant consensus for the use of medicinal species was for malaria (ICF = 0.53). The main species mentioned for malaria were *Zanthoxylum chalybaeum*, *Vachellia nilotica*, *Albizia anthelmintica*. The second highest consensus of informants (ICF = 0.50) was on the treatment of libido disorders, using species of *Mondia ecornuta* (N.E.Br.) Bullock and *Zanha africana*. Infertility health complaints showed third highest consensus (ICF = 0.41) with the most salient species being *Orthosiphon suffrutescens* (Schumach.) J.K.Morton. The fourth highest consensus was for psycho-sociological problems (ICF = 0.40), with the main species being *Cassia abbreviata* Oliv. and *Terminalia kaiseriana* F.Hoffm. Table 1 shows the details of health problems and informant consensus factor for each health problem.

Plant parts most commonly used for the treatment of human health problems included, roots (55.3%), bark (23.7%), leaves (15.8%), seeds (1.6%), fruits (2.0%), corms (1.0%) (Table 3). Occasionally whole plants were used (0.6%). Vendors harvest most of the medicinal plants (98%) from the wild and only 2%, which is equal to 10 out of 522 market samples, were from cultivated sources (Table 3). Of all of the reported medicinal plant species in the local markets, 49.0% were indicated by

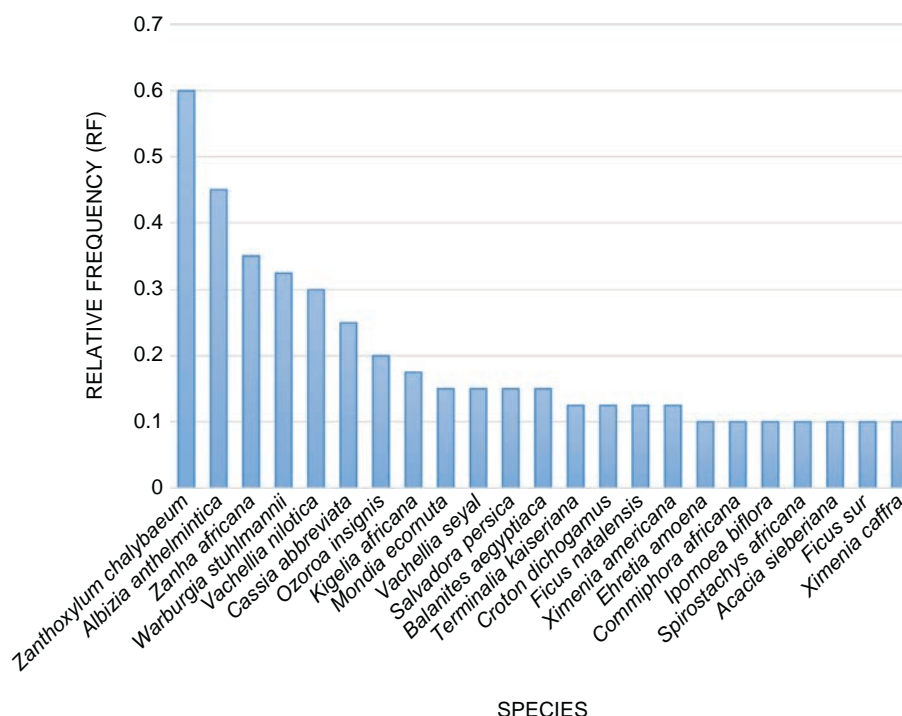


Fig. 2. The medicinal plants with highest frequency of citation (RFC) in local markets of Tanzania.

Table 1
Health problems recorded and informant consensus factor (ICF) for each category health problem.

Use categories	Number of taxa (N _t)	Number of use reports (N _{ur})	Consensus factor (ICF)
Malaria	47	98	0.53
Libido disorder/Aphrodisiac	30	59	0.50
Impotence/Infertility	11	18	0.41
Psychosociological problems	17	28	0.40
Dysmenorrhea	29	46	0.38
Headache and fever	18	28	0.37
Stomachache	35	55	0.37
Hernia	18	30	0.35
Eye problems	3	4	0.33
Cancer/tumour	5	7	0.33
Epilepsy	5	7	0.33
Urinary tract infection	5	7	0.33
Increase breast milk	3	4	0.33
Heartburn	2	3	0.33
Liver problems	3	4	0.33
Migraine	3	4	0.33
Sexually transmitted diseases	24	35	0.32
Typhoid	8	11	0.30
Skin rashes	11	15	0.29
Diabetes	6	8	0.28
Bile/jaundice	4	5	0.25
Bone weakness	4	5	0.25
Haemodialysis	4	5	0.25
Worms	4	5	0.25
Dental caries	9	11	0.20
Kidney problems	5	6	0.20
Fractured bones	5	6	0.20
Oedema	5	6	0.20
Diarrhea/dysentery	15	18	0.18
Constipation	11	13	0.17
Bilharzias	6	7	0.17
Cold and flu	6	7	0.17
Fungus	7	8	0.14
Ulcers	7	8	0.14
Sickle cell anaemia	8	9	0.13
Numbness	12	13	0.08

vendors as rare, 32.4% less available and 18.6% were reported as available (Table 3).

3.3. Quantity of medicinal plants in commercial trade

The quantity of medicinal plants varied from one study site to another. Among the most common species traded in Tanzania, based on presence as dominant species in individual markets, are *Albizia anthelmintica*, *Vachellia nilotica*, *Warburgia stuhlmannii*, *Zanha africana*, *Zanthoxylum chalybeum*. The markets in Dodoma town (central zone) account for 1891 kg per year in commercial trade, and in addition to the nationally dominant species we find *Cassia abbreviata* and *Spirostachys africana* Sond. (Table 3). The markets in Arusha city (northern zone) account for 1838 kg per year, and dominant species in addition to those listed above were *Salvadora persica* L., *Lippia javanica* (Burm.f.) Spreng., *Erythrina abyssinica* DC. and *Dombeya shupangae* K.Schum. (Table 3). The markets of Mbeya city (southern zone) were good for 1794 kg in trade with addition species being *Ozoroa insignis* Delile, *Vachellia seyal* (Delile) P.J.H.Hurter, *Tecoma stans* (L.) Juss. ex Kunth, *Mondia ecornuta*, *Ipomoea biflora* (L.) Pers., *Cassia abbreviata*, *Balanites aegyptiaca* (L.) Delile (Table 3). The Morogoro town markets (eastern zone) with 1666 kg in trade were similar to other cities with the exception of dominant trade in *Mondia ecornuta* (Table 3). In Mwanza, trade was the least in weight, but included a number of species not extensively traded elsewhere *Acacia sieberiana* DC., *Terminalia*

kaiseriana, *Pterocarpus angolensis* DC. and *Aspilia mossambicensis* (Oliv.) Wild (Table 3).

Plant species with the largest volume of trade in this study were *Ozoroa insignis* (510 kg), *Zanthoxylum chalybaeum* (482 kg), *Albizia anthelmintica* (390 kg) and *Zanha africana* (307 kg). These are also among the most frequent medicinal plants traded in the markets, and this suggests they are used in large quantities in the national market. Plant parts with the largest volume of trade were roots (3818 kg), bark (1163 kg and leaves (492 kg) followed by flowers (196 kg), seeds (88 kg) and whole plant (13 kg).

3.4. Chain of commercial trade

The chain of medicinal plant trade from the collectors at source to the final consumer involves a range of intermediaries (harvesters, middlemen, vendors, traditional healers) and destinations (local community, urban consumers, international arena). While trade in medicinal plants is often perceived as a mostly rural activity, the urban dimension should not be underestimated. Our study found that in Tanzania complex rural to urban supply networks have developed for the medicinal plants trade that are driven by urban demand. The majority of vendors report to harvest by themselves or sometimes order harvesters to bring medicinal plants from rural areas to town centers. In Mbeya town, vendors harvest medicinal plants from the rural areas of Mapogoro, Uwanji hills and Mjere-Momba. In Morogoro town, many vendors bring their medicines from village reserve forests of Melela and Mbala. In Arusha town, the majority harvests from rural areas of Ketumbeine and Sambasha hills. Dodoma vendors order medicinal plants from Simanjiro and Arusha as well as Dar es Salaam. The majority of vendors from Mwanza town harvest their medicines from around the Saint Augustine

Table 2
International trade of medicinal plants through registered routes

Scientific name	Part/product	Route	Weight (MT)	Destination
<i>Phyllanthus engleri</i> Pax	Stem bark	Dar es Salaam port	125.01	India and Germany
<i>Osyris lanceolata</i> Hochst. & Steud.	Stem and roots	Dar es Salaam port	24	India and China
<i>Jatropha curcas</i> L.	Seeds	Dar es Salaam port and Dar es Salaam International Airport	0.011	Muscat, Oman, London, Japan, Thailand
<i>Ricinus communis</i> L.	Seeds	Dar es Salaam port	31	Thailand
<i>Moringa oleifera</i> Lam.	Seeds and leaves	Dar es Salaam port and Dar es Salaam International Airport	33.20	Vietnam, India, USA and South africa
<i>Croton macrostachyus</i> Hochst. ex Delile	Stem (wood)	Dar es Salaam port	315	China
<i>Cucurbita maxima</i> Duchesne	Seeds	Dar es Salaam port	50	Yemen
<i>Milicia excelsa</i> (Welw.) C.C. Berg	Stem (Timber)	Dar es Salaam port	23	United Arab Emirate
Assorted herbs for research	Powder	Dar es Salaam International Airport	0.01	Kenya
<i>Gmelina arborea</i> Roxb. ex Sm.	Seeds	Dar es Salaam International Airport	0.01	Mozambique
Natural herbs	Powder	Dar es Salaam International Airport	0.28	USA, Ethiopia
<i>Gynandropsis gynandra</i> (L.) Briq.	Leaves	Dar es Salaam International Airport	0.001	Unknown
<i>Eucalyptus globulus</i> Labill.	Stem (barks)	Namanga	22.6	Kenya

Table 3
Details of medicinal plants, scientific names, local names, relative frequency, health problems treated, market place, plant part used, harvest source, conservation status, and annual trade volume of medicinal plants

Family	Species (Collection number)	Local names	Part used	Health problems treated	Market place*	Harvest source	Status	RFC	Annual trade (kg)	
Acanthaceae	<i>Barleria aristata</i> I.Darbysh. (SH34)	Osekilekop	R	Inflammation	Njombe BT	Wild	Available	0.025	11	
	<i>Duosperma crenatum</i> (Lindau) P.G. Mey. (SH235)	Mchwabigufu	L	Constipation	Posta AM	Wild	Available	0.025	4	
	<i>Thunbergia alata</i> Boj. ex Sims (SH196)	Wankula	L	Hypertension (high blood pressure), foot numbness	Posta AM	Wild	Less Available	0.025	7	
Amaranthaceae	<i>Chenopodium album</i> L. (SH151)	Oshafeza	L	Charms	Kilombero MM	Wild	Less Available	0.025	11	
Anacardiaceae	<i>Lannea humilis</i> (Oliv.) Engl. (SH199)	Mkuruguta	L	Malaria	Posta AM	Wild	Rare	0.025	6	
	<i>Lannea schweinfurthii</i> (Engl.) Engl. (SH80)	Sayu, Enjanilongera	B, R	Typhoid, oedema	Kilombero MM, Mbeya CM, Morogoro CM	Wild	Less Available	0.075	B (18), R (13)	
	<i>Lannea schweinfurthii</i> var. <i>stuhmannii</i> (Engl.) Kokwaro (SH106)	Mumbii	R	Anaemia	Morogoro CM	Wild	Less Available	0.025	14	
	<i>Ozoroa insignis</i> Delile (SH8)	Membepori, Olokunonoi	B, R	Malaria, constipation, increase sperm count and breastmilk	Dodoma CM, Kilombero BTA, Mbeya CM, Njombe BT, Morogoro CM	Wild	Available	0.2	B (39), R (120)	
	<i>Sclerocarya birrea</i> (A. Rich.) Hochst. (SH32)	Ormangwai	R	Anaemia, sexually transmitted diseases, diarrhoea, fever and ulcers, eye problems	Mafyati AM, Morogoro CM	Wild	Available	0.05	36	
	<i>Searsia natalensis</i> (Bernh. ex Krauss) F. A. Barkley (SH302)	Mshelela	R	Pain and inflammation	Morogoro CM	Wild	Rare	0.025	11	
Annonaceae	<i>Annona senegalensis</i> Pers. (SH166)	Konola	B, R	Against evil spirits	Kilombero MM	Wild	Available	0.025	B (6), R (3)	
	<i>Uvaria kirkii</i> Oliv. ex Hook. f. <i>kirkii</i> (SH113)	Msofu	R	Painkiller, malaria	Morogoro CM	Wild	Less Available	0.025	17	
Apiaceae	<i>Steganotaenia araliacea</i> Hochst. (SH4)	Mnyongamembe	B, R	To regulate menstrual cycle	Mbeya CM	Wild	Rare	0.025	B (8), R (9)	
Apocynaceae	<i>Catharanthus roseus</i> (L.) G. Don (SH203)	Mti wa kansa	L	Cancer	Posta AM	Wild	Rare	0.025	6	
	<i>Ceropegia stenoloba</i> Hochst. ex Chiov. (SH3)	Mkambaku	R	Libido disorder	Mbeya CM	Wild	Less Available	0.025	25	
	<i>Holarrhena pubescens</i> (Buch.-Ham.) Wall. Ex (SH114)	Onjanikale	R	Syphillis, dysentery	Morogoro CM	Wild	Rare	0.025	9	
	<i>Hunteria zeylanica</i> (Retz.) Gardner ex Thwaites (SH281)	Loliondoi	B	Stomachache	Kilombero BTA	Wild	Rare	0.025	9	
	<i>Landolphia kirkii</i> Dyer (SH115)	Kibanalomo	R	Gastrointestinal	Morogoro CM	Wild	Rare	0.025	11	
	<i>Mondia ecornuta</i> (N. E. Br.) Bullock (SH25)	Mkongora	R	Libido disorder	Dodoma CM, Kilombero MM, Njombe BT, Mbeya CM, Morogoro CM	Wild	Rare	0.15	130	
	<i>Strophanthus eminii</i> Asch. ex Pax (SH140)	Msungururu	R	Malaria	Kilombero MM	Wild	Rare	0.025	21	
	<i>Asparagus falcatus</i> L. (SH121)	Olopirolopapaa	R	Infertility	Morogoro CM	Wild	Rare	0.025	21	
	<i>Ageratum conyzoides</i> L. (SH211)	Katabataba	L	Cancer, lung problems	Posta AM	Wild	Available	0.025	6	
	<i>Artemisia afra</i> Jacq. (SH87)	Fivi	L	Malaria	Dodoma CM	Wild	Rare	0.025	37	
Asparagaceae	<i>Aspilia mossambicensis</i> (Oliv.) Wild (SH246)	Nyangaanyangaa, Suruwa	L	Retarded growth in children	Posta AM	Wild	Less Available	0.05	10	
	<i>Bidens pilosa</i> L. (SH219)	Vishikishio	L	Constipation	Posta AM	Wild	Available	0.025	5	
	<i>Conyza pyrrophappa</i> Sch.Bip. ex A.Rich. (SH212)	Rufugakande	L	Malaria	Posta AM	Wild	Available	0.025	6	
	<i>Dicoma anomala</i> Sond. (SH1)	Karibekantu	R	Heartburn	Mbeya CM	Wild	Rare	0.075	90	
	<i>Emilia fosbergii</i> D.H. Nicolson (SH204)	Kanyorokazi	L	Lung problems	Posta AM	Wild	Available	0.025	6	
	<i>Linzia glabra</i> Steetz (SH207)	Rushalila ya cancer	L	Cancer	Posta AM	Wild	Available	0.025	6	
	<i>Tridax procumbens</i> L. (SH233)	Mkakara	L	Urinary tract infection, malaria	Posta AM	Wild	Available	0.025	4	
	Bignoniaceae	<i>Kigelia africana</i> (Lamarck) Benth. (SH110)	Aldaraboi, Mwegea, Mwicha	B, R	Dysmenorrhoea, sexually transmitted diseases, gynaecologic disorders, rheumatism, malaria, anaemia, body numbness	Kilombero BTA, Dodoma CM, Mafyati AM, Kilombero MM, Morogoro CM	Wild	Available	0.175	B (80), R (42)
		<i>Markhamia obtusifolia</i> (Bak.) Sprague (SH61)	Embel, Mkoyoyo	B, L	Kidney problems, malaria	Mafyati AM, Posta AM	Wild	Less Available	0.025	B (6), L (5)
		<i>Markhamia zanzibarica</i> (Bojer ex DC.) K.Schum. (SH143)	Mpapa	L	Against evil spirits	Kilombero MM	Wild	Less Available	0.025	13
		<i>Stereospermum kunthianum</i> Cham. (SH165)	Mtelezo	R	Love charm	Kilombero MM	Wild	Rare	0.025	9

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Table 3 (continued)

Family	Species (Collection number)	Local names	Part used	Health problems treated	Market place*	Harvest source	Status	RFC	Annual trade (kg)
	<i>Ehretia amoena</i> Klotzsch (SH38)	Nembu, Jabalelon,	R	Eye problems, stomachache,	Kilombero MM, Morogoro CM, Mafyati AM	Wild	Less Available	0.1	42
	<i>Trichodesma zeylanicum</i> (Burm. fil.) R. Br. (SH243)	Mchango wa bandama	L	dysmenorrhoea, gonorrhoea, bilhaziasis Spleen problems	Posta AM	Wild	Available	0.025	4
Burseraceae	<i>Commiphora africana</i> (Rich.) Engl. (SH35)	Silalei, Tanguta	F	Hernia, ulcers, against evil spirits	Ngaramtoni AA, Kilombero MM, Mbeya CM, Morogoro CM	Wild	Less Available	0.1	81
	<i>Commiphora mollis</i> (Oliv.) Engl. (SH141)	Mponda	R	Stomachache, infertility	Kilombero MM	Wild	Rare	0.025	19
Canellaceae	<i>Warburgia stuhlmannii</i> Engl. (SH93)	Sokonoi	B, R	Headache, hernia, malaria, diabetes, Libido disorder, numbness, cold and flu, dysmenorrhoea, fever	Dodoma CM, Kilombero BTA, Morogoro CM, Msamvu BTM	Wild	Rare	0.325	B (130), R (118)
Cannabaceae	<i>Trema orientalis</i> (L.) Bl. (SH224)	Muuwe	L	Fungal diseases, headache	Posta AM	Wild	Available	0.025	5
Capparaceae	<i>Maerua angolensis</i> DC. (SH283)	Ngirei	R	Fever	Kilombero BTA	Wild	Rare	0.025	9
	<i>Maerua angolensis</i> var. <i>africana</i> L.E. Kers (SH173)	Solula	B, R	Charms	Kilombero MM	Wild	Less Available	0.025	B (2), R (6)
Celastraceae	<i>Elaeodendron buchananii</i> (Loes.) Loes. (SH262)	Oladang'anango	B	Libido disorder	Kikatiti A	Wild	Rare	0.025	32
	<i>Gymnosporia senegalensis</i> (Lam.) Loes. (SH160)	Alaimurunyai, Mweza	R	Charms	Posta AM, Kilombero MM	Wild	Less Available	0.05	13
Chrysobalanaceae	<i>Parinari curatellifolia</i> Benth. ex Planch. (SH154)	Naji	L	Stomachache	Posta AM	Wild	Less Available	0.05	14
Cleomaceae	<i>Cleome gynandra</i> L. (SH237)	Mgagani	L	Retarded growth in children	Posta AM	Wild	Available	0.025	4
Clusiaceae	<i>Garcinia livingstonei</i> T. Anders. (SH51)	Orpinasi, Orkilalagoso	R	Libido disorder, headache	Dodoma CM, Mafyati AM, Morogoro CM	Wild	Less Available	0.075	26
Combretaceae	<i>Combretum adenogonium</i> Steud. ex A. Rich. (SH209)	Mwamila	L	Against evil spirits	Posta AM	Wild	Rare	0.025	6
	<i>Combretum molle</i> R. Br. ex G. Don (SH97)	Namata	R	Body numbness	Kilombero MM	Wild	Available	0.025	9
	<i>Combretum zeyheri</i> Sond. (SH179)	Msana	R	Against evil spirits	Dodoma CM	Wild	Less Available	0.025	29
	<i>Terminalia kaiseriana</i> F. Hoffm. (SH16)	Olbukoi, Jimia, Mkelenge	B, R	Malaria, skin diseases	Arusha CM, Posta AM, Kilombero MM, Mbeya CM	Wild	Available	0.125	B (50), R (63)
Convolvulaceae	<i>Ipomoea biflora</i> (L.) Pers. (SH46)	Karandarugo, Nazimba	L, R	Pressure, urinary tract infection, malaria, stomachache	Posta AM, Mafyati AM	Wild	Rare	0.1	L (4), R (36)
Cucurbitaceae	<i>Momordica charantia</i> L. (SH192)	Kabindizi	L	Malaria	Posta AM	Wild	Rare	0.025	7
Ebenaceae	<i>Diospyros usambarensis</i> F.White (SH50)	Simanjiroi	B, R	Dental problems, Libido disorder	Mafyati AM, Morogoro CM	Wild	Less Available	0.05	B (15), R (16)
	<i>Euclea divinorum</i> Hiern (SH158)	Sagunida	R	Constipation	Kilombero MM	Wild	Rare	0.025	9
	<i>Euclea natalensis</i> A.DC. (SH130)	Sojoi	R	Gout	Morogoro CM	Wild	Less Available	0.025	27
Euphorbiaceae	<i>Acalypha fruticosa</i> Forssk. (SH127)	Mchacha	R	Gonorrhoea	Morogoro CM	Wild	Less Available	0.025	15
	<i>Croton dichogamus</i> Pax (SH40)	Oreboriberneki	R	Headache	Dodoma CM, Kilombero MM, Mafyati AM, Morogoro CM	Wild	Rare	0.125	64
	<i>Croton megalocarpus</i> Hutch. (SH260)	Olmalbaiti	B	Stomachache	Kikatiti A	Wild	Available	0.025	37
	<i>Erythrocca bongensis</i> Pax (SH217)	Msongisongi	L	Malaria, sexually transmitted diseases, liver inflammation	Posta AM	Wild	Available	0.025	5
	<i>Euphorbia</i> sp (SH63)	Lonzwe	F	Love charm	Kilombero MM	Wild	Rare	0.025	9

Fabaceae	<i>Euphorbia hirta</i> L. (SH230)	Kaligarugo	L	Malaria, sickle cell disease	Posta AM	Wild	Available	0.025	5
	<i>Jatropha curcas</i> L. (SH218)	Mubona	L	Malaria	Posta AM	Wild	Available	0.025	5
	<i>Spirostachys africana</i> Sond. (SH129)	Ormatanga, Mharaka	R	Dysmenorrhoea, tumour, stomachache	Dodoma CM, Morogoro CM	Wild	Rare	0.1	88
	<i>Abrus precatorius</i> L. (SH131)	Burunga, Ngoponi	R	Impotence, chest, bilhaziasis, spinal cord pain, Libido disorder	Kilombero MM, Morogoro CM	Wild	Available	0.075	62
	<i>Acacia sieberiana</i> DC. (SH169)	Mnyinyi, Suha, Ndepesi, Elerai	R	Malaria, typhoid, stomach ache, swollen, hernia, cough	Posta AM, Njombe BT, Kilombero MM, Morogoro CM	Wild	Less Available	0.1	63
	<i>Afzelia quanzensis</i> Welw. (SH15)	Mkola	R	Stomach ache, dysmenorrhoea, epilepsy, malaria, diarrhoea	Dodoma CM, Mafyati AM, Morogoro CM	Wild	Less Available	0.075	56
	<i>Albizia anthelmintica</i> Brongn. (SH6)	Mukutani, Mfuleta	R	Dysmenorrhoea, bile/jaundice, worms, Libido disorder, kidney problems, malaria, hernia, skin diseases	Dodoma CM, Arusha CM, Kikatiti A, Kilombero MM, Njombe BT, Mbeya CM, Msamvu BTM, Morogoro CM	Wild	Rare	0.45	390
	<i>Albizia glaberrima</i> (Schum. & Thonn.)Benth. (SH125)	Mtihere	R	Bilharziasis	Morogoro CM	Wild	Less Available	0.025	7
	<i>Albizia gummifera</i> (J.F.Gmel.)C.A.Sm. (SH156)	Shishigula	B, R	Stomach ache	Kilombero MM	Wild	Less Available	0.025	B (6), R (5)
	<i>Albizia harveyi</i> E.Fourn. (SH48)	Orkiporlong'o, Enjaniengushi	B	Dental problems, Libido disorder	Mafyati AM, Morogoro CM	Wild	Less Available	0.05	27
	<i>Albizia lebbeck</i> (L.)Benth. (SH197)	Mlongelonge, Myenjejeje	F, L	Dysmenorrhoea, malaria, diarrhoea	Posta AM	Wild	Available	0.05	F(11), L(1)
	<i>Albizia verrucosa</i> Capuron (SH53)	Ormsambira	R	Stomachache, worms	Mafyati AM	Wild	Less Available	0.025	6
	<i>Alysicarpus vaginalis</i> (L.) DC. (SH242)	Biugula	L	Fractured bone	Posta AM	Wild	Less Available	0.025	4
	<i>Bauhinia thonningii</i> Schum. (SH37)	Osagalami, Sagararami2	R	Stomachache, Libido disorder	Mafyati AM, Morogoro CM	Wild	Available	0.05	21
	<i>Bauhinia tomentosa</i> L. (SH75)	Sagararami	R	Constipation, stomach ache	Morogoro CM	Wild	Available	0.025	15
	<i>Cassia abbreviata</i> Oliv. (SH36)	Singwai	B, R	Malaria, stomach ache, amoebiasis, sexually transmitted diseases, woman failing to conceive, dysmenorrhoea, diabetes	Mbeya CM, Dodoma CM, Kilombero MM, Mbeya CM, Morogoro CM	Wild	Less Available	0.25	B(50), R (151)
	<i>Chamaecrista mimosoides</i> (L.)Greene (SH216)	Kasinganziro	L	Fractured bone	Posta AM	Wild	Less Available	0.025	5
	<i>Dalbergia nitidula</i> Baker (SH202)	Rugumu	L	Constipation	Posta AM	Wild	Rare	0.025	6
	<i>Dichrostachys cinerea</i> (L.)Wight & Arn. (SH55)	Endulundi	R	Dysentery, headaches, syphilis	Arusha CM, Mafyati AM, Morogoro CM	Wild	Available	0.075	40
	<i>Entada abyssinica</i> A.Rich. (248)	Mbilimbili, Pogoro	L, R	Charms	Posta AM, Kilombero MM	Wild	Less Available	0.05	L(3), R(11)
	<i>Erythrina abyssinica</i> DC. (SH286)	Oluponyi	B	Stomachache	Kilombero BTA, Arusha CM	Wild	Less Available	0.05	25
	<i>Indigofera arrecta</i> A.Rich. (SH229)	Msoroza	R	Libido disorder	Posta AM	Wild	Available	0.025	5
	<i>Indigofera volkensii</i> Taub. (SH198)	Ndarabugazi	L	Urinary tract infection, gonorrhoea	Posta AM	Wild	Available	0.025	6
	<i>Julbernardia globiflora</i> (Benth.)Troupin (SH60)	Kilepori	R	Spinal cord pain, hernia, joint pain, infertility, stomach ache	Mafyati AM, Morogoro CM	Wild	Available	0.05	24
	<i>Kotschyia africana</i> Endl. (SH232)	Changu	L	Malaria, spinal cord numbness	Posta AM	Wild	Available	0.025	4
	<i>Lonchocarpus bussei</i> Harms (155)	Male	B, R	Increase volume of milk to lactating mother	Kilombero MM	Wild	Rare	0.025	B(9), R(2)
	<i>Ormocarpum kirkii</i> S.Moore (SH238)	Kalemanjonjo	W	Against evil spirits	Posta AM	Wild	Less Available	0.025	4
<i>Pterocarpus angolensis</i> DC. (SH136)	Mninga, Fifi	B, R	Anaemia	Kilombero MM, Mbeya CM	Wild	Rare	0.075	B(41), R(19)	
<i>Senegalia brevispica</i> (Harms) Seigler & Ebinger (SH137)	Ikeye, Girgiri	B, R	Against evil spirits, dysmenorrhoea	Kilombero MM, Morogoro CM	Wild	Less Available	0.075	B (5), R(60)	
<i>Senna alata</i> (L.)Roxb. (SH152)	Njorwambogo	L	Dysmenorrhoea	Kilombero MM	Wild	Available	0.025	11	
<i>Senna didymobotrya</i> (Fresen.)H.S.Irwin & Barneby (SH195)	Mgabagaba	L	Diarrhoea, oedema	Posta AM	Wild	Available	0.025	7	
<i>Senna occidentalis</i> (L.)Link (SH221)	Mwitanjoka	L	Hernia, dysmenorrhoea	Posta AM	Wild	Available	0.025	5	
<i>Senna siamea</i> (Lam.)H.S.Irwin & Barneby (SH299)	Mjohoro	R, L	Malaria, sexually transmitted diseases, typhoid	Dodoma CM, Mbeya CM	Cultivated	Available	0.075	R(40), L (41)	
<i>Sesbania sesban</i> (L.)Merr. (SH58)	Mbondobondo,	R	Stomachache, worms	Posta AM, Mafyati AM	Wild	Rare	0.05	9	

(continued on next page)

Table 3 (continued)

Family	Species (Collection number)	Local names	Part used	Health problems treated	Market place*	Harvest source	Status	RFC	Annual trade (kg)
	<i>Tamarindus indica</i> L.(SH96)	Ormusere Omsembere	B	Foot pain, constipation	Msamvu BTM	Wild	Less Available	0.025	9
	<i>Tephrosia villosa</i> (L.)Pers. (SH194)	Kaulile	L	Cough and flu	Posta AM	Wild	Available	0.025	7
	<i>Vachellia nilotica</i> (L.) P.J.H.Hurter & Mabb. (SH65)	Kiloriti	B, R	Pressure, stomach ache, malaria, Libido disorder, haemodialysis, gonorrhoea, fungal diseases, hernia	Dodoma CM, Ngaramtoni AA, Kikatiti A, Mafyati AM, Msamvu BTM, Morogoro CM	Wild	Available	0.3	B(31), R(219)
	<i>Vachellia robusta</i> subsp. <i>robusta</i> Brenan in F.Z. (SH172)	Mgando, Sese	B	Libido disorder, spinal cord and joint numbness	Posta AM, Kilombero MM	Wild	Less Available	0.05	12
	<i>Vachellia seyal</i> (Delile) P.J.H.Hurter (SH18)	Elerai, Naju, Oltepesi	R	Stomach ache, malaria, hernia, dysmenorrhoea	Njombe BT, Dodoma CM, Kilombero BTA, Mbeya CM	Wild	Available	0.15	110
	<i>Vachellia zanzibarica</i> (S.Moore) Kyal. & Boatwr. (SH89)	Elerai	B, R	Constipation	Morogoro CM	Wild	Less Available	0.025	B(4),R(8)
	<i>Xeroderris stuhlmannii</i> (Taub.)Mendonca & Sousa (SH142)	Njundu	R	Sickle cell disease	Kilombero MM	Wild	Rare	0.025	19
Lamiaceae	<i>Clerodendrum rotundifolium</i> Oliv. (SH190)	Enjaning' ahe, Kichumuchuma	B	Stomach ache, diarrhoea	Arusha CM, Posta AM	Wild	Available	0.05	25
	<i>Hoslundia opposita</i> Vahl (SH241)	Mzitoima	L	Malaria	Posta AM	Wild	Less Available	0.025	4
	<i>Mesosphaerum suaveolens</i> (L.) Kuntze (SH240)	Rushalila	L	Cancer	Posta AM	Wild	Available	0.025	4
	<i>Ocimum kilimandscharicum</i> Baker ex Gürke (SH205)	Kashwagala	L	Malaria	Posta AM	Wild	Available	0.025	6
	<i>Ocimum suave</i> Willd. (SH223)	Kachumbamwani, Olemoran	L	Stomach ache, fever, headache	Posta AM, Mafyati AM	Wild	Available	0.05	13
	<i>Orthosiphon suffrutescens</i> (Schumach.) J.K. Morton (SH274)	Olemorani	L	Infertility	Kilombero BTA	Wild	Available	0.025	11
	<i>Premna senensis</i> Klotzsch (SH288)	Ormisigie	R	Diarrhoea, stomach ache	Kilombero BTA, Dodoma CM	Wild	Rare	0.05	19
	<i>Rotheca myricoides</i> (Hochst.) Steane & Mabb. (SH285)	Omukutuk	R	Vomiting	Kilombero BTA	Wild	Rare	0.025	9
	<i>Vitex domiana</i> Sweet (SH295)	Mfudu	L	Headache, fever	Posta AM	Wild	Less Available	0.025	3
	<i>Vitex schaueriana</i> Moldenke (SH182)	Sungwi	L	Headache, fever	Posta AM	Wild	Less Available	0.025	7
Loganiaceae	<i>Strychnos spinosa</i> Lam. (SH162)	Ngodakalomo	B, R	Dysmenorrhoea	Kilombero MM	Wild	Less Available	0.025	B(3),R(6)
Loranthaceae	<i>Erianthemum dregei</i> (Eckl. & Zeyh.) Tiegh. (SH300)	Muharaka	R	Stomach ache	Dodoma CM	Wild	Available	0.025	7
Malvaceae	<i>Abutilon mauritanium</i> (Jacq.) Medic. (SH22)	Lakichocho, Makirikara	W	Bilhaziasis, fungal diseases	Posta AM, Njombe BT	Wild	Less Available	0.05	4
	<i>Dombeya shupangae</i> K. Schum. (SH287)	Olayapiyap	R	Indigestion	Kilombero BTA, Kikatiti A	Wild	Less Available	0.05	38
	<i>Grewia bicolor</i> Juss. (SH20)	Mkoma, Esteti	R	Anaemia, cold, diarrhoea, snakebites, hernia	Posta AM, Mbeya CM	Wild	Available	0.05	40
	<i>Grewia</i> sp (SH157)	Sasi	R	Love charm	Kilombero MM	Wild	Rare	0.025	10
	<i>Sida acuta</i> Burm.f. (SH188)	Mti wa meno	L	Dental caries	Posta AM	Wild	Available	0.025	7
Meliaceae	<i>Azadirachta indica</i> A. Juss. (SH214)	Mwarobaini	R	Malaria	Dodoma CM	Cultivated	Available	0.025	18
Moraceae	<i>Ficus natalensis</i> Hochst. (SH42)	Orgilai, Oreteti	R	Detoxification, headache, haemodialysis, gonorrhoea	Kilombero BTA, Mafyati AM, Msamvu BTM, Dodoma CM	Wild	Rare	0.125	63
	<i>Ficus sur</i> Forssk. (SH26)	Ng'aboli, Twaligana	L	Infertility, diarrhoea	Kilombero BTA, Posta AM, Mbeya CM, Morogoro CM	Wild	Available	0.1	47
Moringaceae	<i>Moringa oleifera</i> Lam. (SH132)	Mlonge	S	Immune booster, indigestion	Morogoro CM	Cultivated	Available	0.025	26
Myrtaceae	<i>Eucalyptus globulus</i> Labill. (SH201)	Mkaratusi	L	Malaria	Posta AM	Cultivated	Available	0.025	6
	<i>Syzygium aromaticum</i> (L.) Merr. & L.M.Perry (SH294)	Karafuu	F	Dental caries, stomach ache	Dodoma CM	Cultivated	Available	0.05	74
Ochnaceae	<i>Ochna holstii</i> Engl. (SH78)	Olbukoi	B, R	Cough, constipation	Morogoro CM, Arusha CM	Wild	Available	0.05	B(12), R(30)
Olacaceae	<i>Olax dissitiflora</i> Oliver (SH45)	Msalaba	B	Dental problems	Mafyati AM	Wild	Less	0.025	9

Family	Species	Local Name	Plant Part	Medicinal Use	Market Place	Availability	Value (R)	Weight (kg)
	<i>Ximenia americana</i> L. (SH27)	Ngomai	R	Dysmenorrhoea, hormones, Libido disorder, irregular menstrual period	Dodoma CM, Mbeya CM, Morogoro CM	Wild	Rare	0.125 102
	<i>Ximenia caffra</i> Sond. (SH5)	Tundwa, Mpingi	R	Dysmenorrhoea, bilharziasis, diarrhoea, body numbness	Kilombero BTA, Kilombero MM, Mbeya CM, Morogoro CM	Wild	Less Available	0.1 67
Orobanchaceae	<i>Jasminum fluminense</i> Vell. (SH208)	Chingula	L	Infertility	Posta AM	Wild	Available	0.025 6
	<i>Schrebera trichoclada</i> Welw. (SH177)	Budika	R	Against evil spirits	Kilombero MM	Wild	Rare	0.025 20
	<i>Cycnium tubulosum subsp. montanum</i> (N.E. Br.) O.J. Hansen (SH228)	Maua ya watoto	W	Malaria	Posta AM	Wild	Available	0.025 5
	<i>Antidesma venosum</i> E.Mey. ex Tul. (SH116)	Enjanemeno	B	Ulcers, snakebite	Morogoro CM	Wild	Rare	0.025 13
Phyllanthaceae	<i>Bridelia cathartica</i> Bertol. (SH13)	Mlembezi, Kausha	L	Oedema, stomach ache, diarrhoea	Posta AM, Mafyati AM	Wild	Rare	0.05 13
	<i>Flueggea virosa</i> (Roxb. ex Willd.) Royle (SH185)	Mizwandimu	L	Malaria	Posta AM	Wild	Less Available	0.025 7
	<i>Phyllanthus amarus</i> Schumach. & Thonn. (SH227)	Mturuka	L	Urinary tract infections, ulcers, kidney disorders, diabetes, wound-healing	Posta AM	Wild	Available	0.025 5
Piperaceae	<i>Piper nigrum</i> L. (SH297)	Pilipili	S	Fractured bones	Dodoma CM	Cultivated	Available	0.025 32
Poaceae	<i>Pennisetum purpureum</i> Schumach. (SH187)	Mtete	L	Typhoid	Posta AM	Cultivated	Available	0.025 7
Polygalaceae	<i>Securidaca longipedunculata</i> Fresen. (SH7)	Nengonengo	R	Epilepsy, aphrodisiac, dysmenorrhoea	Kilombero MM, Kabwe M	Wild	Less Available	0.075 41
	<i>Oxygonum sinuatum</i> (Hochst. & Steud. ex Meisn.) Damm. (SH210)	Kachumitambogo	R	Dysmenorrhoea, malaria, urinary tract infection, gonorrhoea	Posta AM	Wild	Available	0.025 6
Primulaceae	<i>Embelia schimperi</i> Vatke (SH301)	Ngesi	S	Kidney disorders, liver problems, haemodialysis, stomach ache	Kikatiti A	Wild	Rare	0.025 30
	<i>Myrsine africana</i> L. (SH263)	Loodwa	R	Sexually transmitted diseases	Dodoma CM, Kikatiti A, Kilombero MM	Wild	Rare	0.075 56
Rubiaceae	<i>Catunaregam spinosa</i> (Thunb.) Tirveng. (SH59)	Kaboya	F	Malaria, bile	Mafyati AM, Morogoro CM	Wild	Less Available	0.05 21
	<i>Hymenodictyon floribundum</i> (Hochst. & Steud.) (SH19)	Enkoholo	R	Tumour	Mafyati AM, Morogoro CM	Wild	Less Available	0.05 50
	<i>Rubia cordifolia</i> L. (SH289)	Olgiryandus	L	Foot swelling	Kilombero BTA	Wild	Less Available	0.025 6
Rutaceae	<i>Vangueria infausta</i> Burch. (SH186)	Mtangunda	L	Malaria	Posta AM	Wild	Rare	0.025 7
	<i>Harrisonia abyssinica</i> Oliver (SH105)	Soma, Engilelo	R	Hernia, stomach ache, malaria	Kilombero MM, Morogoro CM	Wild	Available	0.05 40
	<i>Vepris nobilis</i> (Delile) W. Mziray (SH144)	Njuu	R	Flu, dysmenorrhoea	Kilombero MM	Wild	Rare	0.025 13
	<i>Zanthoxylum chalybaeum</i> Engl. (SH10)	Oloisuki	B, R	Dysmenorrhoea, fever, malaria, Libido disorder, diabetes, hernia, numbness, headache	Dodoma CM, Kilombero BTA, Ngaramtoni AA, Kilombero MM, Mbeya CM, Kabwe M, Morogoro CM	Wild	Less Available	0.6 B(82), R(400)
Salicaceae	<i>Flacourtia indica</i> (Burm. fil.) Merr. (SH28)	Mbuguswa	R	Ulcers, malaria	Kilombero MM	Wild	Rare	0.025 11
Salvadoraceae	<i>Salvadora persica</i> L. (SH57)	Oremit	B	Dental caries, skin diseases, syphilis	Dodoma CM, Kilombero BTA, Kikatiti A, Mafyati AM, Arusha CM	Wild	Less Available	0.15 100
Santalaceae	<i>Osyris wightiana</i> Wall. ex Wight (SH269)	Lasesei	R	Asthma, sore throat	Kilombero BTA	Wild	Rare	0.025 15
Sapindaceae	<i>Zanha africana</i> (Radlk.) Exell (SH2)	Ermerorai, Mwatia, Mdaula	B, R	Dysmenorrhoea, migraine, cough, Libido disorder	Dodoma CM, Kilombero MM, Mafyati AM, Mbeya CM, Morogoro CM, Msamvu BTM	Wild	Less Available	0.35 B(190), R(117)
	<i>Solanum nigrum</i> L. (SH206)	Shwiga	L	Diabetes	Posta AM	Wild	Available	0.025 6
Thymelaeaceae	<i>Synaptolepis kirkii</i> Oliver (SH293)	Mfungawaume	R	Vomiting, impotence	Morogoro CM	Wild	Rare	0.025 14
Urticaceae	<i>Urtica massaica</i> Mildbr. (SH275)	Ndamojoi	R	Liver problems, stomach ache, skin rushes	Kilombero BTA, Dodoma CM	Wild	Less Available	0.075 50
	<i>Lippia javanica</i> (Burm.f.) Spreng. (SH277)	Osinoni	L	Cough	Kilombero BTA, Arusha CM	Wild	Less Available	0.05 27
Vitaceae	<i>Cissus rotundifolia</i> (Forsk.) Vahl (SH222)	Mchazi, Kakulumo	L, R	Fractured bones, inflammation and swelling on the skin, ulcers, malaria	Posta AM, Morogoro CM	Wild	Less Available	0.05 L(4), R(12)
	<i>Cyphostemma adenocaula</i> (Steud. ex A. Rich.) Descoings (SH220)	Rubombo	L	Malaria	Posta AM	Wild	Less Available	0.025 5
	<i>Rhoicissus tridentata</i> (L. fil.) Wild & R. B. Drumm. (SH170)	Imala	R	Foot numbness	Kilombero MM	Wild	Rare	0.025 8
Zingiberaceae	<i>Zingiber officinale</i> Roscoe (SH296)	Tangawizi	R	Cough, inflammation	Dodoma CM	Cultivated	Available	0.025 33
Zygophyllaceae	<i>Balanites aegyptiaca</i> (L.) Delile (SH9)	Orng'oswai	B	Gonorrhoea, malaria, bone weakness, cough, stomach ache, joint numbness, rheumatism	Dodoma CM, Morogoro CM, Mafyati AM, Posta AM, Kilombero BTA	Wild	Available	0.15 78

* Market place; Arusha Central Market = Arusha CM, Kikatiti Arusha = Kikatiti A, Kilombero Market Mwanza = Kilombero MM, Mbeya central market = Mbeya CM, Morogoro central market = Morogoro CM, Dodoma central market = Dodoma CM, Kilombero bus terminal Arusha = Kilombero BTA, Posta area Mwanza = Posta AM, Kabwe Mbeya = Kabwe M, Njombe Bus Terminal = Njombe BT, Ngaramtoni area Arusha = Ngaramtoni AA, Msamvu bus terminal Morogoro = Msamvu BTM. Plant parts used; R = root, B = bark, L = leaf, F = fruit, S = seed, W = whole plant.

University of Tanzania and near Mwanza Airport along Lake Victoria. In addition, according to vendors, the medicinal plant trade has moved beyond local urban markets to the international arena. According to informants some medicinal plant products are exported through unregistered routes, with most of them transported to Kenya by Maasai vendors who cross from Tanzania to Kenya without registering their products at official border check points. Fourteen species are traded internationally from Tanzania; thirteen species are destined to Kenya (*Zanthoxylum chalybeum*, *Julbernardia globiflora* (Benth.) Troupin, *Aloe secundiflora* Engl., *Warburgia salutaris*, *Albizia anthelmintica*, *Zanha africana*, *Cassia abbreviata*, *Commiphora africana* (Rich.) Engl., *Ozoroa insignis*, *Mondia ecornuta*, *Vachellia nilotica*, *Kigelia africana* (Lamarck) Benth., *Osyris lanceolata* Hochst. & Steud). One species (*Prunus africana* (Hook.f.) Kalkman) is destined to Europe and one taxon (Orchidaceae) to Zambia. These species typically exit from Namanga at the Kenyan border, although Orchidaceae are known to go through Tunduma at the Zambian border. According to the Ministry of Agriculture Export Report, 624.122 Metric tonnes of medicinal plants are exported annually (2016) through Dar es Salaam port, Dar es Salaam International Airport and the Namanga border point (Table 2).

4. Discussion

Most traded medicinal plants in the markets were used for managing malaria, libido disorders, infertility, dysmenorrhea and for spiritual/psycho-social purposes. The highest RFC of medicinal plants related to local health problems (van Andel et al. 2007; van Andel and Fundiko 2016; Busmann et al. 2007; Cousins et al., 2011; Cunningham and Mbenkum 1993; Mati and de Boer, 2010; Towns et al., 2014; Williams, 2003). Most popular medicinal plant species recognized in the markets for managing malaria include *Zanthoxylum chalybaeum*, *Vachellia nilotica*, *Albizia anthelmintica* (Meke et al., 2017; Odugbemi et al., 2007). These plant species are also reported for managing other diseases such as sexually transmitted diseases and diabetes (Rakotoarivelo et al., 2015). Depending on the plant species, different plant parts are used to treat different health problems; roots (55.3%) and bark (23.7%) were the most commonly used plant parts represented the largest trade volumes (Table 3). However, harvesting of roots and barks is an additional threat to plants as unsustainable overharvesting destroys the individual plants. This is less urgent compared to species of leaves, seeds or fruits are harvested (Yineger et al. 2008; Jusu and Sanchez, 2014; Randriamiharisoa et al., 2015).

The quantity of medicinal plants traded varies from one region to another with Dodoma at the top (1891 kg) and Mwanza at the bottom (1446 kg). The plants species with higher quantity treat more than one health problem (Table 3) (Towns et al., 2014). Tanzania is one of the exporters of medicinal plants, in 2016 about 624.122 metric tonnes medicinal plant samples were exported (Table 2). Most of this export is done through three exit points: Dar es Salaam International Airport, Dar es Salaam Port and Namanga border. Some exported medicinal species are used for other purposes like timber (Mkurungu/Croton, Eucalyptus) which increases the quantity of medicinal plants exported through the exit points (Hedberg et al. 1982; Marshall, 1998; Hamisy et al., 2002; Swai, 2003; Meke et al., 2017). This amount relies mainly on wild stock and it increases pressure in the wild plant populations (Lewington, 1993; Williams 2003).

The commercial chain of medicinal plant species shows that stakeholders rely mainly on the wild stock for the medicinal plant in trade (Nahashon, 2013). Interviewed vendors claimed that they harvest medicinal plants on their own, perhaps due to time constraints, or they order the medicinal plant samples from other vendors or harvesters (Kahatano 1997). Traditional medicine serves as means of generating income to the local communities (McMillen, 2008, 2012; Nahashon, 2013). Some vendors export medicinal plants without permits from regulatory authorities, and most of this material is exported to Kenya by Maasai, whom live on both sides of the border. Some plants in

international trade are CITES Appendix listed, such as *Prunus africana*, sandalwood (*Osyris lanceolata*) and orchids. However, international trade in these species still flourishes through unregistered routes. Cunningham and Mbenkum (1993) have estimated that Tanzania accounted for 4% of global export of *Prunus africana*. However, this could be a vast underestimation as trade does not follow official border points. The FAO (2010) also highlighted that the international trade of medicinal plants in developing countries is poorly monitored.

This market survey contributes to the literature on the Tanzanian medicinal plant diversity, and the current status of species in commercial trade. It was difficult to measure the exact quantity of medicinal plants that circulate in markets annually, because this quantity is highly dependent on market dynamics, which can be quite irregular even for a single plant species. The chain of commercialization is further complicated due to challenges in eliciting objective information from vendors, collectors and harvesters, traditional health practitioners, and consumers regarding a trade that is their main livelihood. The commercial trade of wild-harvested medicinal plants has implications for conservation concerns, and further research should be done to fully explore the impact of the medicinal plant harvest and trade on the wild population of plants.

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Appendix A. Supplementary data

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References

- Augustino, S., Gillah, P.R., 2005. Medicinal plants in urban districts of Tanzania: plants, gender roles and sustainable use. *International Forestry Review* 7, 44–58.
- Balick, M.J., Cox, P.A., 1996. Plants, people, and culture: the science of ethnobotany. *Scientific American Library*, 60, 200–228.
- Bernard, H., 1995. Research methods in anthropology. *Qualitative and Quantitative Approaches*, second ed Altamira Press, Walnut Creek, CA.
- Busmann, R.W., Sharon, D., Vandebroek, I., Jones, A., Revene, Z., 2007. Health for sale: the medicinal plant markets in Trujillo and Chiclayo, Northern Peru. *Journal of Ethnobiology and Ethnomedicine* 9, 1–9.
- Chen, S., Yu, H., Luo, H., Wu, Q., Li, C., Steinmetz, A., 2016. Conservation and sustainable use of medicinal plants: problems, progress, and prospects, *Chinese medicine*. *BioMed Central* 11, 37.
- Cousins, S.R., Williams, V.L., Witkowski, T.F., 2011. Quantifying the trade in cycads (*Encephalartos* species) in the traditional medicine markets of Johannesburg and Durban, South Africa. *Economic Botany* 65, 356–370.
- Cunningham, A.B., Mbenkum, F.T., 1993. Sustainability of harvesting *Prunus africana* bark in Cameroon. *People and Plants working paper* 2.
- FAO, 2010. The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture. FAO, Rome, Italy.
- FTEA, 1948–2012. In: Verdcourt, B., Turrill, W.B., Milne-Redhead, E., Polhill, R., Beentje, H. (Eds.), *Flora of Tropical East Africa*. Royal Botanic Gardens, Kew, UK.
- Ghimire, S.K., McKey, D., Aumeeruddy-Thomas, Y., 2005. Heterogeneity in ethnobotanical knowledge and management of medicinal plants in the Himalayas of Nepal: Implications for conservation. *Ecology and Society* 9, 6.
- Ghorbani, A., Langenberger, G., Feng, L., Sauerborn, J., 2011. Ethnobotanical study of medicinal plants utilised by Hani ethnicity in Naban River Watershed National Nature Reserve, Yunnan, China. *Journal of Ethnopharmacology* 134, 651–667.

- Groombridge, B., Jenkins, M.D., 2002. *World Atlas of Biodiversity: earth's Living Resources in the 21st Century*. University of California Press, CA, USA.
- Hamisy, W.C., Zilihona, I.E.J., Mwihome, S.T., Mwaseka, D., Documentation and Ethnobotanical Evaluation of Medicinal Plants of the Luguru tribe, Tanzania, Proceedings of the Second and National Workshop on Plant Genetic Resources and Biotechnology, 2002.
- Hedberg, I., Hedberg, O., Madati, P.J., Mshigeni, K.E., Mshiu, E.N., Samuelsson, G., 1982. Inventory of plants used in traditional medicine in Tanzania. I. Plants of the families Acanthaceae-Cucurbitaceae. *Journal of Ethnopharmacology* 6, 29–60.
- Heinrich, M., Ankli, A., Frei, B., Weimann, C., Sticher, O., 1998. Medicinal plants in Mexico: healers' consensus and cultural importance. *Social Science & Medicine* 47, 1859–1871.
- Jusu, A., Sanchez, A.C., 2014. Medicinal plant trade in Sierra Leone: threats and opportunities for conservation. *Economic Botany* 68, 16–29.
- Kahatano, D.E., 1997. Trade in wildlife medicinals in Tanzania. Report prepared for TRAFIC East/Southern Africa (Unpublished).
- Kuete, V., 2013. *Medicinal plant research in Africa: pharmacology and chemistry*. Newnes, Oxford, UK.
- Leaman, D.J., 2011. Newsletter of the Medicinal Plant Specialist Group of the IUCN Species Survival Commission.
- Lewington, A., 1993. A review of the importation of medicinal plants and plant extracts into Europe. TRAFFIC International, Cambridge, UK.
- Mahunnah, R.L.A., Uiso, F.C., Kayombo, E.J., 2012. Documentation of Traditional Medicine in Tanzania: A Traditional Medicine Resource Book. Dar es Salaam University Press, Dar es Salaam, Tanzania.
- Marinelli, J., 2005. *Plant: The Ultimate Visual Reference to Plants and Flowers of the World*. DK Publishing, New York, USA.
- Marshall, N., 1998. Searching for a cure: conservation of medicinal wildlife resources in East and Southern Africa. TRAFFIC International, Cambridge, UK.
- Mati, E., de Boer, H., 2010. Ethnobotany and Trade of Medicinal Plants in the Qaysari Market, Erbil, Kurdish Autonomous Region, Iraq. *Journal of Ethnopharmacology* 133, 490–510.
- McMillen, H., 2008. Conserving the roots of trade: local ecological knowledge of ethnomedicines from Tanga, Tanzania markets. PhD thesis. University of Hawaii, Manoa.
- McMillen, H., 2012. Ethnobotanical knowledge transmission and evolution: the case of medicinal markets in Tanga, Tanzania. *Economic Botany* 66, 121–131.
- Meke, G.S., Mumba, R.F.E., Bwanali, R.J., Williams, V.L., 2017. The trade and marketing of traditional medicines in southern and central Malawi. *International Journal of Sustainable Development & World Ecology* 24, 73–87.
- Myers, N., 1990. The biodiversity challenge: Expanded hot-spots analysis. *The Environmentalist* 10, 243–256 Kluwer Academic Publishers.
- Nahashon, M., 2013. Conservation of wild-harvested medicinal plant species in Tanzania. Chain and consequence of commercial trade on medicinal plant species. Geotryckeriet Uppsala University, Uppsala.
- Odugbemi, T.O., Akinsulire, O.R., Aibinu, I.E., Fabeku, P.O., 2007. Medicinal plants useful for malaria therapy in Okeigbo. Ondo State Southwest Nigeria, *African Journal of Traditional, Complementary and Alternative Medicines* 4, 191–198.
- Otieno, J., Abihudi, S., Veldman, S., Nahashon, M., van Andel, T.R., de Boer, H.J., 2015. Vernacular dominance in folk taxonomy: a case study of ethnospecies in medicinal plant trade in Tanzania. *Journal of Ethnobiology and Ethnomedicine* 11, 10.
- Rakotoarivelo, N.H., Rakotoarivony, F., Jeannoda, V.H., Kuhlman, A.R., Randrianasolo, A., Bussmann, R.W., 2015. Medicinal plants used to treat the most frequent diseases encountered in Ambalabe rural community, Eastern Madagascar. *Journal of ethnobiology and ethnomedicine* 11, 68.
- Randriamiharisoa, M.N., Kuhlman, A.R., Jeannoda, V., Rabarison, H., Rakotoarivelo, N., Randrianarivony, T., Rakotoarivony, F., Randrianasolo, A., Bussmann, R.W., 2015. Medicinal plants sold in the markets of Antananarivo, Madagascar. *Journal of Ethnobiology and Ethnomedicine* 11, 60.
- Roberson, E., 2008. A Native Plant Conservation Campaign Report. Center for Biological Diversity, Tucson, AZ, USA.
- Rossato, S.C., Leitao-Filho, H.F., Begossi, A., 1999. Ethnobotany of Caicas of the Atlantic Forest coast (Brazil). *Economic Botany* 53, 387–395.
- Ruffo, C.K., Birnie, A., Tengnäs, B., 2002. Edible Wild Plants of Tanzania. Regional Land Management Unit, RELMA/Sida, Nairobi, Kenya.
- Schippmann, U., Leaman, D., Cunningham, A.B., 2006. A comparison of cultivation and wild collection of medicinal and aromatic plants under sustainability aspects. Eds. In: Bogars, R.J., Craker, L.E., Lange, D. (Eds.), *Medicinal and Aromatic Plants*. Springer, Dordrecht, The Netherlands, pp. 75–95.
- Swai, R.E.A., 2003. Utilization and commercialization of medicinal tree products in Tanzania.
- Tardío, J., Pardo-de Santayana, M., 2008. Cultural importance indices: a comparative analysis based on the useful wild plants of Southern Cantabria (Northern Spain). *Economic Botany* 62, 24–39.
- Towns, A.M., Quiroz, D., Guinee, L., De Boer, H., Van Andel, T., 2014. Volume, value and floristic diversity of Gabons medicinal plant markets. *Journal of Ethnopharmacology* 155, 1184–1193.
- Trotter, R.T., Logan, M.H., 1986. In: Etkin, L.N. (Ed.), *Informant consensus: a new approach for identifying potentially effective medicinal plants*. Bedford Hill, New York: Redgrave Edited by.
- van Andel, T., Fundiko, M.C., 2016. The trade in African medicinal plants in Matonge-Ixelles, Brussels (Belgium). *Economic Botany* 70, 405–415.
- van Andel, T., Behari-Ramdas, J., Havinga, R.M., Groenendijk, S., 2007. The medicinal plant trade in Suriname. *Ethnobotany Research and Applications* 5, 351–372.
- Williams, V.L., 2003. Hawkers of health: an investigation of the Faraday street traditional medicine market in Johannesburg, Gauteng. *Plant Ecology and Conservation Series* 15.
- Yineger, H., Yewhalaw, D., Teketay, D., 2008. Ethnomedicinal plant knowledge and practice of the Oromo ethnic group in southwestern Ethiopia. *Journal of Ethnobiology and Ethnomedicine* 4, 11.