Short communication

Traditional knowledge, use and conservation of plants by the communities of Tharaka-Nithi County, Kenya

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ABSTRACT

Rural communities in Kenya largely depend on plant resources for their livelihood. The utilization of these resources depends on the availability of plant resources and the level of knowledge of the residents. We conducted an ethnobotanical study in Tharaka-Nithi County in Kenya to determine the knowledge and utilization of various plant species by the local communities. The study was conducted in four major administrative regions from June 2018 to February 2019, involving interview schedules using semi-structured open-ended questionnaires and guided field collections with 48 informants. A total of 214 plant species distributed in 73 families and 169 genera with 616 Use Reports (URs) were documented. Fabaceae was the highest family cited by the informants (31 species) followed by Lamiaceae and Euphorbiaceae (each with 11 species). Trees (49%) and shrubs (32%) were the top life forms of the plants frequently utilized by the local residents. The general plant uses reported were medicinal, food, fodder, construction, fuel, pesticidal, religious, live fencing, and making crafts. *Zanthoxylum gilletii*, *Prunus africana*, and *Solanum incanum* were found to be highly valued by the local communities. Plant utilization as food and medicinal uses against snake-bite related problems had the highest Informant Consensus Factor (ICF). Only 29 (13.6%) of the species reported had their status assessed by the International Union for Conservation of Nature (IUCN). Conservation measures, alongside awareness creation in this region, are highly recommended for the species endemic to the region, highly depended on by the community, and those threatened according to IUCN standards.

1. Introduction

Plants play a key role in providing essential services in an ecosystem (Jamshidi-Kia et al., 2018). Humanity has developed expertise for routine survival through human–plant interactions.

Such knowledge is transmitted from one generation to another and has yielded practical discoveries and development of different cultures (Senanayake, 2006). Cultural diversity, therefore, depends on biological diversity to provide material for humans to create lifestyles in their societies (Padulosi et al., 2002; Rahman et al., 2019). These include food, medicine, ornaments, religious purposes, rituals, recreation, protection, arts, literature, music and folklore traditions (Norton, 1981; Pei, 1991). Cultures also attempt to prevent over-exploitation of natural resources by regulating their use and protection (Sobrevila, 2008). Ethnobotany, thus, is about the dynamic relationships between humans and their environment (Cox and Balick, 1994), which is consistently developing

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due to the depletion or discovery of plant resources (Brokensha and Riley, 1986).

Both traditional and contemporary communities in Africa rely on plant resources (Bussmann et al., 2006; Lykke, 2000) as plants are useful determinants of culture and economic activities. In Kenya, there are estimated 6881 vascular plant species (Zhou et al., 2017), of which 800 are nutritive (Maundu, 1996). Most of these are fruits and traditional vegetables, which are widely utilized by the rural communities to improve food security, nutrition and health (Maundu et al., 1999). The utilization and value of these food plants varies from one place to another due to income, trade and land utilization (Muthoni and Nyamongo, 2010; Okeno et al., 2002). Previous studies have shown that households in Tharaka-Nithi County that report food insecurity, lack off-farm income and have fewer assets, rely greatly on wild edible plants (Shumsky et al., 2014).

Health care in rural communities in Kenya is highly dependent on plant resources due to cultural familiarity. Various ethno-medicinal studies have documented the medicinal plant species in Tharaka-Nithi region examined for their medicinal value (Adongo, 2013; Kaigongi and Musila, 2015; Muthaura et al., 2015). Aside from nutrition and medicine, plants also provide for other imme-diate needs to humans varying with the beliefs and customs of communities, a reflection on how nature and human culture converge at many levels that spans values (Ahlberg, 2017). Tharaka-Nithi County is a suitable community for investigation into the convergence of nature and human culture, viz. beliefs and norms, practices, livelihoods, knowledge and languages (Martin, 1995; Pretty et al., 2009). The county has different localities, vegetation and languages that are closely related. Furthermore, a decline in the practice and spread of traditional knowledge in the communities is evident, which can be attributed to civilization and formal educa-tion (Oduor et al., 2018). Additionally, drastic changes in health and infrastructure in this region have made social amenities more accessible to the communities (Gitonga and Muiruri, 2016).

This study, therefore, contributes to safeguarding the ethnobo-tanical knowledge of the community by documenting the general plant uses in the whole county in view of the threats posed by overexploitation, climate change and the inevitable loss of the older members of the community who are the main custodians of the indigenous knowledge. This study aims to help the community appreciate the value of plant resources in their surroundings and highlights the need to conserve and utilize these resources sustainably.

2. Materials and methods

2.1. Study area

Tharaka-Nithi County is phytogeographically located in the So-mali Masai regional center of endemism (White, 1983) and lies in the K4 floral region of Kenya (Zhou et al., 2017) on the North eastern side of Mt. Kenya, between 00°07'—S to 00°26'—S and 37°19'—E to 37°46'—E, occupying an area of 2639 km^2 (Fig. 1) (Oduor et al., 2018). The elevation ranges from 600 m to 5200 m above sea level and has a bimodal rainfall pattern and an annual precipitation ranging from 500 mm to 2200 mm. Average temperature ranges from 14 °C to 39 °C in the highlands and between 22 °C and 40 °C in the lowlands (Tharaka-Nithi County Integrated Development Plan, 2018).

The vegetation comprises deciduous montane forests, which are found at the higher elevations, while dry forest vegetation char-acterized by shrubs and trees dominates the low-lying areas (Lynch and Berry, 2007). The lowlands are hilly, stony, sandy and fairly forested with *Acacia-Combretum,* and *Acacia-Commiphora,* while

among the vegetation types of the lowest driest parts near the Tana river include *Commiphora-Sanseviera* vegetation (Wisner, 1977). The vegetation of the highlands consists of *Croton-Brachylaena, Calodendrum,* mixed *Podocarpus latifolius, Newtonia* and *Croton-Premna* forests (Gathaara and Leakey, 1999). The natural vegetation is majorly found in 44,617 ha of gazetted forests and 3344 ha of non-gazetted community forests within the county (Tharaka-Nithi County Integrated Development Plan, 2018).

Tharaka-Nithi County has a population of 393,117 people, of which 49% are male and 51% are female; most of the people live in rural areas (City Population Kenya, 2020). The residents of the county are Bantus from the Ameru ethnic group which comprises Tharaka, Mwimbi, Muthambi and Chuka subtribes (Kenya Information Guide, 2019). The main economic activities for these communities are agriculture and livestock farming (Tharaka-Nithi County Integrated Development Plan, 2018). Communities in the drier lands practice livestock farming while those in the fertile highlands cultivate crops such as tea, coffee, maize, beans, sor-ghum, green grams, pigeon peas, millet and bananas.

2.2. Ethnobotanical data collection

Permission for this study was granted by the ecosystem conservator of Tharaka-Nithi County Kenya Forest Service Office. A prior informed oral consent was first obtained from the informants through the administrative officials in the region. The field survey was conducted between June 2018 and February 2019 in various regions of Tharaka-Nithi County (Magutuni, Chogoria, Kiamuriuki, Kiang'ondu, Mitheru, Kijege, Kiagu, Kathangacini and Ntugi) rep-resenting the four major communities in the county. Residents close to the forests and hills were selected as the most suitable subjects for this study because most of the natural vegetation is found in protected areas whereas the community land is used for agriculture and livestock farming. In addition, according to Warren (1991), traditional indigenous knowledge is linked to a specific place, culture or society. This indigenous knowledge is dynamic and belongs to groups of people who live in close contact with natural systems. The informants were recommended by the community heads and the foresters in-charge based on their reputable knowledge in the utilization of indigenous plants in the region. The selection of the informants was done according to their popularity with the local residents and their interactions with those leaders. Some were traditional healers while others were members of the community that are well known to interact with the wild plants at various levels. The ethnobotanical data were collected through in-terviews using of semi-structured open-ended questionnaires, which focused on obtaining botanical data (plants used, parts used, and mode of use). Data collection did not focus on a particular use category of the plants cited and the respondents were given enough time to exhaust the information regarding the plants they could recall during the interview.

2.3. Plant identification and voucher specimen collection

The plant samples were collected using guided field walks by the informants. The plant species reported were indigenous, exotic, and those locally cultivated. The plants together with their uses were identified by the informants based on indigenous traditional knowledge acquired from family and community members, although in some instances, some of the informants had acquired general knowledge on plant uses from literature, workshops and interactions with other people such as researchers. Identification was done in the field by the team while plants which could not be identified were collected and identified following the local mono-graphs of Kenyan flora (Agnew, 2013; Beentje et al., 1994) and later
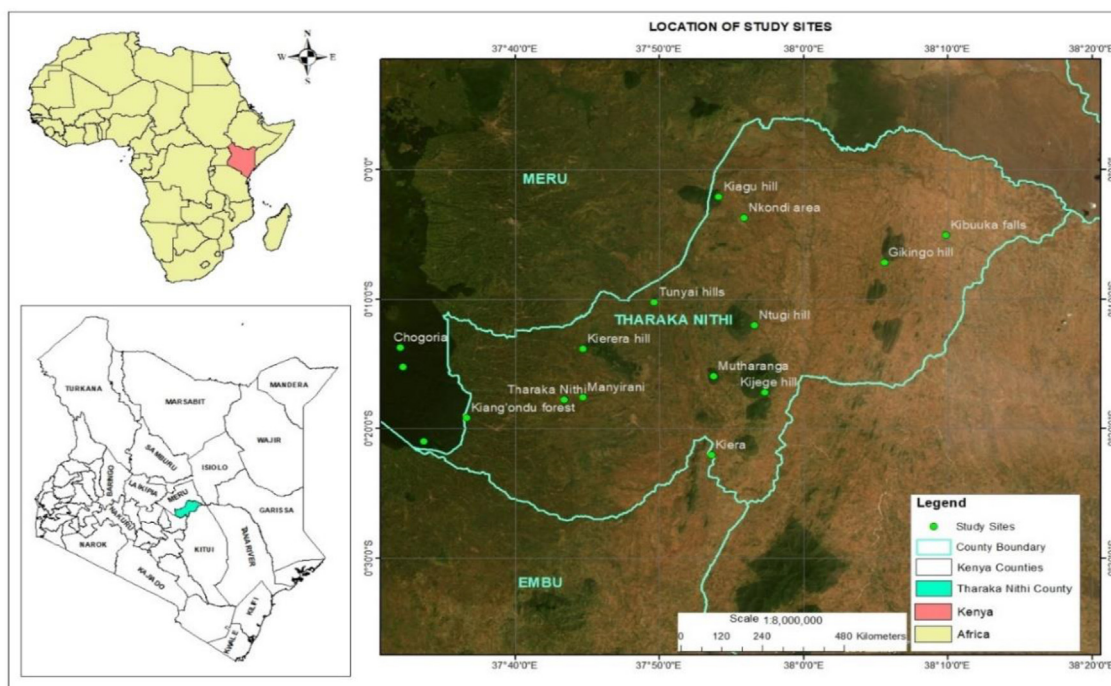
Fig. 1. Location and study sites of Tharaka-Nithi County, Kenya.

deposited at the East African herbarium (EA) in Kenya. The Plant List (http://www.theplantlist.org/) and The World Flora Online (http://www.worldfloraonline.org/) databases were used to resolve all the taxonomic synonymies. The conservation status of the collected species was checked from the IUCN database (https://www.iucnredlist.org/). All data were analyzed in Microsoft Excel (2016).

2.4. Statistical analysis

The level of homogeneity among information provided by different informants was determined as the Informant Consensus Factor (ICF) according to Trotter and Logan (1986), using the formula ICF = (Nur-Nt)/(Nur-1), where, Nur is the number of Use Reports (URs) from informants for a particular plant-use category and Nt is the number of taxa or species that are used for that plant use category by all informants.

The local importance of the plant species cited by the informants was determined based on the Relative Frequency of Citation (RFC) using the formula RFC = FC/N (0 < RFC < 1) (Tardío and Pardo-de-Santayana, 2008), where FC is the number of informants citing the use of a particular plant species, while N is the total number of informants participating in particular survey.

3. Results

3.1. Total flora

A total of 214 plant species distributed in 73 families and 169 genera were documented (Fig. 2). Of the total, 50 plant families were represented by one or two species while 23 families were represented by three species or more. Fabaceae was the best represented family with 31 species, followed by Euphorbiaceae and Lamiaceae (each with 11 species) (supplementary file: Table S1; plant species are accompanied by their respective RFC and UR values).

3.2. Conservation of useful plants in Tharaka County

In total, 194 plant species were native to the study area while 20 species were found to be exotic in Kenya. Informants reported three endemic species: *Euphorbia friesiorum* (Hassl.) S.Carter, which is endemic to the K4 region, and *Uvariodendron anisatum* Verdc. and *Vitex keniensis* Turrill, which are endemic to Kenya in general. Of the total plant species, IUCN conservation status has been assessed for only 29 species (13.6%) (Table 1); 19 plant species were of Least Concern (LC), three were Data Deficient (DD), four were Vulnerable (VU) (*E. friesiorum*, *Jacaranda mimosifolia* D.Don, *Prunus africana* (Hook.f.) Kalkman, and *U. anisatum* Verdc.), one was Near Threatened (NT) (*Milicia excelsa* (Welw.) C.C.Berg), and two species (*Vitex kiniensis* Turrill and *Coffea arabica* L.) were found to be Endangered (EN). *Coffee arabica* is, however, under cultivation in this area, whereas *J. mimosifolia* is an exotic species.

3.3. Plant growth habits

Trees (49%) and shrubs (32%) were the most frequently collected plants (Fig. 3).

3.4. Plant parts

Informants reported that whole plants are collected in addition to roots, leaves, bark, fruits, seeds, stems, branches, and buds. The most common method of collecting plants is root harvesting (36%), followed by leaf (34%) and fruit harvesting (17%) (Fig. 4).

3.5. Plant uses

Residents of Tharaka-Nithi County utilize plant species for traditional medicine against human and livestock ailments, for nutrition, fodder, as pesticides, construction, fuel, fiber, crafts making, religious purposes, bee hives, and as live fences or boundaries (Fig. 5). These were captured in 616 URs. The ICF
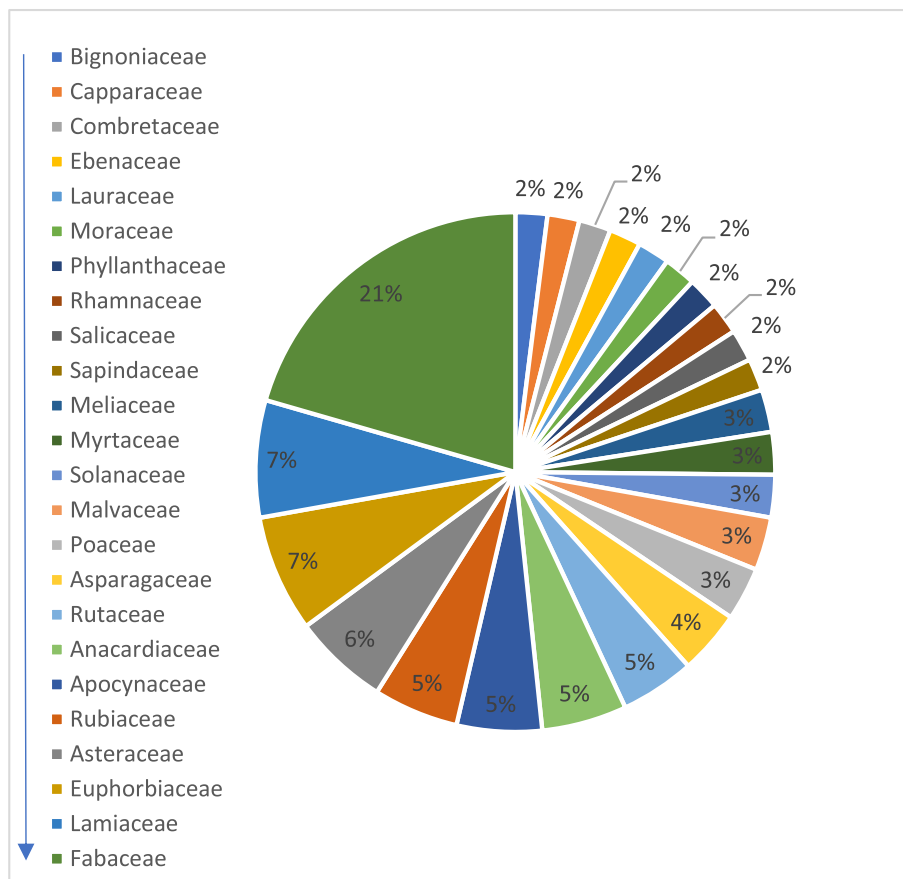
Fig. 2. Major families recorded in Tharaka-Nithi County (arrow indicates an increase in the number of species per family).

Table 1
Endemism and the conservation status of the plant species collected in Tharaka-Nithi County.

| Local name	Family	Species name	Endemism	IUCN category
Mukuria mp(b)ungu	Meliaceae	*Ekebergia capensis*	NA	LC
Muemba	Leguminosae	*Acacia nilotica*	NA	LC
Kibirincha/kithunju/kithurunju	Xanthorrhoeaceae	*Aloe secundiflora*	NA	LC
Mwarobaini	Meliaceae	*Azadirachta indica*	NA	LC
Mikwegwe/mukwego	Phyllanthaceae	*Bridelia micrantha*	NA	LC
Majani	Theaceae	*Camellia sinensis*	NA	DD
Mubabai/paw paw	Caricaceae	*Carica papaya*	NA	DD
Miraa	Celastraceae	*Catha edulis*	NA	LC
Muuga/kaua	Rubiaceae	*Coffea arabica*	NA	EN
Mwarange	Leguminosae	*Delonix elata*	NA	LC
Muthuri/kiatha	Euphorbiaceae	*Euphorbia bicompacta*	NA	LC
Mithuri	Euphorbiaceae	*Euphorbia friesiorum*	K4 region	VU
Kiriria	Euphorbiaceae	*Euphorbia tirucalli*	NA	LC
Kirara	Arecaceae	*Hyphaene compressa*	NA	LC
Jacaranda	Bignoniaceae	*Jacaranda mimosifolia*	NA	VU
Murigi/muthigu/muthigo	Bignoniaceae	*Kigelia africana*	NA	LC
Muembe	Anarcardiaceae	*Mangifera indica*	NA	DD
Mururi	Moraceae	*Milicia excelsa*	NA	NT
Kirii	Santalaceae	*Osyris lanceolata*	NA	LC
Mbukandu/makondofia	Lauraceae	*Persea americana*	NA	LC
Gakindu	Arecaceae	*Phoenix reclinata*	NA	LC
Mubiribiri	Podocarpaceae	*Podocarpus latifolius*	NA	LC
Muiria	Rosaceae	*Prunus africana*	NA	VU
Guava/mapera/mubera	Myrtaceae	*Psidium guajava*	NA	LC
Mukukumanga	Lythraceae	*Punica granatum*	NA	LC
Muriru	Myrtaceae	*Syzygium cordatum*	NA	LC
Muthithi	Leguminosae	*Tamarindus indica*	NA	LC
Muringa	Lamiaceae	*Vitex keniensis*	Kenya	EN
Mutonga/ntonga	Annonaceae	*Uvariodendron anisatum*	Kenya	VU
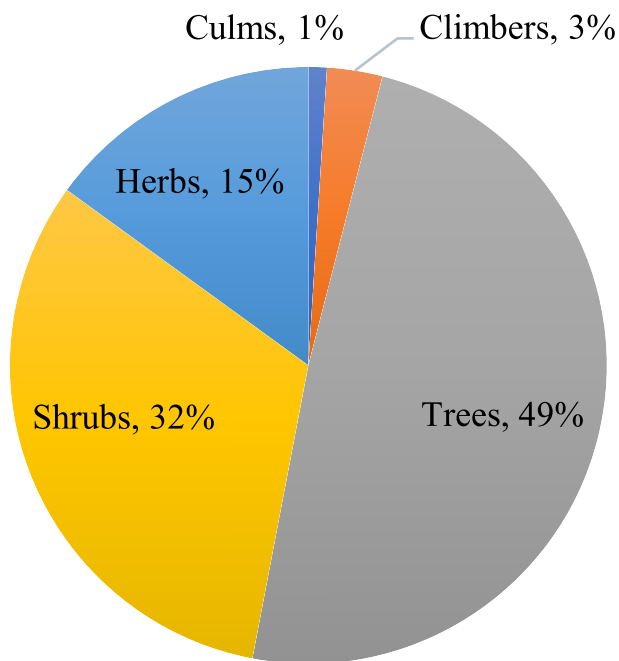
Fig. 3. Growth habits of plant species documented.

(Table 2), RFC and UR analysis revealed the common and the most valuable species to this community. The RFC values were highest for *Zanthoxylum gilletti* (De Wild.) P.G.Waterman (0.29), *P. africana* (0.27) and *Solanum incanum* L. (0.22). *Aloe secundiflora* Engl., *Carissa spinarum* L., *S. incanum* and *Ocotea usambarensis* had the highest URs in the region. *S. incanum* and *A. secundiflora* utilization were ranked highest in this study.

Among the most important plant species based on the RFC values (Table 3) were *Zanthoxylum gilletii*, *Ludia mauritiana* J.F. Gmel., and *C. spinarum,* which were reported to be used in management of malaria. *Rauvolfia mannii* Stapf, *Ludia mauritania, Zanthoxylum gilleti* and *O. usambarensis* Engl. were reported to be applied against cough. *Sclerocarya birrea* (A.Rich.) Hochst. and *Adansonia digitata* L. were reported for backache and gastrointestinal conditions. This

similarity in the utilization of medicinal plants is a potential opportunity for the local communities to diversify their medicinal plant selection pool.

3.5.1. Provision of building materials and fuel

In Tharaka-Nithi County, tree species are exploited from the forests and neighboring hills for house construction, furniture, fiber and fuel through charcoal burning and firewood. The use of tree species such as *Ocotea usambarensis* for building material is common in communities around Mt. Kenya forest. Eleven other tree species were recorded as sources of timber, while seven species were used as fodder. However, all the species recorded can be used for fuel when dry.

3.5.2. Cultural uses

Plants are rarely used in rituals and sacred ceremonies today as these traditions have been greatly influenced by civilization. Only five species (*Abrus precatorious* L., *Ricinus communis* L., *S. incanum, P. latifolius* (Thunb.) R.Br. ex Mirb. and *Senna didymobotrya* (Fresen.) H.S.Irwin & Barneby were cited in this category. They were made known to the younger generations through folklore songs and narratives. *Abrus precatorius* is especially sacred among the Tharaka people during male circumcision. However, most of the informants were not willing to divulge details as it is culturally prohibited to discuss such matters with women and people from other communities.

3.5.3. Pesticidal uses

Few plant species were reported as pesticides. Most plants reported as pesticides are used as whole plants and include small herbs or shrubs that are mostly planted as hedge plants and live fences.

3.5.4. Use as wild foods

Plant utilization for nutritional purposes had the highest ICF (0.78). In total, 38 traditional food plants were recorded. Nine taxa are frequently utilized for food: *Harungana madagacariensis* Lam. ex Poir., *Balanites aegyptica* (L.) Delile, *Citrus sinensis* (L.) Obseck (cultivated species), *Dioscorea cayennensis* subsp. *rotundata* (Poir.) J.Miège, *Ipomoea batatas* (L.) Lam., *Meyna tetraphylla* (Schweinf. ex
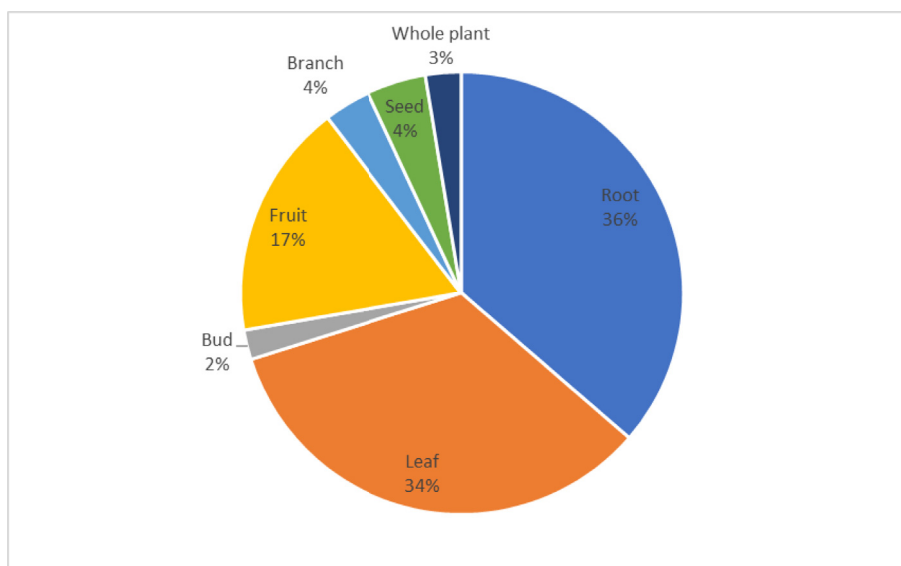

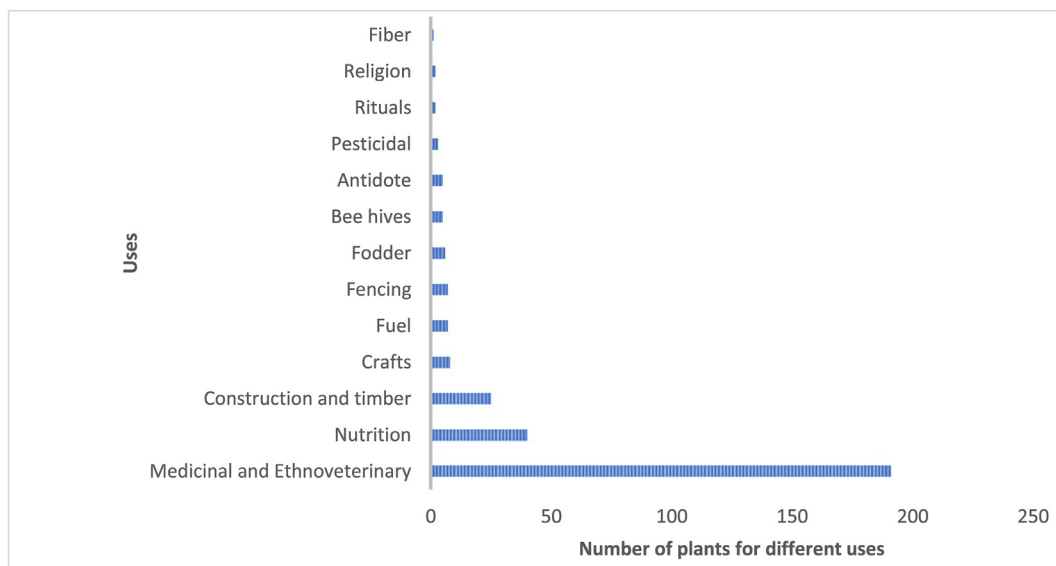**Fig. 4.** Proportion of different plant parts used.

Fig. 5. Number of plant species per use category in Tharaka-Nithi County.

Table 2
Informant Consensus Factor (ICF) of the taxa and use categories in Tharaka-Nithi County.

Use Category	Number of Taxa (Nt)	Number of Use Reports (Nur)	ICF
Snake-related remedy	5	17	0.75
Cancer	2	4	0.67
Gastro-intestinal disorders	50	64	0.22
Cold and cough	75	139	0.46
Malaria and fever	45	106	0.58
Ethnoveterinary	38	68	0.45
Skin-related diseases	6	7	0.16
Cuts and wounds	17	25	0.08
Diarrhea	15	15	0
Anthelmintic	38	45	0.159
All diseases	12	12	0
Antidote	5	5	0
High blood pressure	4	4	0
Edema	5	5	0
Dental health	13	19	0.33
Immunity boosters	9	9	0
Backache pain relief	23	29	0.21
Food	9	38	0.78
Construction	3	25	0.64

Table 3
Frequently cited plant species from the study regions.

Region	Species	RFC	Use
Kiang'ondu	Rauvolfia mannii	1	Treats cough and toothache
Kiamuriuki	Ludia mauritiana	1	Treats malaria
Kiamuriuki	Zanthoxylum gilletii	1	Treats malaria and cold
Mitheru	Zanthoxylum gilletii	0.8	Treats cold, cough, malaria, and prostate cancer
Mitheru	Prunus africana	0.8	Treats cold, cough, malaria, and prostate cancer
Chogoria	Ocotea usambarensis	0.6	Treats cold
Kiagu	Tamarindus indica	0.75	Trade and edible
Kiagu	Berchemia bicolor	0.75	Edible
Magutuni	Carissa spinarum	0.89	Edible, treats malaria and aids digestion
Kathangacini	Adansonia digitata	0.67	Edible, treats backache, stomachache and anthelmintic
Ntugi	Sclerocarya birrea	0.75	Treats backache, cough and STI's
Kijege	Sclerocarya birrea	0.8	Treats cough

Hiern) Robyns, *Rubus pinnatus* Willd., *Syzygium guineense* (Willd.) DC. and *Ziziphus mucronata* Willd.

3.5.5. Medicinal uses

The majority (86%) of plant species recorded in this study were medicinal. Snake-related remedies had the second highest ICF (0.75). Two species (*S. incanum* and *Entada leptostachya* Harms) were frequently reported as remedies for managing snake-bite related cases, with each plant species cited six times by the informants. Other plant species reported to be used against snake-bites were *Maerua endlichii* Gilg & Bened., *R. communis* L. and *Erythrina melanacantha* Harms. Cough, cold, gastro-intestinal

disorders and malaria were the common human ailments managed using most of the medicinal plant species. The common ethno-veterinary diseases managed using 68 plant species recorded include anthrax, constipation, bloating in cattle, East Coast Fever, anthelmintic, diarrhea, tonsillitis and eye problems.

Herbal medicinal formulations were mostly prepared as infusions, decoctions or concoctions which were administered orally. The drugs were prepared through boiling, chewing, pounding, heating and roasting. Other herbal preparations were reported to be applied to the respective organs directly as in the cases of edema, skin infections, wounds, cuts and snake-bites. Most of the species are not used independently hence these formulations could be a mixture of different species. Most of the informants lacked government certification to practice herbalism on the larger population, though they were well known by the community members since they administered treatment to family members and friends.

4. Discussion

Fabaceae, Euphorbiaceae, and Lamiaceae families comprised most of the species reported by the informants. In a recent study elsewhere in Kenya (Mutie et al., 2020a), Fabaceae, Euphorbiaceae and Lamiaceae were reported to comprise most of the plants used for traditional medicine. Fabaceae has also been reported in Tharaka-Nithi as the most collected plant family for use in traditional medicine (Kaigongi and Musila, 2015). Fabaceae comprises most of the plant species utilized as sources of wild foods by some communities in Kenya (Mutie et al., 2020b). It is also the largest plant family in the flora of Kenya (Zhou et al., 2017). African legumes are tolerant to drought and are therefore important resources for people living in arid and semi-arid areas (Duodu and Apea-Bah, 2017).

Shrubs and trees comprise most of the plants used for traditional medicine in various parts of Kenya (Kipkore et al., 2014; Mutie et al., 2020a). The populations in the highlands were more exposed to conventional medicine compared to those in the lowlands, hence, the plant forms common in drier ecosystems comprised most of the species reported (Muthaura et al., 2015). It is also in the dry regions where food from wild plants is important to the local communities since drylands are more vulnerable to drought (Johns and Kokwaro, 1991). In Kenya, diversity of wild edible plants in arid areas such as savanna is reported to be richer than in other forests zones (Ichikawa, 1980). Since in the dry regions the vegetation has been conserved to a greater extent in some regions of Kenya (Johns and Kokwaro, 1991), communities inhabiting such regions are likely to rely on wild plant resources to meet human needs such as food, medicine among others.

Root harvesting was found to be the common method of collecting the plants in Tharaka-Nithi. Previous studies (Malonza et al., 2006; Mutie et al 2020a) have reported root and bark harvesting as the most common and popular methods of collecting medicinal plants elsewhere in Kenya. In Tharaka-Nithi, root harvesting is also a common practice of collecting medicinal plants (Kaigongi and Musila, 2015). This practice increases the level of vulnerability of plant species hence impacting their long-term survival in the wild (Kisangau and Herrmann, 2007). Among the over-exploited plant species in the highlands of Kenya is O. usambarensis, whose logging has already been banned in Mount Kenya forest (Bussmann, 1996; Kleinschroth et al., 2013). Use of this species in construction and furniture, traditional medicine, and craft making makes it a priority species for conservation.

The cultural value of plant resources has declined significantly in the recent years. Little is left conserved in shrines and protected areas in the region and only a few people can recognize the sacred trees. The cultural species are mostly known by the older

generations and men who have undergone traditional circumcision. However, food plants were found to be popular during the study. Fruits, leaves and roots have been reported to comprise most of the plant parts eaten from wild plants (Mutie et al., 2020b). Foods from wild plants are important sources of macronutrients and minerals, and serve as buffers against periodic famines (Johns and Kokwaro, 1991; Stadlmayr et al., 2013), through diversification of diets and improving food security (FAO,1988). In Tharaka-Nithi, wild food plants are regarded as important sources of supplementary nutrition (Shumsky et al., 2014).

It is evident from this study that, ethnomedicine is an important part of the culture of Tharaka people. The most valuable plant species in the region such as Z. gilletti, P. africana and S. incanum are also important medicinal species in other regions of Kenya and elsewhere in the world (Abebe et al., 2014; Al-Fatimi et al., 2007; Beaman and Muhammed, 1976; Henderson, 2002; Mwonjoria et al., 2014). The efficacy of some of the species such as S. incanum and A. secundiflora which were reported to be used in management of most of the common ailments has been affirmed by previous studies (Mariita et al., 2011; Mwonjoria et al., 2014; Yim et al., 2011). Medicinal use against snake-bites related problems was frequently reported. A previous study elsewhere in Kenya revealed the plight of local communities in arid areas in regard to snake-bites and envenomation (Ochola et al., 2018). E. leptostachya, which was reported for management of snake-bites, has also been reported elsewhere in Kenya (Mutie et al., 2020a; Owuor and Kisangau, 2006). Snake-bites are considered a matter of emergency by the local communities, hence antidotes are administered within half an hour (Owuor and Kisangau, 2006), perhaps before the onset of envenomation manifestations. Traditional medicine in Kenya is also common against infectious diseases and gastrointestinal disorders (Githinji and Kokwaro, 1993; Mutie et al., 2020a). According to Lindsay and Hepper (1978), herbal medicines are prepared in various forms which include infusions, decoctions, ashes and instillations; administered as fomentations, inhalations, plasters, enemas, embrocation, baths and fumigations. Other plant formulations are combined before administration, a practice reported elsewhere in Kenya to be applied by herbalists against ailments which are difficult to manage using a single plant species (Mutie et al., 2020a).

5. Conclusion and recommendations

This study significantly contributes to the value, diversity and popular knowledge of useful plant species in Tharaka-Nithi County, whose role as sources of basic needs in the community cannot be disregarded. The common use of medicinal plant species in Tharaka-Nithi is an indication of the global value of natural resources with medicinal properties. We recommend that conservationists raise public awareness and engage the communities in Tharaka-Nithi County in the conservation of plant resources. The results from this study should be disseminated to the community in simple and understandable material. Further studies in this area should investigate plant diversity of the region and outline conservation measures.

Author contributions

Vivian Kathambi, Guang-Wan Hu and Qing-Feng Wang designed the project; Vivian Kathambi, Fredrick Munyao Mutie, Peninah Cheptoo Rono, Neng Wei, Jacinta Ndunge Munyao and Guang-Wan Hu performed the field investigation; Vivian Kathambi and Fredrick Munyao Mutie analyzed the data; Vivian Kathambi, Fredrick Munyao Mutie, Peris Kamau and Robert Wahiti Gituru

wrote the paper; all authors read, reviewed and approved the final manuscript.

Declaration of interest

The authors declare that they have no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pld.2020.12.004.

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