The Use of Medicinal Plants and Its Implication on Plants Conservation: The Case of West Usambara, Tanzania

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Abstract

In recent decades, medicinal plants have been overused. The failure of some modern medicines, an increase in degenerative diseases and the trading of medicinal plants are among the factors that have triggered such over-utilization. This study was carried out in West Usambara Mountains, in Tanzania, to investigate the effects of medicinal plant harvesting on plants conservation. We collected ethnobotanical data from 160 respondents. Interviews and field observation were the main data collection methods. SPSS Version 25 was used to analyse the collected data to understand the knowledge on the parts of medicinal plant used, the preparation of medicines from plants, amount harvested, and the effects of harvested herbs on plants conservation. Information obtained from key informants was analysed through thematic analysis. The study revealed that some medicinal plant species such as *Omphalogonus calophyllus* and *Aloe spp.* were being unsustainably harvested. Furthermore, the change from cultural ways of using medicinal plants to commercial purposes was found to be threatening plant species in the area. The study concludes that West Usambara is a rich region of diverse medicinal plants and traditional healthcare knowledge. However, the change from the culture of using medicinal plants for domestic use only to commercial use is threatening the existence of medicinal plants. Hence, it signals the need for serious efforts to be made to create public awareness; initiate and establish laws so that appropriate measures are taken to conserve medicinal plants in the fragile natural ecosystem of the West Usambara Mountains.

Keywords: *medicinal plants, human diseases, plant species, conservation*

1. Introduction

Medicinal plants used for medical care have a long history (Bekele et al., 2022; Rasool et al., 2020). This makes it difficult to point out the actual date of their commencement (Borokini & Lawal, 2014; Erichsen-Brown, 2013). Undoubtedly, the use of medicinal plants began once human beings started to exist, and ever since they have continued to be used in many communities, particularly in developing countries (Hosseinzadeh et al., 2015; Van Wyk &

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Prinsloo, 2018). For thousands of years, human beings have used medicinal plants found in their surroundings employing a variety of methods based on culture, phytogeography, and climate (Singh & Bharadvaja, 2021; Bottoni et al., 2020). Traditionally, the knowledge of using plants to treat human beings, however, was restricted to a few specialized herbal therapists and the elderly in rural communities. Thus, the transfer rate of the herbal knowledge from generation to generation, and nation to nation was not fast; hence the use and preparation of plants for medical purposes was mainly based on local interests (Aziz et al., 2018, Saraiva et al., 2015; Tribess et al., 2015).

It is estimated that about 80% of rural communities in southern countries use and depend on medicinal plants for their basic healthcare (Hosseinzadeh et al., 2015; Jarić et al., 2015; Jamshidi-Kia et al., 2018). For instance, Ayeni et al. (2021) reported that various plant species -- such as *Zanthoxylum zanthoxyloïdes* L, *Allium sativum* L*, Datura innoxia* Mill., *Tamarindus indica* L. and *Ocimum canum* L. – are used to treat human ailments in West Africa. Bekele et al. (2022) reported a total of 145 plant species used to treat human ailments in Ethiopia. Such reported species include *Solanum incanum, Phytolacca dodecandra, Securidaca longepedunculata, and Stephania abyssinica*. In Tanzania, among the species that have been reported to be used for the treatment of human ailment include *Zanthoxylum chalybeum, Ocotea usambarensis, Azadirachta indica, Chassalia pavifolia, Artocarpus heterophyllus, Myrica salicifolia, Bersama abyssinica, Sureganda zanzibariensis, Maesa lanceolata, Albizia versicolor, Hoslundia opposite, Trichoscypha ulugurensis, Albizia harveyi, Ocotea usambarensis, Mangifera indica, Annona senegalensis* and *Vernonia hymenolepis* (Nondo et al., 2015; Moshi et al., 2010; Amri & Kisangau, 2012; Mbinile et al., 2020b; Tembo et al., 2021).

The use of traditional complementary medicine (TCM), particularly from plants, has increased steadily following the failure of some modern medications (Chebii et al., 2020). However, the reliance on TCM is threatening the loss of the biodiversity of plant species, including medicinal trees, following unsustainable harvesting of tree parts (Papageorgiou et al., 2020; Tsioutsiou et al., 2019). In Tanzania, as in many other developing countries, medicinal plants are commonly used to treat various human diseases such as gastrointestinal disorders, malaria, stomach-aches, wounds, muscular pain, diarrhoea, spiritual problems, psychiatric problems, and other human diseases in both rural and urban communities (Bansal et al., 2017). Frequently, parts of medicinal plants -- such as roots, barks, and leaves -- have been reported to be utilized (Oguntibeju, 2018). The government, therefore, has been supporting the use of medicinal plants in healthcare services by passing the Traditional and Alternative Healthcare Practice Act of 2002, since plants can play a significant role as an alternative to modern medication (Traditional and Alternative Medicine Act, 2002).

The Usambara Mountains, located in the Tanga region, Tanzania, form one of the biodiversity hotspots where several medicinal plants are found (McMillen, 2012; Otieno et al., 2015). As a part of the Eastern Arc biodiversity hotspot area, the area has various medicinal plants, with people collecting and using different medicinal plants found in the area for the treatment of human diseases (McMillen, 2012). The high demand for medicinal plants in West Usambara Mountains can be associated with an obvious situation in many African countries: an imbalanced ratio between the number of rural dwellers and that of modern medical doctors is a common phenomenon (McMillen, 2012; Otieno et al., 2015). Sen and Chakraborty (2016) argued that the growing demand for medicinal plants as an alternative to modern treatments is largely due to the limited capacity of governments in developing countries to provide primary healthcare to an expanding population, which has resulted in a rapid increase in the use of medicinal plants (Otieno et al., 2015; Mpanda et al., 2014). Mbonile et al. (2020a) and Amri and Kisangau (2012) say that medicinal plants support over 60% of the rural population in Tanzania.

Furthermore, the emergence of new difficult-to-cure diseases such as malaria, strokes, diabetes, typhoid, cancer, and heart diseases continue to exert pressure on the use of medicinal plants (Rasool et al., 2020). Also, people in rural areas prefer to use medicinal plants due to the high cost of modern treatment, including transportation to-and-from healthcare centres; while some believe that herbal medicine is more effective for certain diseases (Nugraha et al., 2020; Gunjan et al., 2015; Sam, 2019, Mintah et al., 2019). On the other hand, the increasing demand for medicinal plants has been met by an indiscriminate harvesting of wild flora, including those found in forests. As a result, many plant species have become extinct, and some are critically endangered (Chebii et al., 2020; Sharma & Thokchom, 2014). As per Di Minin et al. (2019) and Sharma and Kala (2022), many medicinal plant species, or their populations, are threatened by unsustainable intensities of use and patterns of harvesting.

The collection of medicinal plants is unsustainable since it is not guided by laws of conservation in many communities (Sharma & Kala, 2022). Collection practices include uprooting, debarking, or cutting fresh leaves from the plants (Tesfahuneygn & Gebreegziabher, 2019; Asmare et al., 2018). Besides, there have been increasing frequencies of collection throughout the year, regardless of the climatic seasons. Consequently, such utilization practices have contributed to the decline and loss of some medicinal plant species (Van Wyk & Prinsloo, 2018; Ho et al., 2015; Sharma & Kala, 2022).

According to Groner et al. (2022) and Liu et al. (2019), about 15,000 species of medicinal plants are globally threatened, commercial overharvesting being one

of the causes. The evaluation of priority plant species in East/Southern Africa by the Wildlife Trade Monitoring Network (TRAFFIC) identified nine medicinal plant species in Tanzania most in need of conservation, management, and research due to their endangered status caused by over-exploitation. These include *Dioscorea dumetorum*, *Cadaba farinosa*, *Milicia excelsa, Acalypha fructicosa, Harrisonia abyssinica, Steganotaenia araliacea, Acacia mellifera, Ehretia amoena,* and *Wedelia mossambicensis* (McMillen, 2012). Similarly, some medicinal plants in West Usambara are currently threatened due to overcollection (McMillen, 2012).

However, despite the increase in demand for medicinal plants, there is limited information on its impact on plant species conservation that can prevent their over-exploitation, and consequently, extinction. The aim of the study, therefore, is to assess the use of medicinal plants in West Usambara, its effect on the sustainability of these plant species, and its implication on the conservation of these plant species. This study is worthwhile as it provides important conservation information for policy makers and conservationists to use in the conservation of plant species found in the area.

1.1 Theoretical Framework

This paper draws from Hardin's (1968) theory known as the 'tragedy of the unregulated commons' or 'tragedy of the commons', which he conceptualized to understand the problems of managing common-pool resources. Hardin (1968) draws attention to the problems of human population growth and the use of the earth's finite natural resources: that free access and unrestricted demand for finite resources ultimately reduce the resources through over-exploitation, temporarily or permanently. However, as shown in this paper, the over-exploitation of natural resources (in this case, medicinal plants) is not only caused by population growth, but also by their utilization for commercial purposes.

Ostrom (2002) argued that 'the tragedy of the common' always occurs to highly valued open-access natural resources, where those involved do not establish effective governance to control their use. According to Ostrom (ibid.), effective governance is important as it regulates one or more of the following: those who are allowed to appropriate resources; timing, quantity, location, and technology of appropriation; and monitoring and enforcement of appropriation activities. In this context, medicinal plants are free natural resources, i.e., unrestricted and unregulated natural resources (commons), which are free for everyone to access. In our case, some people collect medicinal plants for business purposes, and use improper ways to harvest them to maximize benefits, thereby threatening the survival of some of the species. This is a scenario whereby the benefits of the exploitation accrue to an individual or a group, but the effects (of the extinction

of some species) are shared by the entire community: 'the tragedy of the commons'. If care is not taken to monitor and control the harvesting of this natural resource, there will be an over-exploitation that can result in the loss of important medicinal plants, and thus biodiversity. As suggested by Ostrom (2002), there is a need for effective governance to regulate appropriation to avoid the tragedy of the commons from unsustainable utilization of medicinal plants.

2. Materials and Methods

2.1 Study Area

This study was conducted in West Usambara, specifically in Lushoto and Korogwe districts in Tanga region, in three villages: Magundi, Irente, and Maringo. The areas were selected purposely based on their records on the use of medicinal plants (Msuya & Kideghesho, 2009). The study area is a part of the Eastern Arc formed by mountain ranges. The West Usambara Mountains are located in north-eastern Tanzania (4° 24'–5° 00' S and 38° 10'–38° 36' E) (Figure 1), and cover an area of 4,500 km².
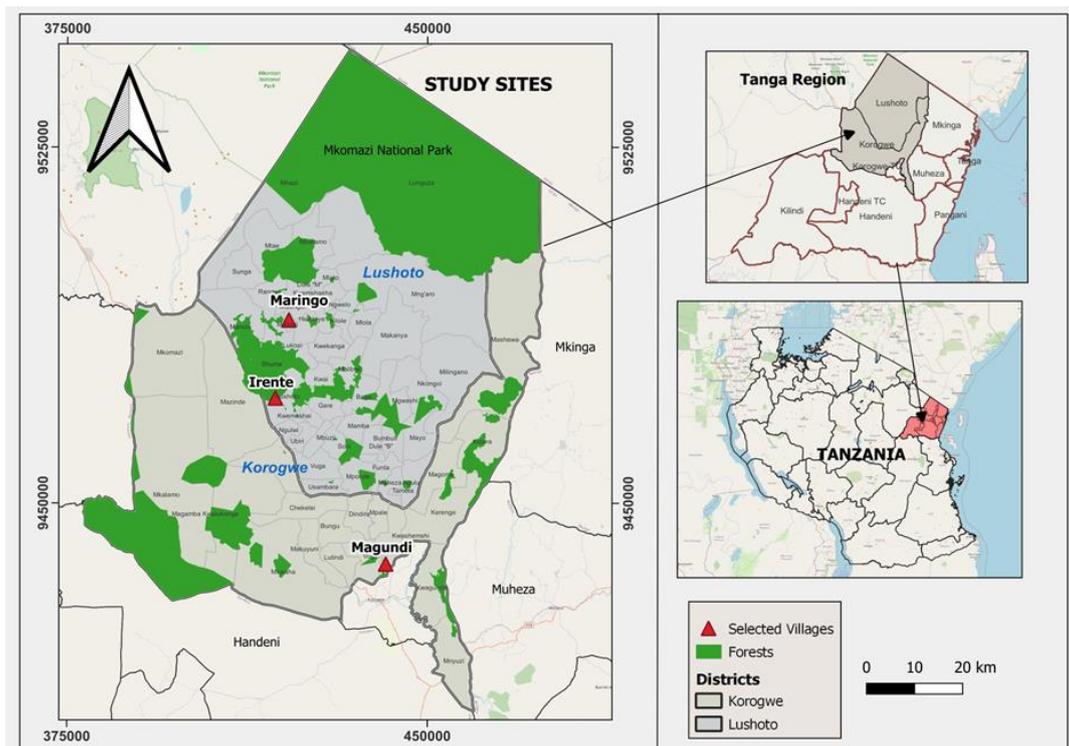
Figure 1: Location of the Study area in West Usambara Tanga Region, Tanzania
Source: GIS Lab, UDOM, 2020

The West Usambara Mountains were chosen since the area is rich in plant species with medicinal values (McMillen, 2012), and the mountains are one of the 25 globally important biodiversity hotspots (Green et al., 2013); and also one of the top ecoregions of biodiversity importance in Africa (McMillen, 2012).

Tanzania's human population census of 2012 shows that West Usambara had 419,970 residents, with an annual growth rate of 1.8%. The indigenous tribe is Sambaa, whose livelihood depends mainly on subsistence farming. The zone is a mountainous area in the northeast highlands of Tanzania, which is a part of the chain of the Eastern Arc Mountains. Its altitude is over 500m above sea level, and it is jaggedly upward almost from the bottom of the whole escarpment. West Usambara consists of three types of natural forests: lowland, intermediate, and highland evergreen forests. The mountains consist of various species of vascular plants and endemics. The area receives two rain seasons: long rains, which start from March to May; and short rains, which fall between November and December (Halperin & Shear, 2005). The annual rainfall ranges between 600mm and 1,200mm annually. The temperatures in the area range between 13°C and 27°C. Similarly, extreme temperature ranges between 7°C during cold seasons, and 30°C during hot seasons (Halperin & Shear, 2005).

2.2 Ethnobotanical Data Collection

Ethnobotanical data was collected using semi-structured interviews, key informant interviews, and participant observation. Data were gathered from knowledgeable local herbal practitioners and key informants via semi-structured questionnaires and interview guides, respectively. Different types of information were gathered, such as medicinal plant species, collection, preparation, uses, and their effects on plants conservation. Interviews were conducted in Kiswahili. In cases where the local language was used (which was rare), literate local people assisted in translating what was said in the local language into Kiswahili language; which was eventually translated into English by a professional translator. A total of 160 individual respondents (150 local herbal practitioners, and 10 key informants) were involved in the study. The snowball technique (Galvis-Tarazona et al., 2022; Chow et al., 2021; Bautista-González et al., 2022) was used to contact 150 knowledgeable elders who were local herbal practitioners: 65 from Maringo, 50 from Irente, and 35 from Magundi. The sample size was determined by the level of saturation of the collected data (Parker et al., 2019). The local herbal practitioners were interviewed by using semi-structured questionnaires. At the beginning of the interview, local administrators (village chairpersons) were consulted to list the respondents. Also, an interview guide was used with key informants who were purposely involved. The key informants included the taxonomist, natural resource officer, and the rural cultural officer from the study are.

2.3 Plants Identification

The identification of medicinal plants was done in two phases. The first phase involved a preliminary identification of the collected specimens in the field for each encountered plant. In the second phase, the collected specimens were dried, deep-frozen, and taken to the Lushoto Herbarium for identification. The identification was made by using published volumes of the flora and comparing them with authentic herbarium specimens. Plant identification was conducted in the field with the help of a botanist from the Tanzania Forest Research Institute (TAFORI). Furthermore, online image databases such as the USDA Plants Database and CalPhotos (Baskauf, 2008) were used during identification. The plant specimens were identified and authenticated by the taxonomist from the Lushoto Herbarium, where voucher specimens were deposited.

Local administrators, villagers, herbal practitioners, natural resources officers, and a taxonomist were purposefully chosen as the key informants with knowledge of medicinal plants to identify the ten (10) most popular medicinal plant species. Then, a preference ranking was used to examine people's opinions on the likely threatened medicinal plant species due to unsustainable harvesting. Those plants listed as the most preferable for treatment were selected for comparison. Each selected informant was asked to compare the given species of medicinal plants based on the degree of threatened medicinal plants in the area. Each of the informants was given fresh specimens of the medicinal plants that were most reported as threatened species by most of the key informants. Thereafter, the selected informants were asked to rank them.

2.4 Data Analysis
2.4.1 Ethnobotanical Data Analysis

Descriptive statistics, such as proportions and frequencies, were used to analyse ethnobotanical data. All identified medicinal plants were grouped into their respective taxa (families). The associated knowledge and relative importance of each reported plant in the community was determined, summarized, and presented in tables. SPSS Version 25 was used to analyse respondents' information to understand the proportion of the reported knowledge on medicinal plant parts used and what they treat, the preparation of medicines from plants, location of medicinal plants and the effects of the collection of medicinal plants on plants conservation. The informants' consensus was used to investigate the most preferred medicinal plant/s to treat different human diseases. The ten (10) most preferred medicinal plants identified were grouped into their botanic groups and presented in Table 1 with their associated uses. Regarding data from preference ranking, each respondent was requested to rank the plant species given by comparing the levels of threats among the given species. The informants were instructed to provide scores (1–5) for each species, where 1 represented a low level of threats,

and 5 indicated a high level of threats. Thereafter the numbers were summed up for all respondents, giving an overall ranking for the objects by the selected groups of the respondents. The total rank of a paired comparison was obtained by summing the number of times each item was chosen. The item with the highest frequency of choices had the highest score. Responses from all selected informants were added to make general statements about the items.

Information such as the collection of medicinal plants and its effects on plants conservation obtained from key informants was analysed through thematic analysis (Terry et al., 2017). The technique is important as it involves a systematic identification and organization; and offers insights into patterns across themes such as medicinal plants and their uses, place of collection, preparation, and effects of medicinal plant harvesting on conservation.

3. Results
3.1 Medicinal Plants and Their Uses in the Study Area
One hundred and fifty (150) local herbal practitioners were involved in this study, of whom 52% were older than 50 years, and 48% were aged between 38 and 50 years. In the case of ethnobotanical data, we documented remarkable traditional medicinal plant knowledge and practice from the study area. Various plant species were identified as having medicinal values to treat different human diseases. During discussions with key informants, 10 medicinal plant species (Table 1) were identified as the most preferred ones because they were used to treat multiple human diseases effectively.

Table 1: Most Preferred Medicinal Plants in West Usambara

Species	Family Name	Parts Used	Uses
Plectranthus barbatu Andr	Labiatae	Leaves	Malaria, stomach-ache, coughing
Omphalogonus calophyllus Baill	Asclepiadaceae	Roots	Colic in babies, loss of libido
Artemisia afra Jacq. ex Willd	Compositae	Leaves	Malaria, Bile
Myrica salicifolia Hochst ex. A. Rich	Myricaceae	Barks, Roots	Pain/inflammation, Gastrointestinal disorders (hernia), pyomysitis
Bidens pilosa L	Compositae	Leaves	Cut, wound, scars, peptic ulcer, haemoglobin women's problems
Aloe spp L	Aloaceae	Leaves, Latex	Inflammation, warms, tropical spleeno megally syndrome, skin rushes
Tetradenia riparia (Hochst) L.E. Codd	Euphorbiaceae	Leaves	Malaria, bile
Rumex abyssinicus Jacq.	Polygonaceae	Leaves	Gastrointestinal disorders
Solanecio angulatus (Vahl) C.Jeffrey	Asteraceae	Leaves	Peptic ulcer diseases, diarrhoea, vomiting
Ocimum suave Wild	Labiatae	Leaves	Malaria, Bile, colic in babies

Source: Field survey, 2019

3.2 Reported Human Diseases

Various human diseases were reported to be treated by medicinal plants. The diseases have been categorized into 15 groups for simple presentation (Table 2). The most frequently mentioned diseases were gastrointestinal disorders (116), childhood-related diseases (112), as well as malaria and other fevers (101). Meanwhile, men's libido problems (33), urinary tract diseases (27) and diabetes (17) were the least reported diseases. The findings of this paper do not differ much from Amri and Kisangau (2012), who found that the highest percentage of medicinal plant species (15%) was used to treat stomach-aches, followed by diarrhoea (13%) in Morogoro. Both stomach-aches and diarrhoea have been classified as gastrointestinal disorders in this study.

Table 2: Reported Human Diseases Treated Using Herbal Medicine in West Usambara

Human Diseases	Frequency	Percentage
Gastrointestinal disorders	116	12.44
Children diseases	112	12.00
Malaria and other fevers	101	10.80
Pain/fatigue	103	11.00
Female dysfunctional bleeding	79	8.47
Skin diseases	72	7.72
Diarrhoea	61	6.54
Toothache	54	5.80
Respiratory diseases	67	7.18
Men's libido	33	3.54
Blood diseases	43	4.61
Urinary tract diseases	27	2.90
Diabetes	17	1.82
Others (34)	47	5.04
Total	**932**	**100.00**

Source: Field Survey, 2019

3.3 Medicinal Plants Parts Used and Methods of Preparation

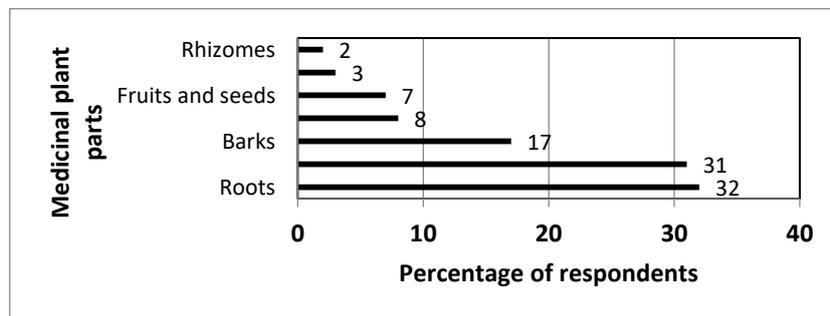The most frequently utilized medicinal plant parts were roots (32%), followed by leaves (31%) (Figure 2).

Figure 2: Harvested Parts of Medicinal Plants
Source: Field data, 2020

The findings of this study correspond to Chebii et al. (2020) who also found that most of the herbal practitioners in Kenya collect roots and leaves. These parts contain therapeutic properties and pharmacological mechanisms that explain their potential for the treatment of various human diseases (Thorn et al., 2020).

Furthermore, it was found that herbal medicines were being prepared in different forms; with decoction being the most common form (48%). Others forms included smoke (12%), vapour (8%), eating raw (12%), and powdering (20%) (Figure 3). Also, it was noted that most of the medicinal plants were prepared in a liquid form.
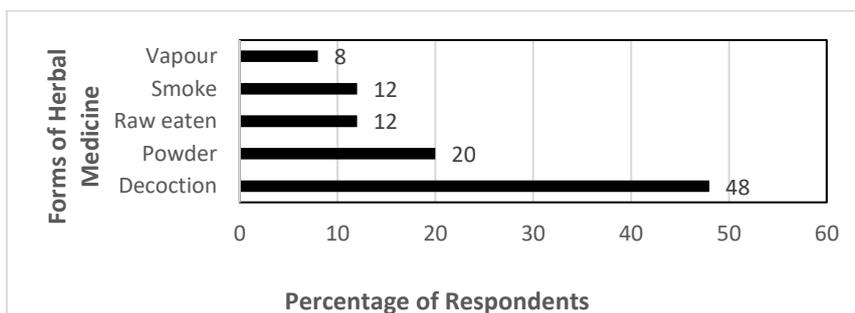

Figure 3: Prepared Forms of Herbal Medicines
Source: Field data, 2020

3.4 Collection of Medicinal Plants and Its Effects on Plants Conservation
The study revealed that the majority (71.33%) of the informants collected medicinal plants from the forest, 20% collected them from cultivated land (farms), and only 8.67% collected them from home gardens (Figure 4). An interview with a botanist in Lushoto revealed that many local practitioners have no habit of having a garden of medicinal plants; hence, the main sources of herbs are natural forests. The interviewee added that there is only one garden of medicinal plants in the entire West Usambara region, which is owned by the Muhimbili University of Health and Allied Sciences (MUHAS). The heavy dependence on natural forests for medicinal plant has been causing a reduction or loss of some species.
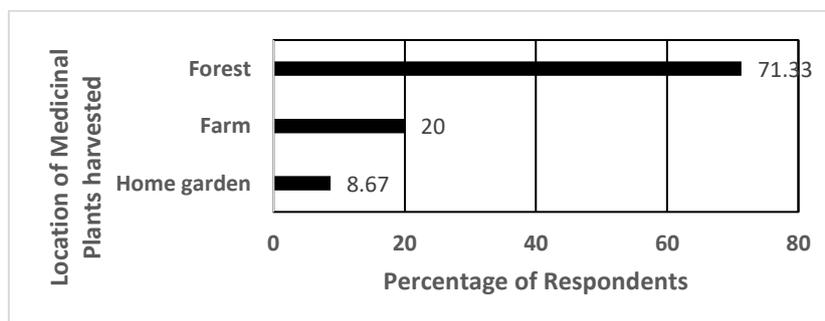

Figure 4: Locations of Medicinal Plant Harvests
Source: Field data, 2020

It was noted that most herbal practitioners believed that effective medicinal plants were those that were located interior in the forest. Furthermore, it was revealed that the respondents preferred to collect medicinal plants in far forests to those near their home places since they believe that plants from far away from home are free from pollution as they are not frequently in contact with human beings. During the assessment of the effects of the utilization of medicinal plants on plant population, the informants had different perceptions. As the findings reveal, the majority (32%) reported that medicinal plant collection had only a slight effect on the conservation of plant population. A considerable number (30%) believed that it did not have any effect. Only 17% reported that medicinal plant collection highly affected the conservation of plant population (Figure 5).
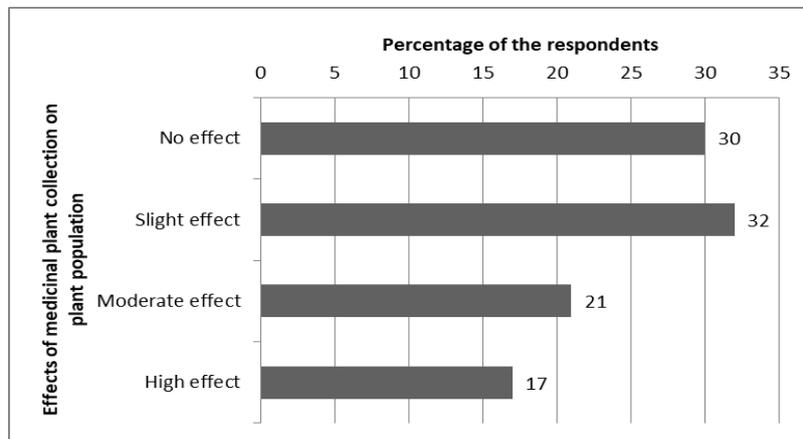

Figure 5: Respondents' Perceptions on the Effects of Medicinal Plant Collection on Plant Population Conservation
Source: Field data, 2020

These findings indicate that many herbal practitioners believe that the collection of herbal medicine has no effect on plant conservation. During an interview with one of the key informants, he narrated that many people believe that medicinal plants will never vanish: they have been there since vegetation started, and will continue to exist forever. Such findings indicate the low awareness of many people about the effects of unsustainable utilization of herbal plants.

Although the majority of the informants reported that medicinal plant collection was having little effect on the plant population, some of the herbalists showed concern about the current unprecedented collection of medicinal plants. These respondents claimed that the collection of medicinal plants was not sustainable; hence, it was affecting plant diversity.

During an interview with the district forest officers and natural resources managers from the study area, it was revealed that there was an increase in the utilisation of herbs not only by the elderly, but also by emerging young herbal practitioners. This was having an effect on the medicinal plant population since some plant species were being over-harvested without being aware of the unintended consequences, which could result not only in the loss of flora biodiversity, but also in the extinction of vital natural resources for future generations.

The findings from semi-structured interviews show that the majority (66%) of herbal practitioners reported that some medicinal plants have decreased due to over-utilization. These findings correspond to those of Chen et al. (2016), who reported that Tanzania is one among the countries where there is a substantial decline in medicinal plants.

Furthermore, about 34% of the respondents reported that unsustainable harvest of medicinal plants has caused a stunted growth of some medicinal plant species. The main reasons listed as the causes of such stunted growth include: over-collection of roots (42%), overcutting of green leaves (36%), and debarking (22%). In an interview with the natural resource manager of Lushoto district, he informed that the collection of medicinal plant roots has been a problem for the conservation of medical plant as some herbal practitioners uproot entire plants to collect large quantities of roots. The findings were corroborated during field observation: one of the herbal practitioners was found uprooting wild herbal plants by using a hand hoe at Maringo village (Photo 1).

Photo 1: Herbal Practitioner Uprooting Herbal Plant
Source: Field data, 2020

The findings from preference ranking in this study show that the abundance of some medicinal plant species in West Usambara, such as *Artemisia afra Aloe spp.* and *Omphalogonus calophyllus,* were reported to be decreasing. The uprooting of the herbs, increased frequency of collection, and large quantities of herbs collected were found to be contributing to the decrease of medicinal plant species in the study area. It was noted that the inherited practice of collecting medicinal plants freely throughout the year might also contribute to this negative effect on plant conservation. Many herbal practitioners reported that they neither had a specified season for collection, nor a specified amount (quantity) of medicinal plants to be harvested: they harvested medicinal plants whenever they needed to, and of whatever amount they wanted.

Although this habit is inherent in many communities, in the past medicinal plants were also frequently collected but only in small amounts: just enough to cover household needs. However, the district natural resources officers revealed that the collection of herbs is currently not only for domestic use but also for commercial purposes. During this study we observed herbs being sold at Lushoto town (Photo 2). It is also possible that this commercialisation of medicinal plants for healthcare purposes has also invited the involvement of many young herbalists who are driven by income generation due to an increased demand for medicinal plants. The findings of this study are supported by McMillen (2012) who found young Sambaa men from rural Lushoto engaging in collecting and selling medicinal plants in Tanga town markets. Similarly, McMillen (2012) found that, in Mlalo village, Lushoto, co-wives and their children harvest medicinal plants for sale to enable them buy school uniforms and seeds to plant in their farms.

Photo 2: Herbs on Sale at Lushoto Town
Source: Field data, 2020

3.5 Threatened Medicinal Plants Species Caused by Unsustainable Utilization

Results of preference ranking was made to examine the most likely threatened medicinal plants among the ten (10) agreed species that were mostly being over-harvested. Omphalogonus *calophyllus* Baill, *Artemisia afra* Jacq. ex Willd and *Aloe spp* L. were the most three over-utilized medicinal plant species (Table 3).

Table 3: Threatened Medicinal Plant Species in West Usambara Mountains

Species	Scores Given by Respondents (R1-R10)										Total score	Rank	Respondents' perception on the level of threats
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10			
Omphalogonus calophyllus	4	5	3	4	5	5	5	3	5	2	41	1st	Very threatened
Artemisia afra	5	3	4	2	4	4	3	5	3	5	38	2nd	Threatened
Aloe spp	1	4	5	3	2	3	4	4	2	3	31	3rd	Threatened
Tetradenia riparia (Hochst) L.E. Codd	2	3	3	3	3	4	3	4	1	2	28	4th	Slightly threatened
Myrica salicifolia Hochst ex. A. Rich	2	1	3	4	3	3	2	2	2	3	25	5th	No threat
Bidens pilosa L	2	2	3	2	1	2	4	2	3	2	23	6th	No threat
Rumex abyssinicus Jacq.	1	1	2	2	3	2	3	3	3	1	21	7th	No threat
Plectranthus barbatu Andr	1	1	2	2	1	2	3	2	2	3	19	8th	No threat
Solanecio angulatus (Vahl) C.Jeffrey	1	2	1	3	2	1	2	2	2	2	18	9th	No threat
Ocimum suave Wild	1	1	2	1	2	1	2	2	1	2	15	10th	No threat

Source: Field data, 2020

The fact that some species like *Omphalogonus calophyllus* Baill*, Artemisia afra* Jacq. ex Willd, and *Aloe spp. L.* are deemed as being at risk of being threatened may implies that the species are highly exploited compared to other plant species. Thus, they need special attention. An increasing demand for medicinal plants that stimulate men's libido is likely to have contributed to the overuse of *Omphalogonus calophyllus*. With regard to this, one of the herbal practitioners revealed that there has been an increased reproductive problem among men. However, some plant species, particularly *Omphalogonus calophyllus,* have been locally found effective in solving that problem. *Omphalogonus calophyllus* is uprooted and its roots are used by men to increase or stimulate virility. The species is transported and sold even outside of the region. McMillen (2012) reported that engagement with a market economy can degrade medicinal plants in Lushoto, Tanga as there is an increase in medicinal plant harvesters who sell to vendors in town.

4. Discussion

Various plant species were identified as having medicinal value to treat different human diseases. It was revealed that other medicinal plants are preferred by the

community due to their potential to treat different human diseases. In line with this, it was reported that the abundance of some of the medicinal plant species such as *Omphalogonus calophyllus*, *Aloe ssp.* and *Artemisia afra* had already been reduced due to over-utilization by the community. These plant species are at risk of over-exploitation since the majority of practitioners collect plant species from the forest and extract medicinal properties from the roots of plants by uprooting them, thereby affecting species biodiversity (Chen et al., 2016). The practice of exploiting plant parts, such as roots, however, relatively slows the growth of woody species, which can result in a decline in both the size and distribution of populations of the exploited species, and ultimately may result in their local extinction. Some plant species are most commonly collected in the forest, and there was no initiative identified to conserve or to domesticate such plant species. This finding complies with Marsh et al., (2021), Marsh et al., (2022) and Burgess et al. (2019) who reported a threat to biodiversity due to over-exploitation of medicinal plants. Most herbal practitioners believe that effective medicinal plants are those that are interior, as the nearby plants are mostly disturbed. Practitioners also believe that medicinal plants found in the wild are mature enough and free from pollution; thus, they interfere with domesticated medicinal plants.

However, there was no regulation identified to guide the harvesting of medicinal plants for commercial purposes in the West Usambara Mountains since there was over collection of herbs for business purposes. Despite the overuse of medicinal plant species, the majority of respondents reported a minor impact on plant species biodiversity. This reveals that the community in West Usambara is not aware of the effects of over-collection of herbs on plant conservation and, due to that, there is a need for conservation education for plants with medicinal value. However, some of the herbalists showed their concern about the unprecedented medicinal plant collection and unsustainable ways of collection, hence the need for conservation education (Chebii et al., 2020; McMillen, 2012).

For the case of absence of regulations guiding the utilization of medicinal plant species in West Usambara, such finding is contrary to other scholars who reported that the collection of medicinal plants was an exclusively scheduled activity for the majority of herbalists as it was mostly taking place based on weather conditions and level of maturity (Papageorgiou et al., 2020). The lack of regulation led to overharvesting frequently in large quantities in all seasons of the year, thus compromising the biological conservation of plant species (Rasool et al., 2020). This was also reported by other scholars who revealed the decrease of various medicinal plants was a result of unsustainable utilization (Papageorgiou et al., 2020) and thus the need for conservation awareness.

5. Conclusion and Recommendations

The community in the West Usambara Mountains uses various medicinal plants to treat various diseases. The most utilized medicinal plant parts are mainly

roots and, in some cases leaves, bark, and the whole plants. Uprooting plants was found as a problem that could lead to overexploitation of various medicinal plants. These plants are mostly harvested from the forest, and no conservation efforts have been identified. It was noted that the community was not aware of the effects of unsustainable collection of medicinal plants on conservation of medicinal plants, though there was an increase in demand for medicinal plants. The study revealed that herbalists harvest herbs not only to treat the surrounding community but also for other commercial purposes, such as selling the medicinal plants in the town. This situation attracts youth to be involved in the commercialization of medicinal plants through selling in various parts of Tanzania, and that leads to overexploitation of various plant species. In this scenario, the study proposes the establishment of bylaws and regulations that govern the exploitation of medicinal plants for commercial purposes to enhance the sustainability of medicinal plant species. Also, conservation education to be provided to the surrounding community on sustainable ways of utilization of medicinal plants is important to protect those species from overexploitation.

Competing Interests
The authors declare that they have no competing interests.

Authors' Contributions
MKS carried out field studies. MKS and KHP analysed data and prepared manuscript. MKS edited the manuscript, further analysed the data, and finalised the article. Both authors approved the final version of this manuscript.

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