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Research Article

Ethnobotanical Survey of Medicinal Plants used by Tachoni People of Luhyia Community at Maturu Village in Lugari Sub-County, Western Kenya

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ABSTRACT
For millennia, the Tachoni people of Lugari sub-county in western Kenya have conserved a rich, collective and accumulative ethnomedicinal knowledge of plants, worth documenting and evaluating for successful application in the primary healthcare system. It was envisaged that the documentation and evaluation would provide a basis for further research on the efficacy of medicinal plants. Non-alienating, dialogic, participatory action research (PAR) and participatory rural appraisal (PRA) approaches were utilised, involving 57 women and men aged 18-80 years from the Tachoni community. Results indicated 93 useful medicinal plant species, of which 89 were identified and distributed across 43 families, along with the parts used to manage a wide range of illnesses affecting humans. Only 4 species could not be traced and located for field collection and scientific identification in the herbarium. Many ethnopractitioners preferred barks, followed by leaves, roots, flowers, fruits, and seeds, in that order, as their sources of ethnomedicines from forests, woodlots, arable farms, bushes, and, finally, woodlands.
These field observations confirmed that the Tachoni people have a well-maintained, wealthy ethnomedicinal knowledge of plants worth documenting. This, however, provides the basic background against which new and useful ethnopharmacological agents can be discovered through in-depth classical scientific studies that should explain the safety, quality, and efficacy of the herbal products used to manage human illnesses in communities

Keywords:
Ethnoknowledge; Ethnomedicines; Ethnopharmacology; Ethnopractitioners; Ethnicity

INTRODUCTION

The idea of people using plants, plant parts, and products as medicines (also called ethnobotany) is very ancient in human history (McMillen, 2012). Ethnomedicines have coevolved alongside humanity's evolutionary history (Gagwani & Cheprasov, 2023; Wanzala & Minyoso, 2024). Much of what is known about ethnomedicines is purely ethnobotany, with plants and plant parts and products such as barks, leaves, roots, stems, buds, flowers, fruits, seeds, saps and gums being used based on the perceived ethnopharmacology and preference by individuals and ethnic background (Bakhru, 1990; Chelashaw et al., 2007; Wanzala et al., 2012). The growing interest in herbs is consistent with the belief that plants have a vast potential for use to support the livelihoods of all kinds as food, medicines, sources of cultural artefacts, sites of shrines for worship, energy, timber, etc., ever since human history (Arum, 1989; Henrietta Marrie, 2019). Plants and plant parts and products are of medicinal and cultural value with potential to manage a wide range of ill-health conditions affecting humans, animals, plants and general ecosystems in different environments due to the varied chemical compositions (alkaloids, glycosides, essential oils and other organic substances) existing *de novo* in uniquely arranged ratios to achieve the required synergism effect (Heinrich, 2010). For instance, *Digitalis purpurea* L. (Scrophulariaceae) contains cardiac glycosides such as digitoxin and digoxin. While plants such as *Ocimum* spp. (Lamiaceae), *Artemisia* spp. (Asteraceae) and *Aloe* spp. (Aloeceae) have been exploited extensively to produce a wide range of commercial products currently on the market, with most modern drugs having their origins in ethnomedicines (Heinrich, 2010; Hines & Eckman, 1993; Maitai, 1996; Wanzala et al., 2005). Although most medicinal plants have little or no harmful effects, it is important to be cautious about their uses, for most of them have no safety, quality and efficacy levels that are scientifically validated to satisfy human curiosity (Chelashaw et al., 2007; Kasilo et al., 2019; M. & Wanzala, 2012). Nevertheless, some medicinal plants and their associated parts can be poisonous when consumed or when in contact with the skin (Wanzala & Wanjala, 2016). In other cases, harvested and prepared herbal products from medicinal plants become toxically contaminated during processing and, as a result, pose unknown threats to innocent consumers (Keter et al., 2016; Safitri, 2025).

Different local and indigenous communities and specialists of ethnomedicine within these communities use different plant species and their associated parts and products as medicines in different ways and for different purposes (Kokwaro, 1993). Today, the use of plants, plant parts, and products as medicines is widespread across all generations of the human race (Abdullahi, 2011). For instance, World Health Organization (WHO) estimates that as many as 70-95 % of the world’s people especially in developing countries rely on ethnomedicines for their primary healthcare needs, while in Kenya, about 70% of the population rely on ethnomedicines as the primary source of healthcare, with up to 90% using medicinal plants and animals as part of any treatment process and henceforth its recommendation for integration into primary healthcare (WHO/UNICEF, 1978).

The high rates of inflation and poverty have led to inaccessibility to conventional healthcare services and exacerbated the high demand for ethnomedicines. This gave western-based multibillion-dollar companies the opportunity to exploit people’s ethnoknowledge to develop ethnopharmaceutical agents from wild plant populations and plant products (Atanasov et al., 2021). This has adversely affected local plant species diversity, as these events consistently pave the way for the extinction of valuable medicinal plants (Ivens, 1989). Some of the locally claimed plant species in the study area are disappearing and becoming extinct due to overexploitation, according to communications from the community’s ethnopractitioners, including Musoima (Syzygium cordatum), Kumuvinuvinu (*Senna didymobotrya*), and Kumusesi (*Spartium junctum*). These are some of the signals for awareness of the taxonomy and diversity of the plant community in the ecosystem (Wanzala, 2009).

Information on the quantities and qualities of plant materials, whether harvested or sold for local trade or use in the preparation of ethnomedicines, has indeed remained sporadic for a long time (Cunningham, 1995). In Kenya, records of the quantities of herbs harvested by local herbalists are not available, nor are datasets on high-demand species (Cavanaugh, 2000; Gachathi, 1989; Kokwaro, 1993). The current research presents data on plant and plant parts utilised in the village of Maturu in Lugari sub-county (Figure 1) in western Kenya with a view to providing some groundwork for future in-depth research work to help understand the underlying rationale of use and explain the safety, quality and efficacy levels of the herbal products being used to manage ill-health conditions of humans in the local communities.

METHODS

Before the start of this project, official permission was sought from the Government of Kenya (GOK) through Lugari District Office, where authorisation was sought to use ethnopractitioners and elders in the village of Maturu (Figure 1) in western Kenya to identify and access ethnomedicinal plant species for documentation and henceforth preservation for future use. Prior informed consent was also sought from individual key respondents through the local administration in the offices of Chiefs and sub-Chiefs following approval from Lugari District Office.

The study area and the Tachoni people

The study was conducted in Maturu village, Lugari sub-county, Kakamega County, western Kenya (Figure 1). Lugari Sub-County is one of the 12 sub-counties that form Kakamega County, located in western Kenya, close to Lake Victoria, within the Lake Basin Region. As per the geographic coordinate system (GCS), Lugari sub-County is located between longitudes 34 ∘ 51′ 36′′ E and 35 ∘ 10′ 51′′ E and between latitudes 0 ∘ 35′ 46′′ N and 0 ∘ 54′ 45′′ N of the equator with an area of 367 km2 and a population of 215,920 (with an urban population of 8, 485)that comprises about 10 tribes, which are primarily mixed farmers specializing in both commercial and subsistence farming of livestock and arable in nature. On average, the population density ranges from 203 to 460 persons per km^2, with an average of about 322 persons per km^2.

Tachoni is a sub-tribe that comprises 2.17% of the Luhya population. The Luhya tribe belongs to the larger Bantu group, which settled in the fertile agricultural region of western Kenya. Among these Luhya sub-tribes, the Bukusu (Babukusu) (30.14%) and the Maragoli (Avalogooli) (23.70%) have the largest populations. Other sub-tribes are the Wanga (Abawanga), Marama (Abamarama), Khayo (Abakhayo), Kabras (Abakabras), Banyore (Abanyole), Tiriki (Abatiriki), Banyala (Abanyala), also called Abanyala ba Ndombi, Marachi (Abamarachi), Tachoni (Abatachoni), Isukha (Abisukha), Idakho (Abidakho), Samia (Abasamia), Masaaba (Abasonga), Gisu (Abagisu), Kisa (Abashisa) and Batsotso (Abatsotso).

The Tachoni people speak *Lutachoni* and occupy the Lugari, Likuyani, and Malava sub-counties of Kakamega County, as well as Trans-Nzoia and Bungoma Counties (Figure 1) in western Kenya. The diverse Tachoni clans include: - Abachikha-Abakobolo, Abachambai, Abakabini, Abacharia, Abamuhonngo, Abakamutebi, Abamarakalu, Abasang'alo, Abangachi, Abasioya, Abaabiya, Abatecho, Abaengele, Abaabichwa, Abamarakalu, Abamakhanga, Abamakhuli, Abalugulu, Abakubwayi, Abakuusi, Abakamlevi, Abachewa, Abameywa, Abamurundi, Abamua, Abachimuluk, Abachivino, Abanyang'ali, Abarefu, Abasamba, Abasamo, Abaluu, Abayumbu, Abawande, Abaabichu, Abasonge/Abasonje, Abasaniaka, Abamweya and Abamalicha (Lihraw, 2010). The Saniaga clan, found among the Maragoli people in Kenya and the Saniak in Tanzania, is said to have originally been Tachoni too (Lihraw, 2010). Other clans thought to have been Tachoni are the Bangachi, found among the Bagisu; the Balugulu, found in Uganda; and the Bailifuma, found among the Banyala in Kenya. This is indeed an implication of the widespread presence of the Tachoni community across the entire East African region; hence, its rich ethnomedicinal plant knowledge arises from multifaceted ethnic interactions at different levels. Lugari sub-County was initially occupied by the Tachoni people and just a few other Luhya sub-ethnic groups. However, the demographic patterns of Tachoni people have been changed by large immigration of other Luhya sub-ethnic groups, such as the Maragoli from Vihiga County and new ethnic groups, such as the Kikuyu tribe from the Central and Rift Valley regions of Kenya, the Kalenjin tribe from the Rift Valley region, the Gusii tribe from the Kisii region and the Luo tribe from the Nyanza region in Kenya. This indicates that the Tachoni people are a socially and culturally welcoming ethnic grouping, whose indigenous knowledge may therefore have been influenced by incoming groups to become what it is today.

The study area had altitudes ranging from 1221 m to 4292 m above sea level from the south, which is plain-like to the eastward, which is hilly and rocky, respectively, with temperatures varying from 6 ∘ C to 23 ∘ C in the high-altitude areas and from 18 ∘ C to 24 ∘ C in low altitude areas (Chisika et al., 2020). The study area has long rains from March to August, short rains from October to November, and an average annual rainfall of 1000-1600 mm.

Lugari sub-county has a rich biodiversity, with 3 state-managed forest plantation blocks (Nzoia, Turbo, and Lugari), mainly comprising *Pinus patula*, *Cupressus lusitanica*, *Eucalyptus* spp., and Wattle trees (Chisika et al., 2020). Vegetation patches occur mainly along river valleys, with a wide range of plant species distributed across diverse disturbed and undisturbed ecosystems. These diverse vegetation sources are the main source of ethnopharmacological agents used by the Tachoni people of Lugari sub-County throughout the generations.

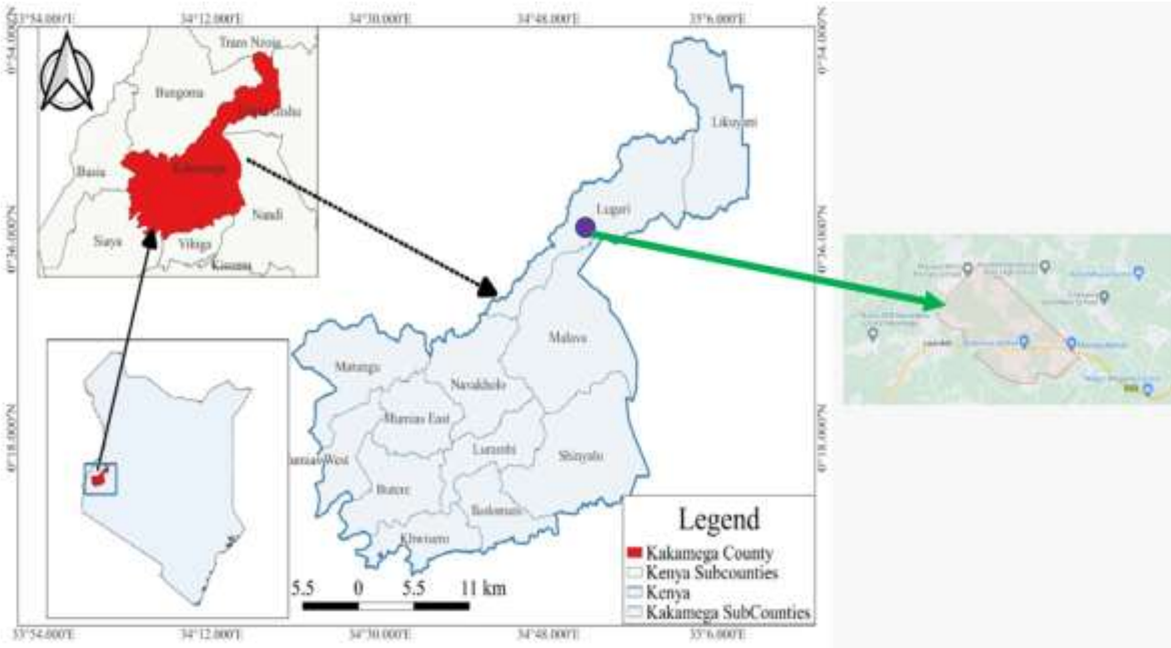

Figure 1. The map of the study area of Maturu village (indicated by a purple-coloured circular dot) among the Tachoni people in Lugari sub-County, Kakamega County, western Kenya.

The source of ethnomedicinal knowledge of plants

The ethnomedicinal knowledge of plants was surveyed from various sources in the study area. The survey involved a sample of 57 key respondents, of mixed sex and age (18–80 years old), who were identified through a range of sources, including meetings of village elders organised by chiefs and sub-chiefs. The ages of key respondents were confirmed from their: (1) birth certificates and (2) national Identity Cards (ID)/passports in Kenya. The sources included attending public meetings organised by local administrators to identify potential respondents. The community/village/clan leaders/elders had very useful information on the ethnomedicinal knowledge of plants. Local ethnopractitioners, including traditional healers/herbalists/spiritualists/ritualists, formed a particular subset of knowledgeable people from whom key respondents were drawn. Centres known for the preparation of a local Luhyia brew (indigenously known as *Busaa*) were the most important meeting points for old men and women and served as venues for discussion. All these groups were consulted because each was associated with a specific aspect of ethnoknowledge relevant to the study (Gupta et al., 2023).

Key steps to accessing the desired ethnomedicinal knowledge of plants

Constitution of a sampling group

The first step was to generate a purposive sample of key respondents from the varied sources mentioned above. Key respondents were local experts or people in the study area with knowledge of a particular issue or technology of interest (in this case, ethnomedicinal knowledge of plants) (Etkin, 1993; McCorkle et al., 1997; Waters-Bayer & Bayer, 1994). They have a more extensive understanding of local social and cultural systems regarding ethnomedicinal knowledge of plants than others in the community. A purposive sample is a specific subset of knowledgeable and practicing individuals in the field of ethnomedicinal plant knowledge. Intensive and extensive collaboration and interaction with these key respondents were considered effective research strategies (Oakley, 1981; Warry, 1992). A random sample would not have been appropriate for this type of socio-cultural setting, as not everyone sampled at random may have the required ethnomedicinal knowledge (Broota, 1982; Etkin, 1993; Martin, 1996).

The questionnaire method

This was the main method used to identify key respondents and obtain local ethnomedicinal knowledge of plants from largely illiterate people. During the encounter of residents in their meetings, mainly those called *Baraza*s (the village elders', sub-chiefs' and chiefs' meetings), interviews were conducted about ethnopractices of ethnomedicinal knowledge of plants, and to fill in the answers of the respondents in a structured questionnaire. The questionnaire was administered to over 100 respondents and consisted of 9 questions: (1) the geographical location where questionnaire is being administered, (2) identity of the person being interviewed, (3) choice of healthcare services when sick, (4) rationale of the choice of the type of healthcare services, (5) the duration of exposure to ethnomedicinal knowledge of plants,(6) human and livestock ailments treated and parts of the plants used,(7) whether ethnomedicinal knowledge of plants is applied as curative means or preventive mechanisms, (8) any existing rules for ensuring that these medicinal plant species are conserved for future use, and (9) ease of accessibility of medicinal plants. From the questionnaires, key respondents were identified based on whether their responses indicated they had potentially useful information on ethnomedicinal knowledge of plants. This method was considered very useful and robust because it reduced the following sources of bias: (1) modelling bias, which was the projection of the interviewer's views on to those studied, (2) strategic bias, which was the expectation of benefits by the subject, (3) familiar relationships between interviewer and interviewee, which would reduce resistance to questioning but could lead to rote answers and outsider bias (Sutton and Orr, 1991). These three preconceived notions would therefore lead to poor selection of key respondents (Etkin, 1993; Wanzala, 2017; Waters-Bayer & Bayer, 1994).

Personal interviews with selected key respondents

The next step involved interviews/discussions with the selected 57 key respondents. These were guided exchanges, semi-structured by a mental checklist of relevant points to confirm the validity of the information collected from other sources.

Collection of plant specimens

Following a personal interview with the selected 57 key respondents, several field trips were conducted to identify and collect the listed plant specimens and/or ethnobotanical products. The specimens were harvested, prepared, packaged, and stored according to the herbarium rules and regulations until transported to the University Herbarium, Jomo Kenyatta University of Agriculture and Technology, Kenya, for botanical identification using voucher specimens and the Hutchinson system of plant taxonomy based on the plants' probable phylogeny. While in the herbarium, additional non-experimental studies were also conducted to further validate the documented information. For each plant species collected from the field, a voucher specimen was prepared and deposited in the Herbarium of the University.

Focus-group discussions

The next step was to conduct joint focus group discussions with all stakeholders. In the study area, 10 focus group discussions were formed, each comprising 5-6 stakeholders based on their geographical location, ethnicity, conventional profession, economic activities, age, interests, and practices related to ethnohealth. A focus-group discussion was an exploratory discussion designed to obtain perceptions on a specific theme from a target group in a non-threatening environment (Etkin, 1993; Krueger, 1988). This kind of group interaction produced data and insights that would have otherwise been less accessible (Morgan, 1988). The interaction among all stakeholders shaped the collaborative, non-alienating, dialogic, participatory action research (PAR) and participatory rural appraisal (PRA) approaches utilised to build consensus and verify that information from other interviewees was accurately recorded (Martin, 2004). The group interaction also minimised the objectification of the respondents as the only source of data (Oakley, 1981). One purpose of this form of collaborative research was to shift decision-making grounded in theoretical knowledge to the community, rather than ceding this role to the conventionally trained expert (Warry, 1992).

Enumerations of documented ethnomedicinal plants

An extensive list of plants used as sources of ethnomedicines, including their scientific and vernacular names, growth habits, family names, and other information on their use, was prepared (Appendix 1). Family taxonomic ranks and/or units were prioritised because they are more stable than lower taxonomic levels, such as genera and species, and because they simplify the discovery of new species, particularly during field surveys (Sahney et al., 2010; Sahney & Benton, 2008). Because of the ethnic diversity amongst communities living in the study area, the village of Maturu, which is occupied by mainly Tachoni people of the Luyhia tribe), more than one vernacular name may be used to refer to a particular plant species and/or any other related plant species within a given genus or family. Two or more plant species may have the same vernacular name depending on their geographic locations, uses, and associated ethnic group(s). In Appendix 1, the classification of the plant specimens and/or ethnobotanical products into the column of growth life forms and/or habits was based on the definition and description of Yumoto and co-workers (1994).

Data collection, management and analysis

Data were mainly collected through the administration of the questionnaire, during face-to-face interviews and focus group discussions conducted amongst the key respondents. The Statistical Package for the Social Sciences (SPSS) programme was used for data entry, management, evaluation, and descriptive analysis. The evaluation of the plant species is considered case by case, based on the parts used, such as roots, barks, aerial parts, fruits, stems, seeds or leaves, as well as the frequency of use and their growth habitat.

RESULTS AND DISCUSSION

The questionnaire method

From the selection questionnaires administered to about 100 respondents, 57 were purposively selected as the key respondent team based on their deep understanding of the local social and cultural systems of the ethnomedicinal knowledge of plants in the study community. The questionnaire method enabled a cross-section of local residents to participate in the research survey. This strategic method helped to obtain much useful and relevant information and ensured that plants with more than one vernacular name were correctly identified and their uses accurately recorded. In addition, it enabled a considerable number of illiterate individuals, ethnopractitioners, and other knowledgeable respondents living in remote areas to be reached and to participate in the survey, thereby meeting the survey targets (Sutton & Orr, 1991). Many of these people gave useful information and many leading viewpoints, as shown in Appendix 1.

Interviews with key respondents and focus-group discussions

Interviews with key respondents and focus-group discussions were instrumental in enabling accurate transcription of the local Tachoni language, especially regarding local plant names and their meanings, as well as their applications for various ill-health conditions. The series of discussion sessions helped harmonise amongst interviewees the use of multiple names for one plant and vice versa. A consensus was thus built on the identity of locally used plants, their local names, processing methods, and the varied applications of individual plant species (Appendix 1). This facilitated the acquisition of more useful information about individual plant species, which may merit further classical scientific investigations in the future (Beentje, 1994; Wanzala, 2009). The experience with the respondents highlighted need for conventionally trained scientists to: (1) foster communication with different respondents and take time to establish a strong, trusting relationship based on openness and cooperation, (2) demonstrate respect for the ownership, source and origin of ethnoknowledge of medicinal plant species and the needs and sensitivities of its holders, and (3) undertake to provide value-added knowledge back to the community in the form of useful products (such as reports) and to share equitably with the key holders any benefits arising from the use of their ethnoknowledge. Specifically, ethnopractitioners need to be made aware of legislation protecting their ethnoknowledge base through relevant state ministries, and of possible threats arising from biopiracy and bioprospecting malpractices (Lindsay, 1978; M. & Wanzala, 2012).

From the focus discussion groups, it was realised that there is a significant difference between the frequency of use and the age of the people. The older generation in society is more conversant with medicinal plants than the younger generation, in terms of utilisation and knowledge content. There are two kinds of ethnoknowledge: the general ethnoknowledge known by everyone, and the secrets of the society known only to the elders and most reliable people of the community, passed on from generation to generation to only a few trusted people (Wanzala et al., 2012).

Responses to questionnaires and results from the discussion groups

Despite initial limitations in accessing the Tachoni people's ethnomedicinal knowledge of plants, participating stakeholders were willing to ensure the project's targets were met. From the survey studies, it became apparent that although the ethnomedicine industry has existed long before conventional medicine, it has been neglected ever since (Kofi-Tsekpo & Kioy, 1998), and in some cases, completely replaced by its conventional counterpart, depending on the belief and level of ethnopractice within the culture. However, a considerable proportion of the Tachoni people in Lugari sub-county in western Kenya still depend on the ethnomedicine industry for daily healthcare services as their first option. This was clearly evidenced by the complex composition of the purposive sample (n = 57) of key respondents, and their voluminous and high-quality responses (Appendix 1 and Table 2; and Figures 2, 3, 4 and 5), henceforth, implicating their dependence on the ethnohealthcare services (Wanzala & Minyoso, 2024). Even more important was the commitment and determination of all the stakeholders to have their local ethnoknowledge of medicinal plants (Appendix 1) recognised, documented and evaluated and further requested for value addition on their ethnoknowledge by conventional classical science during focus discussions with a view to increasing its wider acceptance across local communities and henceforth, avoid risks of its gradual loss in time and space (Wanzala et al., 2012). Nevertheless, strategies and mechanisms for conserving and preserving ethnomedicinal knowledge of plant species were discussed too, henceforth, the development and existence of woodlots in arable farming systems.

Just like the previous similar studies conducted in other indigenous Kenyan communities (Gakuubi, et al., 2016; Ndondolo et al., 2016a; Wanzala et al., 2012), this study too will help restore confidence amongst ethnopractitioners in the community and henceforth boost the ethnomedicine industry at a local level (Jain et al., 2022; Wanzala & Minyoso, 2024). Further, the results of this study will help enhance the working relationship between ethnopractitioners, conventional health workers, and scientists, without the risks of biopiracy (Ageh & Lall, 2019; Sysoev et al., 2021).

The diversity of documented medicinal plant species

The results from the field studies are comprehensively summarised in Appendix 1, where the key respondents provided local names and/or names for the identified plants, including the specific plant parts used and the plant species' growth habitats. Common English names of every plant species were also identified and documented. However, some plant species, such as *Opuntia vulgaris* Mill. and *Alchornea laxiflora* (Benth.) Pax & K. Hoffm. were not given local names and/or names, most probably because these plant species were the newest to be identified in the community for ethnomedical utilization (Blundell, 1987; Ndondolo et al., 2016b), likely due to massive immigration in the study area. Most probably, the plant species might have been brought into the study area by emigrants, herbivores, or other natural mechanisms from their natural habitats; an indicator of the occurrence of biological invasions (IPBES, 2019). The results indicated a documentation of 93 useful medicinal plant species, of which 89 plant species were scientifically identified and spread in 42 plant families, while their parts (roots, barks, stems, leaves, flowers, fruits, seeds and aerial parts of the plants) for which they are used to manage a wide range of ill-health conditions affecting humans were also documented (Appendix 1). In addition to Luhyia's local names of the Tachoni community in particular, English names of all 93 plant species, except the 4 non-located species, have been documented, along with those of the corresponding plant families, to facilitate future in-depth scientific research. The family names of plant species were given a priority in the documentation process because family taxonomic ranks and/or units in plant taxonomy and systematics studies are more stable than lower taxonomic levels such as genera and species and further simplify the detection of new plant species particularly during such ethnobotanical surveys in the field (Backes, 1998; Sahney et al., 2010; Sahney & Benton, 2008; Wanzala et al., 2012).

The results of the ethnobotanical survey indicated that the Fabaceae family was represented with the highest number of species (10.26%), followed by Euphorbiaceae (6.41%) and then Myrtaceae, Solanaceae, Amaranthaceae, Apocynaceae and Asteraceae, each was represented by 3 plant species comprising 3.85%, while the rest of the plant families (ie. 35 plant families) were represented by either 2 or 1 plant species. These results compared favourably with those previously obtained from a neighbouring area, Marakwet, in a similar ethnobotanical survey (Kipkore et al., 2014). However, the family with the highest number of mentions for use was Rutaceae (50), followed by Asteraceae (48), Solanaceae (47), Anacardiaceae (37), and Lamiaceae (33), in that order. Nevertheless, the number of ill-health conditions for which each plant species is used for management varied widely and was not in any way correlated with the number of times it was mentioned for use (Appendix 1). For instance, plant species from the Rutaceae family had 22 ill-health conditions mentioned, followed by Lamiaceae (20), Euphorbiaceae (18), Anacardiaceae (16), Pinaceae (15), and Fabaceae (14), in that order (Appendix 1), thus not reflecting the anticipated immediate order above.

Of the 93 plant species documented, 4 were mentioned by ethnopractitioners as very useful ethnomedicinally but could not be traced in the field for collection and taken to the university herbarium for scientific identification (Appendix 1). These four plant species, known locally as *Neruelala*, *Olunyiri*, *Chindararwa,* and *Lilande* (Appendix 1), may have been previously overexploited in time and space over generations and may now be rare or extinct in the study area. Alternatively, these four plant species could be introduced into the study area through immigration (Lihraw, 2010; Wanzala et al., 2012). The disappearance of the locally known plant species is also a sign that the environmental conditions were probably not favourable to their survival and wellbeing; hence, they could not compete with other plant species under the prevailing climatic conditions. Such changes are therefore noted by ethnopractitioners as among the adverse effects of climate change and/or anthropogenic activities affecting biodiversity and ecosystems (Heller, 1996). Under the prevailing circumstances within the study area, the effects of biological invasions due to the creation of artificial ecosystems (the existing planted forest blocks) cannot be ruled out as one of the key contributing factors for the failure of the Tachoni ethnopractitioners to locate the above 4 plant species during the field excursions (IPBES, 2019; Roy et al., 2024; Sankaran et al., 2023; Wanzala et al., 2023; Wanzala & Minyoso, 2024). Nevertheless, more in-depth scientific studies are necessary to understand their status and the prevailing conditions of these plant species within the study area.

Life forms and growth habitats of plant species

Different life forms of the 93 sampled plant species differed significantly across growth habitats (Figure 2). From the analysis of Appendix 1, 39 plant species were mentioned to be harvested from the forest, 20 from woodlots, 15 from farmlands (arable farms), 12 from bushes, 6 from woodlands and 1 from homesteads in that order. One plant species was mentioned, sourced from more than one growth habitat, and was found to be invasive (Appendix 1).

Most of the plant species documented were trees comprising 42.93%, followed by shrubs (26.97%), herbs (20.31%), climbers (5.16), forbs (3.01%), woody plants (1.18) and lianas (0.43%) in that order of their frequency of mention of use of their ethnopharmacological agents from the respective life forms (Table 1). With the exception of forbs and herbs, every life form had the highest mention of being significantly sourced from the forest (Figure 2). This therefore implies that most ethnomedicinal resources were reported to be found in forests, followed by farmland, bushes, woodlots, woodlands, and homesteads, in that order (Table 1).

Table 1: Life forms of the plant species sampled with the desired ethnopharmacological applications were found in different growth habitats.

Life forms of the plant species	Growth habitat of the plant species						Total frequency of mention for each life form (%)
	Forest	Bush	Woodlot	Farmland	Homesteads	Woodland	
Trees	409	129	137	73	11	40	**799 (42.93)**
Herbs	135	33	54	156	0	0	**378 (20.31)**
Shrubs	227	118	46	28	0	83	**502 (26.97)**
Lianas	8	0	0	0	0	0	**8 (0.43)**
Forbs	0	0	8	48	0	0	**56 (3.01)**
Climbers	79	0	0	17	0	0	**96 (5.16)**
Woody plants	22	0	0	0	0	0	**22 (1.18)**
Total frequencies of mention for each habitat (%)	**880 (47.29)**	**280 (15.05)**	**245 (13.16)**	**322 (17.30)**	**11 (0.59)**	**123 (6.61)**	**1861 (100.00)**

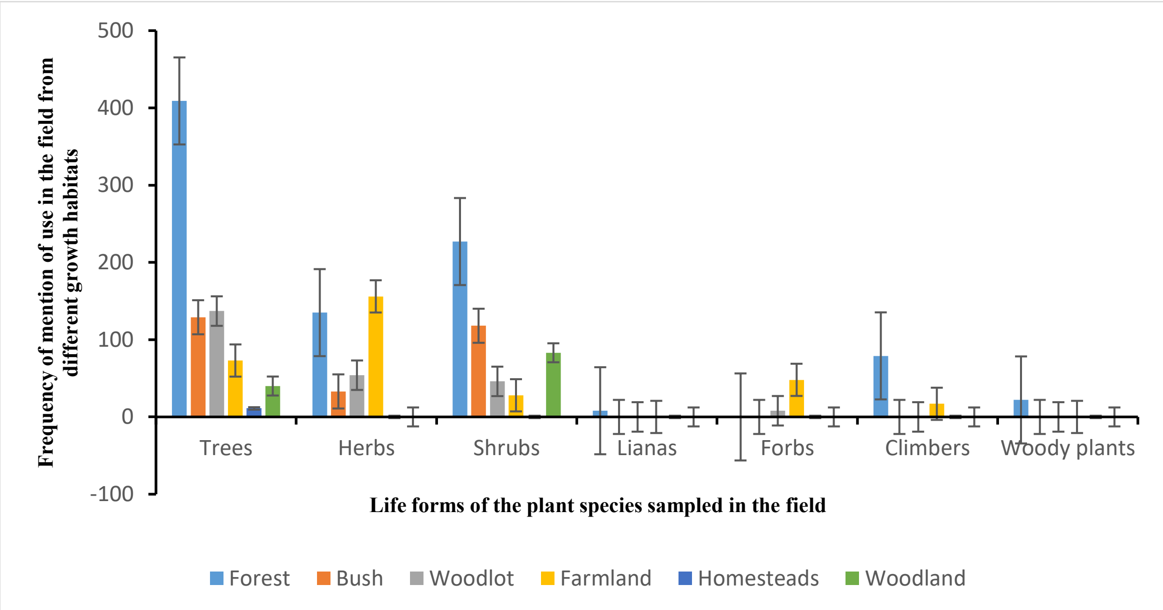

Figure 2. Comparative evaluation of the use of different life forms of plant species found in different growth habitats amongst the Tachoni people.

Local naming of the plant species

Ethnic taxonomy and ethnosystematics of plant species often suggest a strong ethnomedical botany and cultural familiarity and identity that are historical and inherent within the evolutionary lineages of any given community (in this case, the Tachoni people) in time and space. With this realisation, useful plant species were culturally identified and conserved as shrines, sacred plant species, woodlots, etc., and locally known as *siembekho* (Backes, 1998; Wanzala et al., 2012). Therefore, failure to give a locally-based indigenous name of a useful plant species in the dialects of an ethnic grouping under study, suggest a myriad of reasons, including :- (1), loss of memory and or death of the custodian person before knowledge is passed on to the next generation, (2), accidentally misplaced ecological niches of the plant species under considerations for unknown reasons, (3), replacement of natural habitats with the existing artificial state-based forest plantation blocks (namely, Nzoia, Turbo and Lugari) comprising of foreign plant species such as the *Pinus patula*, *Cuppresus lusitanica*, *Eucalyptus* spp. and Wattle trees (Chisika et al., 2020), (4), location of plant species in secured environments like the river valleys, which, unfortunately, are accessed by very few people, (5), a sign of an expression of the immigrants' ethnomedical knowledge of plant species from the original geographical locations, (6), probably the newly discovered medicinal plant species in that particular community and (7), little medicinal and cultural values of the plant species to the Tachoni community (Wanzala et al., 2012). In our current ethnobotanical studies, several plant species lacked a legally acceptable Tachoni ethnic-group name(s) (Appendix 1 and Figure 2). In particular, plant species with no clear Tachoni name(s) included: - *Opuntia vulgaris* and 2 species of *Aspilia* spp., (which are mostly found in arid and semi-arid ecological zones where the native Tachoni people do not live or frequent), *Pinus patula*, *Lantana trifolia* and *Olea europaea*, (which were noted to be foreign plant species to Tachoni people), *Rubia cordifolia* and *Thunbergia alata* (which are confined to river valleys, an environment, traditionally accessed by very few people) and *Fuerstia africana*, *Alchornea laxiflora* and *Crassocephalum picridifolium* (which are seasonally confined to dry tropical biome depending on weather conditions, henceforth, very rare plant species).

Figure 3. Some voucher specimens of the 93 sampled plant species, without a clear understanding of the Tachoni local and/or indigenous names, are being used for various ethnopharmacological applications. These plant species, however, appear to have been introduced into the cultural life of the Tachoni community and adopted accordingly, an indicator of biological invasions.

Parts of plant species that are harvested for use from different growth habitats.

The Tachoni people, together with many immigrant tribes living in the study area, form very interesting, diverse ethnic groupings that utilise various parts of the plant species, such as roots/rhizome, leaves, stems, barks, aerial parts, flowers/buds, fruits, whole plant species, seeds, juice/oil extracts and wood in that order (Table 2). The frequency of use of these parts of plant species is based on the inherent values of the plant species to the indigenous people and local community, and what specific ethnopractitioners of the entire community consider as good ethnomedicine in their cultural framework, and with the approval of the council of elders (Lindsay, 1978; Wanzala & Minyoso, 2024). As discussed by the ethnopractitioners in the field during the ethnobotanical survey, the frequency of mention of use depends on the medicinal value of the plant species to the community, rather than on the growth habitat of the identified plant species (Appendix 1).

Different parts of plant species are significantly sourced from different growth habitats (Figure 4). Most of the herbal medicines prepared in the Tachoni community from these plant parts (roots/rhizome, leaves, stems, barks, aerial parts, flowers/buds, fruits, whole plant species, seeds, juice/oil extracts and wood) are mainly harvested from the forests, followed by farmland (in the arable farming system), woodlots, bushes, woodland and finally, homesteads in that order (Table 2). This implies that Tachoni ethnopractitioners are still harvesting many of their herbal products from the wild, which risks the sustainability of the supply chain and, hence, the continued benefit to the entire community (Cunningham, 1990, 1995; Cunningham & Mbenkum, 1993). It is indeed interesting to note from Table 2 that very little ethnomedicinal material is sourced from homesteads, as many ethnopractitioners believe that plant materials from homesteads are not as powerful as those sourced farther away.

Table 2. The distribution of different parts of the 93-sampled plant species utilised in the Tachoni community in different growth habitats with respect to the frequency of mention of use of a particular part of the plant species in the field.

Parts of plant species harvested for use.	Growth habitat of the plant species						Total mention frequency for each part of the plants (%)
	Forest	**Bush**	**Woodlot**	**Farmland**	**Homesteads**	**Woodland**	
Whole plant	119	7	0	60	0	0	**186 (4.12)**
Aerial parts	17	58	54	98	0	34	**261(5.78)**
Flowers/Buds	84	58	0	71	16	0	**229 (5.07)**
Fruits	24	17	38	113	0	37	**229 (5.07)**
Leaves	337	120	200	190	16	79	**942 (20.87)**
Stems	548	109	67	42	0	71	**837(18.55)**
Barks	389	75	160	47	16	74	**761(16.86)**
Roots/Rhizome	369	153	207	149	0	71	**949 (21.03)**
Seeds	0	0	23	38	0	0	**61(1.35)**
Juice/Oil extracts	0	5	5	24	0	0	**34 (0.75)**
Wood	0	0	0	24	0	0	**24 (0.53)**
Total mention frequency for each growth habitat (%)	**1887 (41.81)**	**602 (13.34)**	**754 (16.71)**	**856 (18.97)**	**48 (1.06)**	**366 (8.11)**	**4513**

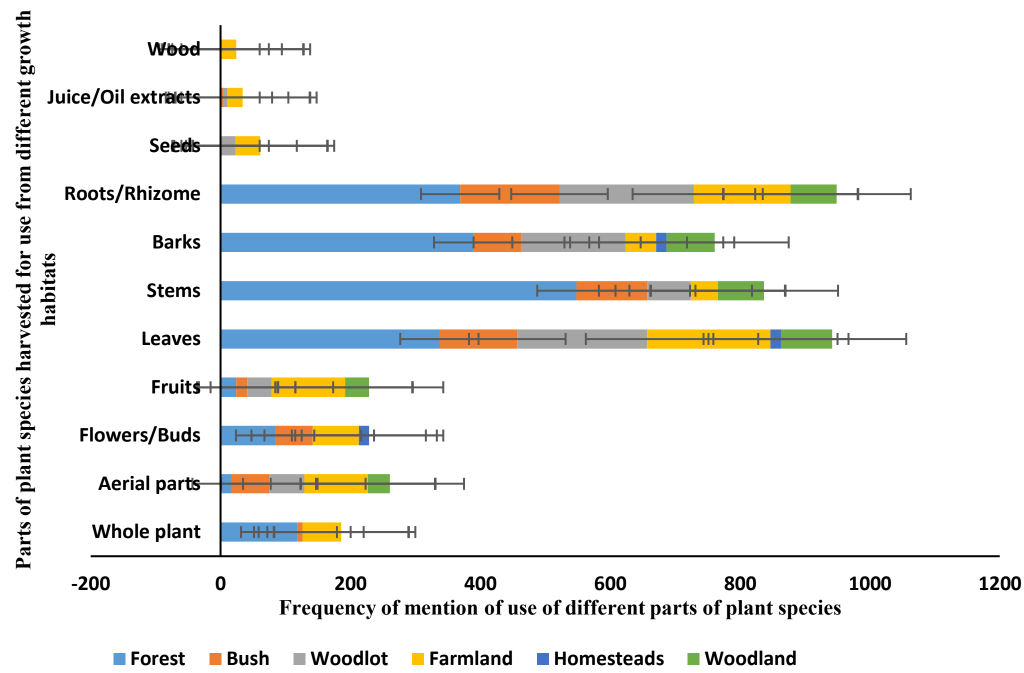

Figure 4. The frequency and significance of the mention of the use of different parts of plant species sourced from different growth habitats, as understood by the ethnopractitioners of the Tachoni community.

Endangerment of medicinal plant species

It was also noted that the idea of a plant species being considered endangered depends solely on the part of the plant used, the frequency of its use, and the frequency of occurrence of the illnesses for which ethnomedicines are sought in the society (Table 3). For instance, plant species whose barks, roots, and leaves are used to prepare ethnomedicines are considered the most endangered, compared to plant parts like flowers, seeds, and fruits (Aondolumun et al., 2025; Gachathi, 1989; Ivens, 1989; Kokwaro, 1993, 1994).

Table 3. Comparative analysis of the mention of the use of different parts of the sampled plant species from different life forms.

Life forms of the plant species	Parts of different plant species mentioned for use											Total frequency of mention (%)
	Whole plant	Aerial parts	Flowers/ Buds	Fruits	Leaves	Stems	Barks	Roots/ Rhizome	Seeds	Juice/Oil extracts	Wood	
Trees	1	2	5	5	26	15	32	24	4	0	1	**115**
Herbs	10	6	1	3	11	4	1	10	0	1	0	**47**
Shrubs	4	2	2	1	14	7	8	18	1	2	0	**59**
Lianas	0	0	0	0	0	1	0	2	0	0	0	**3**
Forbs	0	0	1	0	2	0	0	0	0	0	0	**3**
Climbers	2	0	0	0	1	0	1	1	0	0	0	**5**
Woody plants	1	0	0	0	1	0	2	1	0	0	0	**5**
Total frequency for each part of the plant used (%)	**18**	**10**	**9**	**9**	**55**	**27**	**44**	**56**	**5**	**3**	**1**	**237**

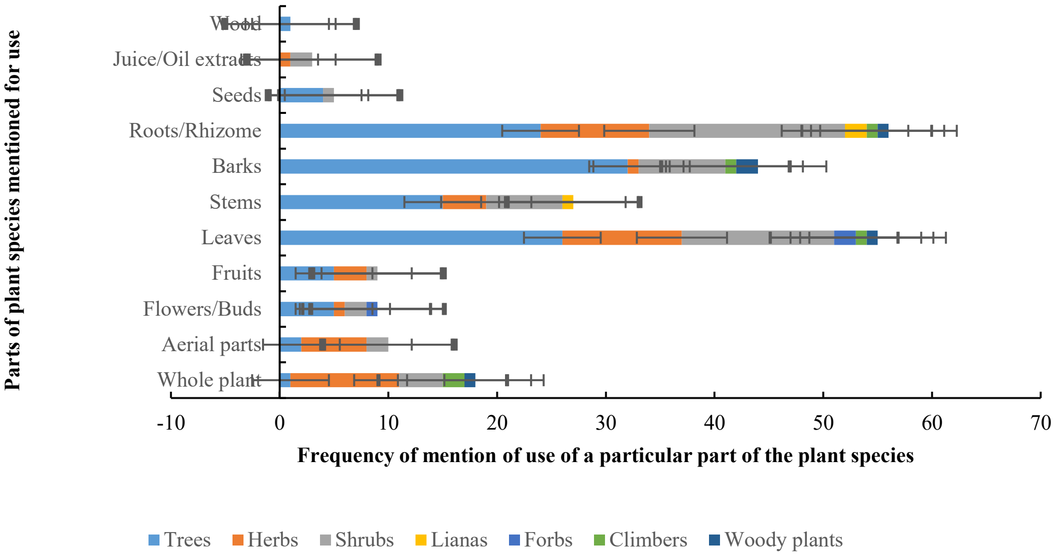

Figure 5. The use of different parts of plant species originating from different life forms.

How harvesting parts of plant species affects the source plants.

The Tachoni people harvest roots, leaves, barks, and stems in significant quantities for their medicinal value (Figures 4 and 5). These plant parts, depending on the amount taken from a source plant and frequency of harvesting, may endanger the source plant species a great deal and, where possible, further cause extinction in that particular geographical location. The parts of any one given plant species taken may endanger the affected plant species in the following ways: -

Roots - The roots have a major function for plants: anchoring the plant firmly in the soil and absorbing water and mineral salts that the plant uses in major biochemical pathways, such as photosynthesis, which produces food used for plants' growth and development. Roots are also used as storage sites in some plants as well as sites for nitrogen-fixing mechanisms. This implies that if the roots are disrupted, the plant is at great risk of dying because the major metabolic processes are disrupted, as there are no raw materials for these processes (Cavanaugh, 2000).

Barks - The barks, which cover both stem and roots of woody plants, provide for protective, transport and structural roles to the livelihood of plants. The barks also regulate water and provide sites for gaseous exchange, that is, the lenticels (Ilek et al., 2021). The outer layers of bark provide sites for the deposition of waste products, serve as pollution indicators, and host many microorganisms, thus creating a balanced ecosystem on a plant. The barks comprise phloem tissue that transports food manufactured in the leaves to the rest of the plant for its survival. The removal of the bark, therefore, exposes the plant to a high risk of pests and infections, and ultimately, death ensues when the photosynthetic products are not uniformly distributed from the leaves to the rest of the plant (Gaoue & Ticktin, 2008).

Flowers - The flowers of the plant are very important reproductive parts, responsible for fruit and seed formation. Their removal, therefore, implies that the plant may not proceed to the next generation, since there are no seeds to ensure its reproduction. This, therefore, risks the extinction of the plant species involved.

Leaves - The leaves of plants are very important parts responsible for the process of photosynthesis that produces food, which is much needed by plants for their growth and development. The leaves, however, are the least endangered parts because they are numerous and the plant keeps growing new leaves throughout its life. Nevertheless, studies have shown that extensive harvest of a plant's aerial parts, including its leaves, may reduce rates and patterns of reproduction, as previously demonstrated in *Khaya senegalensis,* and, hence, reduce population size in the long run (Gaoue & Ticktin, 2008).

From the foregoing, all the plant species documented in the study area are the most endangered species, with the exception of *Persea gratissima (*Avocado) and *Mangifera indica* (Mango trees (Amayembe)), due to the utilisation of their seeds as sources of ethnomedicines. Further, plant species such as *Prunus africana* has been gazetted among the most endangered species in Kenya and is already appearing on the IUCN Red List of Threatened Species (version 2025-2: https://www.iucnredlist.org), following the last assessment in March 3rd, 2020, listed as vulnerable under criteria A2cd+4cd in the World (Hills and Cheek, 2021).

With an ever-increasing human population, deforestation, unsustainable harvesting methods and environmentally based problems, including climate change, may affect and endanger many ethnomedicinal plant species and further increase their extinction rate (Ruffo, 2002). Therefore, ethnomedicinal plants must be harvested sustainably to ensure their continued availability to future generations (Abegaz & Demissew, 1998; Heller, 1996; Hines & Eckman, 1993).

Some critical observations made in the field during the survey studies

During the field survey, the following critical observations were made, highlighting several viewpoints for consideration.

***Removal of barks from medicinal plants, the case of pine tree* (Pinus patula *Schltdl. & Cham.*) *and African cherry* (*Prunus africana* (*Hook.f.*) *Kalkman*)**

Harvesting medicinal products from corresponding trees by debarking (Figure 6). Such ring-debarking, as a harvesting mechanism used by local communities (Figure 6), is more damaging to plant survival (Delvaux et al., 2009). Biologically, the complete removal of bark around the tree results in the particular tree being unable to transport food to the roots, and as a result, the roots die, and henceforth the entire tree has no more anchorage in the soil and no water, together with relevant minerals, are absorbed.

The wood chips prepared from the stem of the pine tree (*Pinus patula* Schltdl. & Cham. - Pinaceae), when burnt (in a situation considered a 'sacred' activity), give off its pleasant fragrance of incense believed to ward off evils and bad omen in homesteads and bring good luck in life, henceforth, its use and application in religious rituals. Ethnomedicinally, the plant is used to treat arthritis and gout, while its leaves, when steeped in water for bathing, are used as a decongestant and pain reliever. Nevertheless, the odorant composition and its characterization using appropriate odorant analysis techniques remain unresolved future issues to pursue. Whereas *Prunus africana* is historically known as an ethnoremedy for wounds, men prostate cancer, malaria, gonorrhea, kidney diseases, stomachache and as a purgative agent.

These field observations confirm that the Tachoni people of Lugari sub-county in western Kenya possess a wealth of well-maintained ethnomedicinal knowledge of plants. This, however, provides the basic background against which new and useful ethnopharmacological agents can be discovered following in-depth classical scientific studies, which should be able to help explain the safety, quality and efficacy levels of the herbal products being used to manage ill-health conditions of humans in the communities (Jain et al., 2022; Stephen, 2007).

(a) (b)

Figure 6. Debarking the medicinal (a) pine tree (*Pinus patula Schltdl.* & Cham. - Pinaceae) and (b) the African cherry (*Prunus africana* (Hook.f.) Kalkman – Rosaceae) as a mode of harvesting medicinal materials from the fence of an arable farming system. This is an example of overexploitation that leads to the extinction of valuable tree species that yield useful ethnopharmacological agents. Rarely do debarked medicinal trees such as these recover by developing algal growth, sheet regrowth, and stress shoots around the ringed stem (Delvaux et al., 2009).

Removal of roots from medicinal plants as herbal products

As indicated in Tables 2 and 3, roots are extensively harvested for medicinal use in the Tachoni community. In most cases, root harvesting negatively affects plant recovery or even kills the plant, thereby affecting its conservation status and, consequently, raising concerns about its survival (Mateo-Martin et al., 2023). Roots play a critical role in the life of any plant species, particularly by anchoring the plant in the soil and absorbing water and mineral nutrients (Das et al., 2014). When roots are harvested for their medicinal values, soil is removed from the said plant species and thereafter, rarely is the soil returned to the plant appropriately (Figure 7), thus making the roots of the plant become vulnerable to damage of all kinds and later, result in death of the plant (Heller, 1996; McGeoch, 2008). Removing the roots of a given plant species automatically reduces that plant's capacity to absorb water and mineral salts from the soil for its growth and development, thereby making it an unsustainable method for harvesting medicinal plants.

Figure 7. Root structure of a medicinal plant species with the soil removed from the roots gradually, thus making the roots of the plant vulnerable to damage of any kind. Harvesting of roots as herbal products from the medicinal plants endangers the survival of that plant species.

Some health risks of herbal products observed in the field

For millennia, it is reported that herbal medicines may produce negative effects that can range from mild to severe, including: allergic reactions and rashes, asthma, headaches, nausea, vomiting and diarrhoea (Stephen, 2007). However, the cause of all these side effects is not known with certainty. Partly, it has been attributed to poor regulatory mechanisms and the quality of herbal products, i.e., poor hygiene (Kaur et al., 2013; Mirriam et al., 2012; Smet, 1995). Nevertheless, herbal products are available on the market without prescription and are not regulated for purity and potency (Abdel-Aziz et al., 2016); hence, their effectiveness and efficiency are highly questionable (Jain et al., 2022; Wanzala et al., 2012).

During field surveys on the ethnomedicinal knowledge of plants, it was noted that some members of the Tachoni community, i.e., ethnopractitioners, prepare herbal products and freely take them to the Lwandeti and Mukhonje open markets for sale and to earn a living (Anjaria, 1989). However, some of the herbal products were carefully observed and found to have growing moulds and or fungi (Figure 8). This indeed poses a very serious public health risk to the ignorant clients and, in itself, is a serious challenge in the ethnomedicine industry (Keter et al., 2016; Pamplona-Roger, 2005). All ethnopractitioners are expected to prepare clean herbal products that are appealing to prospective clients and free of contamination, thereby restoring confidence and hope in the ethnomedicine industry. Growth of mould/fungi-like growth on prepared and stored herbal products found at the Lwandeti and Mukhonje open markets, particularly as shown by the red arrow within the study area, poses a health hazard to consumers. However, some target parts of the plant species, like the leaves, may be harvested while infested (b), but are unfamiliar to the ethnopractitioner and hazardous to the consumer.

(a) (b)

Figure 8. Growth of mould/fungi-like growth on prepared and stored herbal products found at the Lwandeti and Mukhonje open markets, more particularly as shown by the red arrow within the study area, present a health hazard situation to the consumers. However, some target parts of the plant species like the leaves, may be harvested while infested (b), but unfamiliar to the ethnopractitioner while hazardous to the consumer.

Innovation of this study and its future prospects

The study area comprises people with a wide range of ethnic background as immigrants from many parts of Kenya, coming along with them, their original ethnomedical knowledge. This ethnoknowledge, has ever since blended with that of the Tachoni, the original inhabitants of the study area. This explains why some plant species in Table 1 could not have the indigenous Tachoni name(s) presenting the scenario of emergence of new alien plant species, thereby signifying a process of biological invasion taking place. The study area represents one of the disturbed ecosystems of Kenya with 3 state forest plantation blocks (called Nzoia, Turbo and Lugari) comprising of *Pinus patula*, *Cuppresus lusitanica*, *Eucalyptus* spp. and Wattle trees (Chisika et al., 2020) with no historical records of the original plant species. In the disturbed ecosystem, like the study area, the 4 plant species (known in indigenous language as *Neruelala*, *Olunyiri*, *Chindararwa* and *Lilande*) that could not be traced and located for field collection and subsequent scientific identification in the herbarium, is an indicator of the realization of a biological extinction process of some plant species. Both, biological invasions and extinctions, are processes of loss of biodiversity that threaten lives of people and nature across all regions of the Earth with more than 2,300 invasive alien species reported to be found on lands of indigenous people and local communities (IPBES, 2019, Roy et al., 2024). While 200 new alien species every year are reported for introduction into new environments and globally, there are about 3,500 invasive alien species, with negative impacts on nature and also on people (IPBES, 2019). With special focus on people as major agents of biological invasions, stringent laws and policies as well as sound mechanisms of monitoring and evaluation are therefore essential to manage biological invasions and prevent, manage and control invasive alien species in future. Future sustainable approaches to biological invasions may include engagement of indigenous people and local communities and fostering a strong collaboration and partnership amongst stakeholders to promote health equity, cultural heritage, socio-economic transformative agenda and sustainable development. The observations made in the field, documented medicinal plant species and associated ethnoknowledge all together, present great potentials for ethnopharmaceutical applications in the society, henceforth, development of sustainable laws, policies, standards, regulations and ethnopractices for their conservation, preservation, protection and utilization.

CONCLUSION

The survey of indigenous ethnomedicinal knowledge of plants amongst the Tachoni people revealed a treasure of preserved ethnoknowledge on plants and plant products. The field survey revealed 93 useful medicinal plant species, of which 89 species were identified and spread in 43 families, while their parts for which they are used to manage a wide range of ill-health conditions affecting humans were documented, as well as the growth habitats of the plant species. Only 4 species could not be traced and located for field collection and scientific identification in the herbarium, while others were new and could not be given appropriate indigenous names. Many ethnopractitioners preferred barks, followed by leaves, roots, flowers, fruits, and seeds, in that order, as their sources of ethnomedicines from forests, woodlots, farmlands (arable farms), bushes, and, finally, woodlands. These field observations confirmed that the Tachoni people have a wealth of well-maintained ethnomedicinal knowledge of plants. This useful knowledge warrants empowering ethnopractitioners, promoting intercultural dialogue amongst people, conserving plant species and associated sacred sites and strengthening partnerships and collaborations between stakeholders so as to regain the lost glory of practicing ethnomedicines in society. This study, however, provides the basic background against which new and useful ethnopharmacological agents can be discovered, following in-depth classical scientific studies that should explain the safety, quality, and efficacy of the herbal products used to manage human illnesses in communities.

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AUTHOR CONTRIBUTIONS

Wycliffe Wanzala: Conceptualization of research idea; Resource mobilization (Personal funding of the project); Project administration; Supervision of the project; Study design of the project; Validation; Visualization; Writing of the manuscript; Review and editing of the final draft of the manuscript, **Makokha K. Jacquelyne**: Conceptualization of research idea; Investigation and field surveys; Collection and compilation of data; Mobilization of resources; Use of software for plant species identification and writing of the original draft of the manuscript, **Sheila I. Minyoso:** Investigation and study design; Collection and compilation of data; Data analysis; Writing and editing of the manuscript, and **Emma Akinyi Owino:** Collection and compilation of data; Data analysis.

DECLARATION OF CONFLICTING INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that may influence the work reported in this manuscript.

SUPPLEMENTAL MATERIAL

Appendix 1 https://shorturl.at/fYfoP

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