

Role of Medicinal Plants in Sustaining Livelihoods, Socio-economic and Ecosystem Services: A Case study of Dibete Village, Botswana

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ABSTRACT

Numerous tree species of economic and cultural importance in Botswana are at risk due to excessive harvesting. Medicinal plants act as a bridge between traditional wisdom and modern science, yet their survival relies on meticulous management. Considering threats from both human activities and natural factors, the sustainability and resilience of medicinal plants have gained significant attention recently. The article delves into the vital importance of medicinal plants, the obstacles they encounter, and the pressing necessity for conservation and ethical harvesting practices to secure a sustainable future for these plants and the communities reliant on them. A total of thirty-seven ($n = 37$) medicinal plant species were recognized as crucial for local livelihoods, whether for personal use or trade. The research concludes by emphasizing the respondents' heightened reliance on medicinal plants, which can be linked to the enduring traditional knowledge, accessibility, affordability, and cultural relevance of these plants.

1. Introduction

According to the Millennium Ecosystem Assessment (2005), wild plants provide essential ecosystem services. Medicinal plants are significant sources of secondary metabolites that may play a crucial role in combating infectious diseases (Mukanganyama et al., 2011). As a result, millions of individuals worldwide, including 80% of those in developing nations, continue to rely on traditional herbal medicine (WHO, 2013). The contribution of medicinal plants to public health is substantial, as they underpin the traditional or indigenous healthcare systems utilized by the majority of the population in many developing countries (Bodeker, 2000). Herbal medicine offers an accessible and cost-effective alternative to contemporary pharmaceuticals (Motlhanka et al., 2008). Recently, there has been a resurgence of interest in employing medicinal plants for the treatment of diseases in both humans and animals (Kumar et al., 2015). The secondary metabolites present in medicinal plants hold promise for addressing a variety of health conditions (Mukanganyama et al., 2011). Medicinal plants have been used to treat illnesses since ancient times (Majinda and Motswaledi, 1998) and they have supplied the ingredients needed to produce contemporary medications (Chacko et al., 2010).

The overwhelming majority of people in sub-Saharan Africa get their medical care primarily from traditional medicine (Setshogo and Mbereki, 2011) due to a shortage of medical facilities and medication supplies (Rahman and Smith, 1999; Kayombo et al., 2012). The use of medicinal plants has increased as the population size continues to outgrow modern medical facilities, and the cost of healthcare continues to increase (Cunningham et al., 2018).

In Botswana herbal medicine is used in rural and urban areas even though modern medical facilities are available nationwide and affordable, or even free. Documented evidence shows that 80% of the population of Botswana residing in rural areas still use medicinal plants for their health care (Mojeremane et al., 2005). Botswana has numerous and abundant medicinal plant species that grow in the wild. Medicinal plants provide herbal medicine and play a major part in the management and treatment of illness in rural and urban areas of Botswana. Additionally, medicinal plants are a source of income, especially to people residing in rural areas.

The rampant over-harvesting of wild medicinal plants poses a serious risk to their existence. Traditionally, these plants were sourced and used within local settings, with individuals keeping only a modest stock of dried herbs to satisfy local requirements. Nevertheless, the growth of trade relations, powered by urban development and technological progress, has resulted in a more extensive market for medicinal plants. The unsustainable harvesting of medicinal plants presents a significant threat, exacerbated by the lack of replanting after collection (Astutiket et al., 2019; Seileet et al., 2022). While local communities that rely on these plants employ sustainable harvesting practices, those unfamiliar with the natural habitats often resort to unsustainable methods, resulting in resource depletion. Herbal medicine plays a vital role in treating various ailments in both rural and urban areas of Botswana. To develop a more effective, profitable, and sustainable marketing and management system, it is

essential to analyse the structure of medicinal plant potential, including aspects of production, growth, and trade, along with their strengths and weaknesses. However, there is a lack of critical valuation data regarding the use of medicinal plants in Dibete Village, Botswana. Consequently, this study seeks to document how the residents of Dibete Village utilize these medicinal plants.

The main objectives of the study are to identify how medicinal plants sustain livelihoods in Dibete Village, by providing income, reducing poverty, and supporting cultural heritage through the harvesting and sale of remedies. These plants also offer ecosystem services like biodiversity preservation and can be promoted through cultivation to ensure a stable and sustainable income source, as wild yields are unreliable.

2. Materials and Methods

2.1. Study Area

A survey was carried out in the village of Dibete, situated at coordinates 23°45'00.4"S and 26°30'56.7"E. The village experiences an average annual temperature of 30°C, with monthly averages ranging from a low of 24°C to a high of 34°C (Figure 1). Each year, approximately 464 mm of rainfall is recorded. According to the 2022 Census and Statistics Office (CSO), Dibete has a population of 1,403 residents, the majority of whom are engaged in agriculture, including both crop and livestock farming. Additionally, many residents earn a living by selling traditional medicinal plants along the A1 (North-South) road, where several makeshift stalls are located.

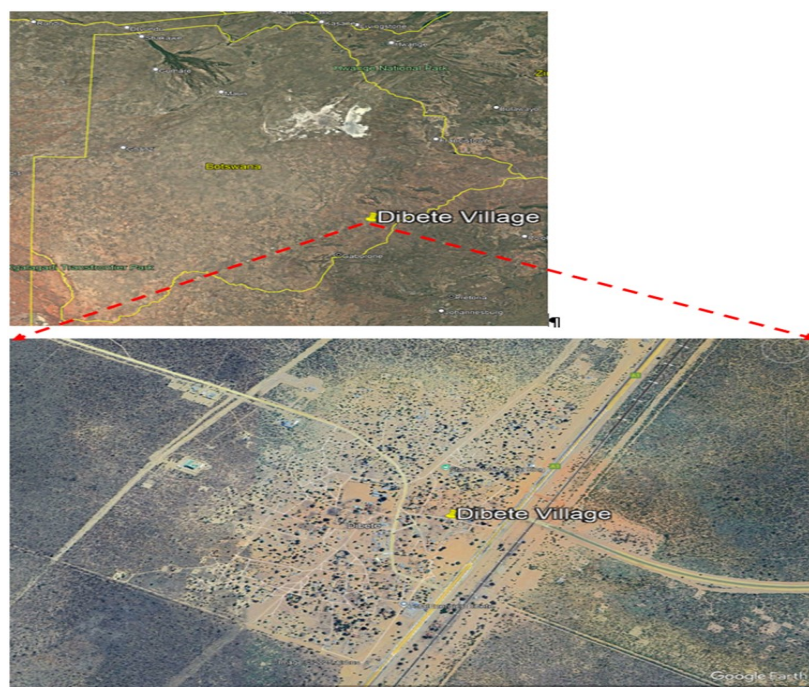


Figure 1. Study area location (google map, 2025)

2.2. Data collection

Data collection was conducted from December 2022 to March 2023. The process unfolded in two phases: the first phase utilized Participatory Rural Appraisal (PRA) to gather insights regarding the community's knowledge, usage, and availability of medicinal plants. The second phase involved socio-economic surveys designed to elucidate the relationship between society and forests. Additionally, secondary data was amassed through comprehensive online desk research, which encompassed educational institutions, published data from governmental and non-governmental sources, strategic frameworks concerning medicinal plants, relevant policies, statistical data, organizational reports, coherence analyses, and archival documents. Field methods employed included focus group discussions and individual interviews. The focus groups consisted of traditional healers, traders, and other significant informants, aimed at identifying key respondents and compiling a thorough checklist of medicinal plants present in the study area. Individual interviews were conducted using semi-structured questionnaires to gather detailed information regarding income derived from medicinal plants, visitation patterns, and the local status of these plants. A minimum of three key informants were purposefully selected from each site, who were then asked to identify the most sought-after medicinal plants based on usage and demand. A total number of 40 participants from Dibete was interviewed.

2.3. Data analysis

The data collected from the survey questionnaires underwent editing to ensure accuracy and consistency, thereby enhancing its quality. Subsequently, the data was coded and entered into a Microsoft Excel spreadsheet, where it was cleaned and then imported into the Statistical Package for the Social Sciences (SPSS) version 16.0 for analysis. Descriptive statistics were employed to characterize quantitative factors, while percentages were utilized to represent qualitative traits. The coherence analysis method allowed the researchers to derive psychological and contextual interpretations of the observations made. Given the relatively small sample size, caution is advised in interpreting the results.

3. Results

3.1. Demographic data

A total of thirty ($n = 30$) local vendors from Dibete village, situated along the A1 Road, were interviewed, in addition to ten ($n = 10$) respondents from within the village (refer to Table 1). The majority of respondents (97.4%) were male, while females constituted 2.6%. The average household size ranged from 5 to 6 individuals, with larger households typically led by a polygamous head. Consequently, while sub-families may reside separately, all members share meals and income. The educational attainment among households was predominantly low, as evidenced by 82% of respondents having not completed tertiary education, while only 14.1% had attended at least some tertiary education (see Table 1). Respondents were categorized into three age groups: young, middle-aged, and elderly. According to the data in Table 1, the largest segment of respondents (38.6%) fell into the middle-aged category, with the elderly and young categories representing 29.5% and 32.1%, respectively. Additionally, the findings in Table 1 revealed that a significant majority of respondents (94.2%) were unemployed.

Table 1. Demographic standing of the Debete respondents. Frequency and valid percent of different variables recorded during this research

Demographic data	Categories	Percentage (%)
Gender	male	97.4
	female	2.6
Educational level	primary	48.7
	secondary	34.0
	tertiary	14.1
	none	3.2
	single	100
Employment status	employed	5.8
	unemployed	94.2
Age	<25 (young)	29.5
	26 – 40 (middle)	38.6
	≥41 (old age)	32.1

Table 2 illustrated a non-significant relationship ($P > 0.208$) between education and gender, indicating no disparity in educational attainment between genders, as both completed similar levels of education.

Table 2. Correlations between gender and education variables

		Gender	Education
Gender	Pearson Correlation	1	0.209
	Sig. (2-tailed)		0.196
	Sum of Squares and Cross-products	3.600	2.000
	Covariance	.092	0.051
	N	40	40
Education	Pearson Correlation	.209	1
	Sig. (2-tailed)	.196	
	Sum of Squares and Cross-products	2.000	25.500
	Covariance	.051	0.654
	N	40	40

Table 2 results indicate that there is no statistically significant relationship between gender and education level in this group. While a slight positive trend ($r = 0.209$) was observed suggesting that one gender may have slightly higher education attainment than the other the p -value ($p \geq 0.05$) confirms that this result is likely due to chance rather than a systematic pattern. While the observed trend suggests a slight directional difference, the

findings are not robust enough to suggest a systematic disparity. Therefore, educational outcomes in this group appear to be driven by factors other than gender identity, highlighting the need for future research with larger, more diverse samples to explore additional socio-economic or environmental variables that may exert a stronger influence on academic success.

3.2. Income from medicinal plants

According to Table 3, there exists a significant association between financial support within families and the monthly earnings from the sale of medicinal plants ($P < 0.001$).

Table 3. Correlation between Financial Support and Monthly Revenue: A Non-Parametric Analysis

			Financial Support	Revenue/ Monthly
Kendall's tau_b	Financial Support	Correlation Coefficient	1.000	0.228
		Sig. (2-tailed)	.	0.097
		N	39	39
	Revenue/ Monthly	Correlation Coefficient	.228	1.000
		Sig. (2-tailed)	0.097	.
		N	39	40
Spearman's rho	Financial Support	Correlation Coefficient	1.000	0.271
		Sig. (2-tailed)	.	0.095
		N	39	39
	Revenue/ Monthly	Correlation Coefficient	0.271	1.000
		Sig. (2-tailed)	0.095	.
		N	39	40

Table 3 shows that although both coefficients indicate a slight positive trend suggesting that higher financial support may be associated with higher monthly revenue the results failed to reach statistical significance at the conventional $\alpha = 0.05$ level. Consequently, possibilities of no relation ship cannot be rejected based on the current sample size ($N=39$). The most likely explanation is a lack of statistical power. With a relatively small sample size, the study may have been underpowered to detect a "true" effect, especially if that effect is small or moderate in the general population. Future research with a larger sample may be required to determine if these trends represent a stable relationship.

3.3. Visitation and use of medicinal plants

Figure 2 demonstrates that a significant 98% of respondents have frequented the forest to gather medicinal plants, in contrast to a small minority of 2% who have not participated in this collection.

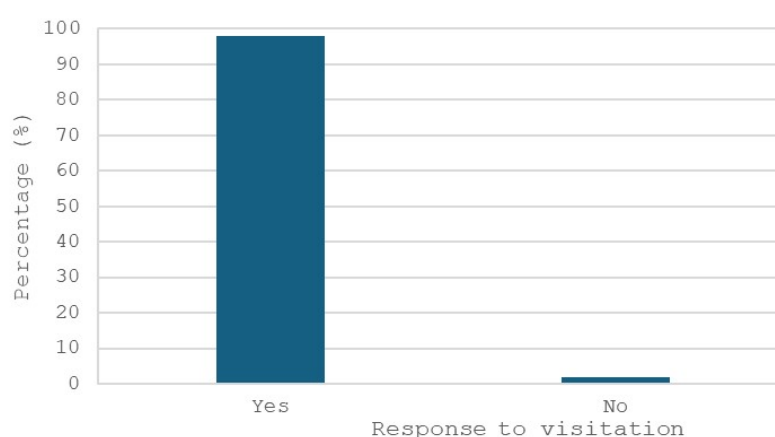


Figure 2. Visitation of forests for medicinal plants

Figure 3 illustrates that 90.46% of the surveyed individuals harvested medicinal plants for sale, in contrast to 9.54% who did so for personal consumption at home.

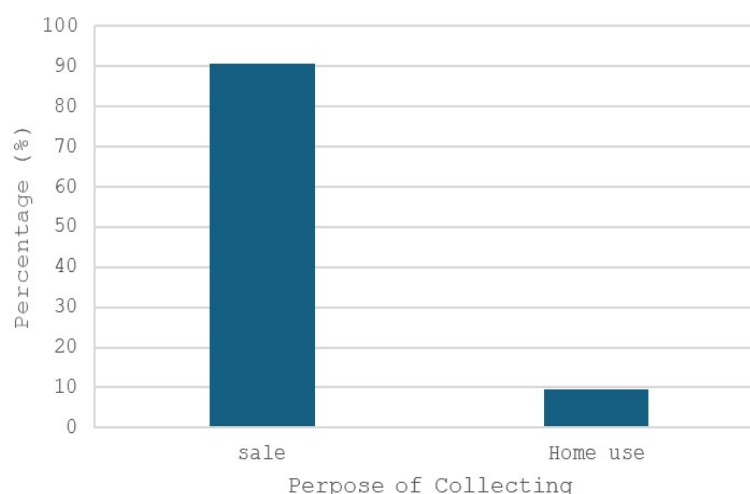


Figure 3. Reasons for collecting medicinal plants from the forest

Figure 4 demonstrated that a significant proportion of respondents rely heavily on medicinal plants in their daily lives, with 75% exhibiting a high level of dependency. Additionally, 20.51% of respondents reported a moderate reliance on these plants, while 3.85% indicated a low level of dependency.

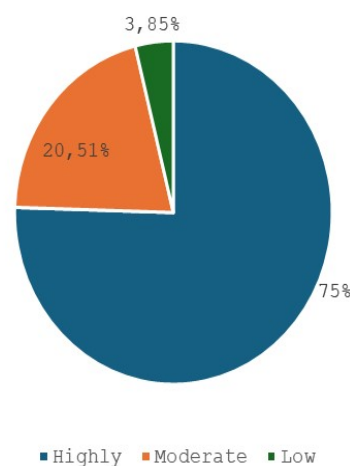


Figure 4. Level of dependence on medicinal plants

3.4. Preferences towards medicinal plants

Table 4 presents the preferred medicinal plants, the specific parts utilized, the number of households employing those parts, and the gender of the users. In total, 34 medicinal plants have been identified as being utilized by the local population in the Dibete region, with various species classified into the following families: Euphorbiaceae, Myrothaminaceae, Hygcinthaceae, Bignoniaceae, Solanaceae, and Capparaceae. These plants are employed to address 22 different ailments affecting both humans and livestock. The respondents' preferences for medicinal plants were assessed based on the existing populations available in their households, which varied from 2 to 12, yielding an average of 4.7 and a mode of 4.

The findings revealed that the most favoured medicinal plant was Motsosa (known as the manhood activator), predominantly purchased by men who utilize the root part. Among the reported uses, the most prevalent include issues related to manhood dysfunction, digestive problems, and cosmetic treatments for women. The most harvested plant parts include subterranean components (roots and tubers), aboveground materials (such as stems and leaves), bark, and fruit, in that order. Occasionally, individuals utilize various parts of the same plant, particularly if it possesses significant utility for multiple medicinal applications, as seen with *Sclerocarya birrea*, *Cassia abbreviate*, and *Ximenia americana*. Most of these medicinal plants are sourced from forested regions.

Figure 5 demonstrated that men comprised 83% of the purchasers of medicinal plants, while 17% is a purchase from females. This trend may be influenced by cultural norms that associate men with decision-making in healthcare matters, as well as their greater exposure to traditional healers. However, various medicinal plants were utilized for distinct purposes, predominantly by both genders.

Table 4. Species preference and use

Name of medicinal plants			Part of plant used					Number household using it	Gender
Scientific name	Family	Local name	Roots	Leave	Bark	Fruit	Use of plant		
<i>Euphorbia tiethymaloides</i>	<i>Euphorbiaceae</i>	<i>Sebabatsane</i>	✓				Cleanse reproductive system	5	M&F
<i>Jatropha erythropoda</i>	<i>Euphorbiaceae</i>	<i>Thotamadi</i>	✓				Cleanse reproductive system	4	F
<i>Harpagophytum procumbens</i>	<i>Myrothamnaceae</i>	<i>Sengaparile</i>	✓				Treat skin rashes	4	F
<i>Urginea sanguinea</i>	<i>Hyacinthaceae</i>	<i>Sekaname</i>					Treatment of skin rashes	4	M&F
		<i>Magorometsa</i>					Penis enlargement	8	M
<i>Oxygonum alatum</i>	<i>Solanaceae</i>	<i>Letswai la khudu</i>		✓			natural contraceptive. Supplement livestock feed	5	F
<i>Hypoxis villosa</i>	<i>Hypoxidaceae</i>	<i>Motsosa</i>	✓				Stimulate libido	3	M
		<i>Lebusa</i>	✓				Cleanse discharge in women. Helps with infertility in women.	5	F
<i>Phragmites australis</i>	<i>Poaceae</i>	<i>Lethaka</i>	✓				Used to cleanse the urinary tract.	4	M
		<i>Khujana</i>	✓				Cleanse blood	5	M
<i>Cadaba aphylla</i>	<i>Capparaceae</i>	<i>Monnamontsho</i>	✓		✓		Cleanse blood	4	M&F
<i>Elephantorrhiza elephantina</i>	<i>Fabaceae</i>	<i>Marotobale</i>	✓		✓		Treat boswagadi	8	F
<i>Cassia abbreviata</i>	<i>Caesalpinaceae</i>	<i>Monepenepe</i>	✓	✓	✓		Herbal tea Help treat diarrhea	3	F
<i>Lycium cinereum</i>	<i>solanaceae</i>	<i>Mmatlakgomo</i>			✓	✓	Cure for asthma	5	M
<i>Erianthemum gamicum</i>	<i>Loranthaceae</i>	<i>Palamela</i>		✓			Cleanse blood	4	M
<i>Bulbinenarcsisifolia</i>	<i>Asphodelaceae</i>	<i>Mmamakgabe</i>	✓				Wound healing	4	M
		<i>Mojaphofu</i>	✓				Treat livestock ailments	6	M
		<i>Mmaxaba</i>					Give body strength	5	M
<i>Thannosmarhodesica</i>	<i>Rutaceae</i>	<i>Moralala</i>	✓	✓			Relieve headaches, fever.	4	M
<i>Abutilon angulatum</i>	<i>Malvaceae</i>	<i>Tshikadihata</i>	✓	✓			Penis enlargement	3	M
<i>Psiadia punctulata</i>	<i>Asteraceae</i>	<i>Masigomabe</i>		✓			Treat internal sores	5	M&F
		<i>Rradipolwana</i>	✓				Cleanse blood	7	M
		<i>Mootapolo</i>	✓				Penis enlargement	4	M
<i>Spredamnocarpus puriens</i>	<i>Malpighiaceae</i>	<i>Tshipisemagala</i>	✓				Cleanse blood	3	M&F
<i>Ximenia americana</i>	<i>Olacaceae</i>	<i>Moretologa</i>	✓	✓	✓		Treat infertility, treat skin problems.	3	F
		<i>Mogagamola</i>	✓				Stimulate libido	9	M
<i>Sclerocarya birrea</i>	<i>Anacardiaceae</i>	<i>Morula</i>		✓	✓	✓	Treatment of diarrhea	3	M
<i>Ozoroa paniculosa</i>	<i>Anacardiaceae</i>	<i>Monokane</i>	✓	✓	✓		Detox kidneys	4	M
<i>Kigelia africana</i>	<i>Bignoniaceae</i>	<i>Moporota</i>	✓	✓	✓	✓	Penis enlargement	12	M
<i>Selaginella panduriforme</i>	<i>Ruscaceae</i>	<i>Mosokela-tsebe</i>					Used to treat asthma	8	M&F
		<i>Lethaka</i>					Relieves pain	2	M
<i>Myrothamnus flabellifolius</i>	<i>Myrothamnaceae</i>	<i>Galalatshwene</i>					Cleanse blood	4	M
<i>Hydnorajohannis</i>	<i>Hydnoraceae</i>	<i>Lethole</i>					Treat skin rashes	7	M&F

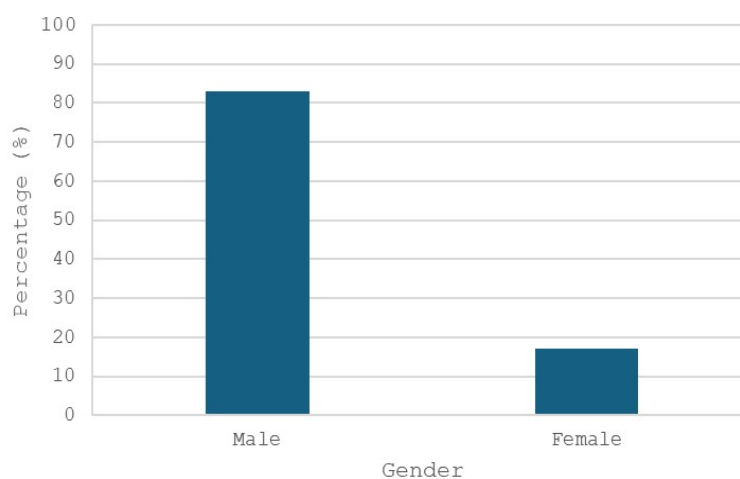


Figure 5. Medicinal usage by gender

4. Discussion

4.1. Socio-economic benefits of medicinal plants

There are multiple reasons why people turn to the sale of medicinal plants for income. Predominantly, these plants have been valued for their healing properties and their role in traditional medicine for centuries (Kala, 2005). In many areas, especially in rural or economically challenged regions, access to modern healthcare is often limited. As a result, local populations frequently rely on traditional medicine as either their primary or supplementary healthcare option (Desta, 1995). This sustained demand for medicinal plants creates economic opportunities for suppliers. The process of cultivating and selling these plants requires relatively modest initial investments and can be pursued by individuals with limited financial resources (Hamilton, 2004). In comparison to other agricultural or business endeavours, the cultivation of medicinal plants generally entails lower production costs and minimal infrastructure requirements. Consequently, individuals with restricted capital or land ownership may find it more practical to engage in the cultivation and sale of medicinal plants as a viable income-generating activity. Additionally, the rising global interest in natural and alternative medicine has further fuelled the demand for medicinal plants (Cunningham et al., 2018). Consumers are increasingly inclined towards organic and plant-based remedies, viewing them as safer and more sustainable options compared to synthetic medications (Li et al., 2016). This shift has enhanced the commercial value of medicinal plants, offering economic incentives for individuals to participate in their cultivation and sale.

4.2. Dependency on medicinal plants

In addition to the notable connection between financial assistance and income generated from the sale of medicinal plants, it is crucial to acknowledge the context of a substantial number of individuals visiting forests to gather these plants, with most indicating that their collection is primarily for commercial purposes rather than personal use. This data sheds light on the motivations driving the dependence on medicinal plant sales as a source of income. The considerable influx of individuals into forests for the purpose of collecting medicinal plants for sale can be linked to several factors. Firstly, the demand for these plants in both local and international markets is considerable. As the popularity of natural and alternative medicine rises, there is an increasing need for medicinal plants as components in various herbal products, supplements, and traditional remedies (Cunningham et al., 2018).

This demand generates economic opportunities for those who can provide these plants, resulting in a greater number of individuals visiting forests for collection. Furthermore, the relative ease of entering the medicinal plant trade plays a role in the high number of collectors; during interviews, respondents noted that selling medicinal plants is a straightforward business since these plants are readily accessible for collection by anyone in Dibete. Moreover, the cultivation and commercialization of medicinal plants typically necessitate lower initial investments compared to other agricultural or business endeavours (Hamilton, 2004). Individuals with limited financial resources or land ownership can partake in the collection and sale of medicinal plants as a means of earning income. This accessibility promotes greater participation in the trade, leading to an increased number of collectors frequenting forests.

4.3. Species preference and use

A variety of medicinal plants were employed to remedy different health issues, as illustrated in Table 4 above. Some of these issues pertained to sexual health, including penis enlargement and libido stimulation. These matters seemed to be of particular concern to men, possibly due to societal expectations and cultural practices. Such influences may shape the purchasing decisions of individuals; in some cultures, men often assume the role of primary decision-makers in household healthcare, which can extend to the procurement of medicinal plants. It is noteworthy that while men were the primary buyers, women also purchased certain medicinal plants for treating various ailments, such as Lebusa, which is utilized for cleansing discharge. Women may be motivated to buy this medication due to their focus on hygiene, personal scent, and the characteristics of their discharge. Moreover, traditional medicine is recognized for its efficacy in addressing prevalent health issues like skin rashes, blood purification, headaches, diarrhoea, and boswagadi (a widowhood state requiring the surviving spouse to perform ritual cleansing and observe specific taboos after a spouse's death) (Tlou, 1996). These rituals are conducted to dissolve the physical and spiritual ties formed during marriage and any future childbirth between the living spouse and the deceased.

The significant reliance depicted in the pie chart regarding medicinal plants can be attributed to various factors, including the traditional knowledge and cultural practices surrounding their use, which are deeply rooted in numerous societies (Voeks, 2017). For generations, these communities have depended on these plants as essential healthcare resources, leveraging their therapeutic benefits to treat a range of health issues and enhance overall well-being. The ongoing utilization and dependence on medicinal plants underscore their efficacy and the

confidence placed in their healing capabilities. Additionally, these plants are often closely linked to local customs, rituals, and belief systems (Pieroni et al., 2018). The application of medicinal plants is perceived not merely as a physical solution but as a holistic approach that encompasses spiritual, emotional, and social dimensions of health. This cultural aspect amplifies the perceived significance and trust in medicinal plants, further solidifying their importance in individuals' lives.

Different components of the tree, such as its leaves, bark, seeds, and flowers, have historically been employed to address a wide range of health issues. According to Table 4, roots were the most frequently utilized parts of the plant in comparison to leaves, twigs, fruits, and barks. The practice of uprooting the entire plant during the collection of medicinal herbs often leads to the displacement of all the plant's inhabitants from their natural environments. If unsustainable harvesting methods are employed, this could lead to overexploitation (Botha et al., 2004). The dynamics of medicinal plant populations can be adversely affected by the removal of roots. Roots are essential for plant reproduction, nitrogen absorption, and soil stabilization (Cunningham et al., 2018). The removal of roots may hinder the plant's ability to regenerate, reduce seed production, and compromise its survival in natural settings (Finch-Savage and Bassel, 2016). Harvesting medicinal plants in a sustainable manner secures their availability for generations to come. These plants serve as sources of remedies for a wide range of conditions and are essential to both traditional and modern healthcare. However, the dangers of overharvesting and habitat destruction jeopardize their survival.

Conclusion

The results of the research indicate a significant reliance on medicinal plants among the participants. This dependence can be linked to the enduring traditional knowledge, ease of access, cost-effectiveness, and cultural importance associated with these plants. The reliance on medicinal plants illustrates their efficacy, affordability, and cultural acceptance as fundamental healthcare resources. The results emphasize the crucial role of medicinal plants in fulfilling the healthcare requirements of individuals and communities, highlighting their significance as a sustainable and culturally integrated healthcare option. This importance is fuelled by the demand for medicinal plants in both local and international markets, the relative simplicity of entering the trade, and the plentiful availability of these plants in forest ecosystems. These elements contribute to the dependence on the sale of medicinal plants as a means of income, underscoring the economic benefits linked to these natural resources. The findings imply that individuals may depend on the sale of medicinal plants for income due to the persistent demand for traditional medicine, the relatively low investment needed for cultivation, and the increasing interest in natural remedies.

However, these medicinal plants are primarily sourced from wild habitats, where there is no assurance of a consistent supply due to issues such as over-harvesting, over-exploitation, and potential extinction. The primary sources of medicinal plants are often wild habitats, where the reliability of supply is compromised by factors such as over-harvesting, over-exploitation, and the risk of extinction. This situation highlights the urgent need for sustainability research. Future investigations could delve into the specific elements that contribute to the economic success of those involved in the medicinal plant trade, including market conditions and strategies for resource management. Additionally, the study pointed out that a significant number of these plants are harvested by their roots, which could lead to a long-term decrease in biodiversity; excessive root harvesting can diminish the diversity of plant species. When plants are consistently harvested for their roots, it may result in the competitive exclusion or displacement of other species, potentially disrupting the ecological balance for organisms that depend on these plants for food, shelter, or other vital resources.

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