

Assessing the Conservation Status, Perceptions and Cultural Beliefs Towards Traded Medicinal Plants to Inform Community-Led Conservation Interventions in Namutumba District, Eastern Uganda

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Abstract

Medicinal plants play a vital role in traditional healthcare and local economies in Uganda. Despite their importance, their survival is increasingly threatened by climate change, overharvesting, lack of conservation measures and unregulated trade. We investigated how trade, perceptions and cultural beliefs influence the conservation of medicinal plants species. A cross-sectional study was conducted in Namutumba District, Eastern Uganda, covering 17 sub-counties and targeting 300 respondents (herbalists, primary collectors, and traders) and 10 key informants using a semi structured questionnaire and interview guide. Quantitative data were analyzed using SPSS, while qualitative data were analyzed thematically to explore respondent perceptions and cultural beliefs regarding medicinal plant conservation. This study revealed that 27 medicinal plant species are highly traded in Namutumba district with over 70% of the respondents selling above 1 Kg of herbal medicine per week, a clear indication of the pressure that trade is exerting on medicinal plants. Notably with great concern, some of these plants (*Warburgia ugandensis*, *Prunus africana*, *Tamarindus indica* and *Mondia whitei*) have been cited as being critically endangered or vulnerable to extinction. Some of these plants have become very scarce over the last 5 years. Most respondents expressed positive perception towards the conservation medicinal plants for future generations and acknowledged the role of cultural beliefs in conservation. The study underscores the need for culturally sensitive, community-driven conservation strategies for ensuring conservation and sustainable utilization of medicinal plants in Namutumba district. There is an urgent need to come up with interventions to conserve the threatened and vulnerable medicinal plant species.

Background to the study

Medicinal plants have long served as a fundamental component of healthcare across cultures, playing a crucial role in treating a wide range of ailments (Shukla, 2023; Hounsou et al., 2024). Their importance remains particularly high in developing countries, where healthcare systems are often under-resourced, and traditional medicine offers an accessible and affordable alternative (Asigbaase et al., 2023; Mbelebele et al., 2024; Mapunda & Mramba, 2025). In Uganda, as in many parts of Africa, traditional medicine remains deeply embedded in local cultures and daily health practices, especially in rural and peri-urban communities (Ssenku et al., 2022). The widespread use of medicinal plants underscores the urgent need to conserve these valuable species.

Despite their recognized value, medicinal plant species are increasingly under threat (Mapunda & Mramba, 2025). The rising global demand for herbal products, coupled with habitat loss, climate change, and unsustainable harvesting practices, are leading to rapid depletion of many species (Applequist et al., 2020; Jimoh et al., 2023). This overexploitation not only threatens biodiversity but also jeopardizes the sustainability of traditional health systems and the economies that depend on them. Furthermore, environmental pressures such

as shifting temperature and rainfall patterns may alter the chemical composition and therapeutic potency of medicinal plants (Applequist et al., 2020).

Eastern Uganda, in particular, faces a significant risk of medicinal plant species extinction, driven by a combination of factors. These include climate change, illegal and unregulated trade, overharvesting, and inadequate conservation strategies (Chen et al., 2016; Ssenku et al., 2022). Key species such as *Ricinus communis* and *Ocimum basilicum* have already shown vulnerability to climate-induced changes in phenology and availability. Unpredictable weather patterns further exacerbate the situation, impacting local harvesting cycles and the reliability of traditional medicine (Harish et al., 2012; Hounsou et al., 2024). While the herbal medicine industry has grown into a multibillion-dollar global market, with exports projected to reach over US\$5 trillion by 2050 (Jadhav et al., 2020), there is very little effort dedicated on their conservation and sustainable utilization. The booming demand for medicinal plants incentivizes indiscriminate harvesting, especially for informal markets dominated by local collectors, healers, and traders, most of whom operate outside formal regulatory frameworks (Rasethe et al., 2019; Mofokeng et al., 2022).

Traditional knowledge about medicinal plants includes time-tested, culturally-rooted methods of identification, understanding, application and conservation of plant-based therapies for health care, which are frequently passed down through generations. Like elsewhere in Africa, in Uganda, this knowledge is often transmitted orally and remains undocumented (Mbelebele et al., 2024). Moreover, this knowledge is increasingly threatened by environmental degradation, commercial exploitation, industrialization, adoption of Western lifestyles, and the marginalization of indigenous conservation practices. Studies reveal low levels of awareness regarding climate change impacts on medicinal plant diversity and a lack of commitment to cultivation practices among local communities (Agunbiade et al., 2012).

Despite their central role in the medicinal plant value chain, the knowledge, perceptions, and attitudes of stakeholders such as herbalists, traders, and local healers towards conservation have not been systematically assessed in Eastern Uganda. This gap hinders the development of targeted, community-informed strategies for the sustainable management of these resources. In response, this study sought to explore and analyze local knowledge and conservation behaviors related to commonly traded medicinal plants in Eastern Uganda within the context of climate change and commercialization. Understanding local attitudes and perceptions could help shape conservation frameworks that not only protect plant biodiversity but also support the livelihoods of communities dependent on traditional medicine. By engaging stakeholders across the medicinal plant value chain, the research aims to inform evidence-based conservation interventions that are culturally relevant, environmentally adaptive, and socioeconomically inclusive.

MATERIALS AND METHODS

Description of study site

Namutumba District is located in Eastern Uganda between latitudes 0°41'49.173"N and 1°19'55"N and longitudes 33°37'59.308"E and covers 812 Sq. Km. The elevation of Namutumba district is approximately 1,080 meters above sea level. It is approximately 120 Km northeast of Kampala, the capital city of Uganda, and 45 Km northwest of Jinja city which is the largest city in Busoga region. The dominant ethnic group is the Basoga whose local language is Lusoga. The district population increased from 252,557 in 2014 to 311,463 in 2024 (growth rate of 2.3% annually), with 157,349 (50.5%) being female (UBOS, 2024). The local economy is largely agrarian, with 85% of the rural population engaged in subsistence farming. Key crops include rice, cassava, millet, groundnuts, and sorghum. Namutumba is one of the poorest districts in the region and like many similar communities, it grapples with inadequate healthcare resources, increasing their reliance on herbal medicine for primary health care. The district is served by two private hospitals, one health centre IV, seven health centre III, and 25 health centre II (Namutumba, 2022).

Namutumba District experiences a tropical climate characterized by a bimodal rainfall pattern, with two main rainy seasons occurring from March to June and August to November. Annual rainfall ranges from 900 mm to 1,150 mm, with an average of approximately 1,000 mm. The temperature ranges between 22°C and 27°C, with an annual mean temperature of 25°C. Despite its relatively favorable climatic conditions for agriculture, the district is increasingly affected by climatic extremes, such as unpredictable rainfall and prolonged dry spells, which pose a threat to the survival and sustainability of local plant diversity, including medicinal plant species. The study was conducted in 17 sub-counties of the District (Fig. 1).

Study population

Namutumba district remains one of the least economically developed in Eastern Uganda, with widespread poverty and limited access to quality healthcare. Health services are constrained, prompting many residents to rely on traditional herbal medicine for both health care and income. The study targeted herbalists, primary collectors, and traders of herbal medicine in Namutumba district. The herbalists were medical practitioners who were directly interacting with patients seeking medical treatment, primary collectors were involved in collection and cultivation of medicinal plants while traders were involved in small scale and large scale sale of medicinal plants. From consultations with the District Community Development Officer (DCDO), 1,400 registered herbal medicine practitioners were identified. A sample of 300 participants was determined using the Krejcie and Morgan (1970) table, and selected through simple random sampling: 240 herbalists, 33 primary collectors, 26 retailers, and 1 wholesaler. Additionally, 10 Key Informants were purposively selected based on their knowledge and expertise in Namutumba district's herbal medicine sector. These included District Community Development Officer (DCDO), District Environmental Officer, District Health Officer, District Forestry Officer, leaders of traditional medical practitioner's association (Tweyambe

Association, Uganda Ne Dagalalyayo, Uganda Traditional Healers and Herbalist Association, Medicinal Plant Traders, Uganda Herbalist and Cultural Association and Traditional Birth Attendants).

Data collection

This was a cross-sectional study using both quantitative and qualitative techniques. Data collection was done between May and September 2024. Face-to-face interviews with herbalists, primary collectors and traders were conducted using a pretested semi-structured questionnaire administered through the Open Data Kit (ODK) software. The questionnaire sought data on socio-demographic characteristics of respondents and explored their perceptions and cultural beliefs on the conservation of medicinal plants. The perceptions were measured using a five point Likert scale. Key Informant interviews were conducted using open-ended questionnaire. All interviews were conducted in Lusoga, and in some cases, in English.

Voucher specimens for the medicinal plants were collected using standard procedure described by Carter et al. (2007) and deposited at Makerere University Herbarium for identification and repository. Scientific names were verified using the comprehensive WFO Plant List database accessed at <https://wfoplantlist.org/>. The global and national threat status of the plants were determined through the IUCN Red List of Threatened Plants (<https://www.iucnredlist.org/>) and the National Plant Threat Status Redlist For Uganda (Prinsloo et al., 2016), respectively.

Data analysis

The data were entered into Ms Excel, cleaned, coded and exported to IBM SPSS version 20.0 for analysis. Frequency tables, bar graphs, and proportions were used to present socio-demographic data and major research findings. Bivariate analyses were done using chi-square test to explore the association between socio-demographic factors and level of respondents' perceptions and cultural beliefs on the conservation of medicinal plants. In addition, ordinal logistic regression was used to model the influence of key demographic variables on selected perceptions, regardless of their initial bivariate significance in order to explore potential interaction effects and control for confounding effects. All statistical analyses were done at 5% level of significance using SPSS Version 20.0 (Armonk, NY: IBM Corp). Data visualization was performed on Graphpad Prism software (v8.0.2; GraphPad Software, San Diego, CA, USA).

For qualitative data, all the interviews that were audio recorded were transcribed verbatim. The Key Informant interviews that were conducted in local languages were translated into English and then transcribed. Validated transcripts were read by a team of four people to

identify and generate the codes, main themes and sub themes. The codes were compared and differences were resolved for validity and reliability.

RESULTS

Socio-demographic characteristics of the respondents

A total of 236 (78.7%) males and 64 females (21.3) were interviewed in this survey with the biggest number of respondents (37.7%) being 41-50 years in age (Table 1). Eighty-nine percent of the respondents were married and 61% had attained at least primary-level education (Table 1). Majority of the respondents were either Muslims (49%) or Christians (35.7%).

Table 1
Socio-demographic characteristics of the respondents

Variable	Frequency	%	Variable	Frequency	%
Marital status			Gender		
Divorced/ Separated	13	4.3	Male	236	78.7
Married	267	89.0	Female	64	21.3
Single	20	6.7	Age		
Religion			< 30	14	4.7
Muslim	147	49.0	>61	31	10.3
Pentecostal	3	1.0	31-40	76	25.3
Protestant	107	35.7	41-50	113	37.7
Seventh day Adventist	1	0.3	51-60	66	22.0
Jews faith	1	0.3	Highest education		
Catholics	29	9.7	None	88	29.3
African Traditional Religion	12	4.0	Primary	183	61.0
Quantity of herbal medicine sold per week			Secondary	28	9.3
<1 Kg	91	30.3	Tertiary	1	0.3
>10 Kg	13	4.3	Category		
1-5 Kg	166	55.3	Herbalists	240	80.0
6-10 Kg	30	10.0	Primary collector	33	11.0
			Retailors	26	8.7
			Whole seller	1	0.3

Commonly traded medicinal plants

This study revealed that over 70% of the respondents sold above 1 Kg of herbal medicine per week (Table 1), a clear indication of the pressure that trade is exerting on medicinal plants, a threat to their conservation. At an average of 1 Kg per person for the 70% (210) respondents translates to 210 Kg of medicinal plants per week. This underscores the need to device strategies to protect and conserve medicinal plant species.

This study interviewed 10 key informants who included leaders of herbalist associations, the district forestry officer, the district community development officer, leaders of medicinal plant

traders' associations and district health officer. The key informants corroborated the study findings by listing 27 medicinal plant species that are highly traded in Namutumba district (Table 2). Notably with great concern, some of these plants have been cited as being critically endangered or vulnerable to extinction by the IUCN Red List of Threatened medicinal plants and Prinsloo et al. (2016). Among these species, it was only *Warburgia ugandensis*, that is reported to be critically endangered as per the IUCN Red List of Threatened Species (<https://www.iucnredlist.org/>) (Table 2). Similarly, it is only *Prunus africana* that is reported to be vulnerable by the IUCN Red List of Threatened Species. We went ahead to assess the national threat status of the highly traded medicinal plants in Namutumba district using The National Redlist by Prinsloo et al. (2016) and it revealed that *Warburgia ugandensis*, *Prunus africana*, *Tamarindus indica* and *Mondia whitei* are 'vulnerable' to extinction (Table 2).

These medicinal plant species are used to treat several ailments, and are thus on high demand nationally. However, there are no efforts to ensure sustainable utilization to conserve the species for the future generations. Therefore, there is an urgent need to come up with species-specific conservation interventions for the threatened medicinal plant species. The remaining species are reported to be either of 'least concern' or 'not evaluated'.

Table 2
Commonly traded medicinal plants in Namutumba district

No.	Local name	Family	Scientific name	Global Threat Status	National Threat Status
1.	Balwegira	Canellaceae	<i>Warburgia ugandensis</i> Sprague	Critically Endangered	Vulnerable
2.	Entasesa	Rosaceae	<i>Prunus africana</i> (Hook.f.) Kalkman	Vulnerable	Vulnerable
3.	Enkoge	Fabaceae	<i>Tamarindus indica</i> L.	Not Evaluate	Vulnerable
4.	Mulondo	Apocynaceae	<i>Mondia whitei</i> (Hook.f.) Skeels	Not Evaluated	Vulnerable
5.	Olweza	Amaranthaceae	<i>Aerva lanata</i> (L.) Juss.	Not Evaluated	Not Evaluated
6.	Mululuza	Asteraceae	<i>Gymnanthemum amygdalinum</i> (Del.) Sch.Bip ex Walp.	Not Evaluated	Not Evaluated
7.	Kafugangande	Asteraceae	<i>Conyza pyrrhopappa</i> Sch.Bip. ex A.Rich.	Not Evaluated	Not Evaluated
8.	Kayayana	Asteraceae	<i>Cyanthillium cinereum</i> (L.) H.Rob.	Not Evaluated	Not Evaluated
9.	Mukasa	Asteraceae	<i>Emilia coccinea</i> (Sims) G.Don	Not Evaluated	Not Evaluated
10.	Izimya	Asteraceae	<i>Solanecio angulatus</i> (Vahl) C. Jeffrey	Not Evaluated	Not Evaluated
11.	Lubirizi olutono	Rubiaceae	<i>Microglossa pyrifolia</i> (Lam.) Kuntze	Not Evaluated	Not Evaluated
12.	Omukondwa	Burseraceae	<i>Commiphora africana</i> (A. Rich.) Engl.	Least Concern	Not Evaluated
13.	Katasubwa	Capparaceae	<i>Capparis tomentosa</i> Lam.	Not Evaluated	Not Evaluate
14.	Zizi	Cucurbitaceae	<i>Kedrostis foetidissima</i> (Jacq.) Cogn.	Not Evaluated	Not Evaluate
15.	Castor plant	Euphorbiaceae	<i>Ricinus communis</i>	Least Concern	Not Evaluate

No.	Local name	Family	Scientific name	Global Threat Status	National Threat Status
16.	Musita	Fabaceae	<i>Albizia coriaria</i> Welw. ex Oliv.	Least Concern	Not Evaluate
17.	Mukyusa nduba	Fabaceae	<i>Chamaecrista nigricans</i> (Vahl) Greene	Not Evaluated	Not Evaluated
18.	Newtonia	Fabaceae	<i>Newtonia buchananii</i> (Baker) G.C.C.Gilbert & Boutique	Least Concern	Not Evaluated
19.	Muhologoma	Fabaceae	<i>Vachellia amythethophylla</i> (Steud. ex A.Rich.) Kyal. & Boatwr.	Least Concern	Not Evaluated
20.	Nimu	Meliaceae	<i>Azadirachta indica</i> A. Juss	Least Concern	Not Evaluated
21.	Mugailei	Moraceae	<i>Ficus natalensis</i> Hochst.,	Least Concern	Not Evaluated
22.	Moringa	Moringaceae	<i>Moringa oleifera</i> Lam.	Least Concern	Not Evaluated
23.	Kalitunsi	Myrtaceae	<i>Eucalyptus tectonia</i>	Not Evaluated	Not Evaluated
24.	Lukandwa	Phyllanthaceae	<i>Flueggea virosa</i> (Roxb. ex Willd.) Royle	Least Concern	Not Evaluated
25.	Mpoza	Talinaceae	<i>Talinum portulacifolium</i> (Forssk.) Asch. ex Schweinf.	Least Concern	Not Evaluated
26.	Kikaka	Asphodelaceae	<i>Aloe perfoliata</i> L.	Least Concern	Not Evaluated
27.	Mutambula-kiro	Anacardiaceae	<i>Lannea barteri</i> (Oliv.) Engl.	Least Concern	Not Evaluated

Availability of medicinal plants in Namutumba district over the last 5 years

We went further to investigate the availability of medicinal plants over the last 5 years in Namutumba district. Quite interestingly, majority of the respondents (88%) agreed that most of the plants have become very scarce to find over the last 5 years (Fig. 2, Table 3). A smaller proportion (9%) reported that most of the plants were available while 2% stated that none

were available (Fig. 2, Table 3). Despite having the knowledge of the rapidly disappearing medicinal plants, a potential threat to their existence, no interventions have been designed to ensure that these medicinal plants are protected and conserved.

Table 3
Medicinal plants whose availability has declined over the past five years in Namutumba district

No.	Local name	Family	Scientific name	Global Threat Status	National Threat Status
1.	Makaka	Fabaceae	<i>Carmichaelia australis</i> R.Br.	Least Concern	Not Evaluated
2.	Omulilira	Hypericaceae	<i>Harungana madagascariensis</i> Lam. ex Poir.	Least Concern	Not Evaluated
3.	Omukondwa	Burseraceae	<i>Commiphora africana</i> (A. Rich.) Engl.	Least Concern	Not Evaluated
4.	Muhologoma	Fabaceae	<i>Vachellia amythethophylla</i> (Steud. ex A.Rich.) Kyal. & Boatwr.	Least Concern	Not Evaluated
5.	Omuwaiswa	Celastraceae	<i>Gymnosporia senegalensis</i> (Lam.) Loes.	Least Concern	Not Evaluated
6.	Omuyirigiti	Fabaceae	<i>Erythrina abyssinica</i> Lam.	Least Concern	Not Evaluated
7.	Mutambula-kiro	Anacardiaceae	<i>Lannea barteri</i> (Oliv.) Engl.	Least Concern	Not Evaluated
8.	Izimya	Asteraceae	<i>Solanecio angulatus</i> (Vahl) C.Jeffrey	Not Evaluated	Not Evaluated
9.	Muzinga kyalo	Capparaceae	<i>Maerua triphylla</i> A. Rich.	Not Evaluated	Not Evaluated
10.	Mukyusa nduba	Fabaceae	<i>Chamaecrista nigricans</i> (Vahl) Greene	Not Evaluated	Not Evaluated
11.	Mukitimbo	Fabaceae	<i>Indigofera garckeana</i> Vatke	Not Evaluated	Not Evaluated
12.	Mwesende	Malvaceae	<i>Sida cuneifolia</i> Roxb.	Not Evaluated	Not Evaluated
13.	Mutamatama	Rubiaceae	<i>Mitragyna rubrostipulata</i> (K.Schum.) Havil.	Not Evaluated	Not Evaluated
14.	Mpangula	Ranunculaceae	<i>Clematis hirsuta</i> Guill. & Perr.	Not Evaluated	Not Evaluated
15.	Kikaka	Asphodelaceae	<i>Aloe perfoliata</i> L.	Least Concern	Not Evaluated
16.	Katasubwa	Capparaceae	<i>Capparis tomentosa</i> Lam.	Not Evaluated	Not Evaluate

No.	Local name	Family	Scientific name	Global Threat Status	National Threat Status
17.	Zilba	Unidentified	Unidentified		
18.	Tusangaire	Unidentified	Unidentified		
19.	Mugabe	Unidentified	Unidentified		
20.	Iwosa	Unidentified	Unidentified		
21.	Rundusu	Unidentified	Unidentified		
22.	Bakitya	Unidentified	Unidentified		

Importance of conservation and strategies for protecting medicinal plants amidst climate change

When asked about the importance of conserving medicinal plants, the most common reason cited was their availability and accessibility (98.3%) (Fig. 3A). In contrast, provision of ecosystem services was the least cited reason (29.3%) (Fig. 3A). Key informants corroborated these findings by listing affordability, accessibility, income generation and ability to treat various ailments as key reasons for conservation of medicinal plants. This study also revealed that the respondents were aware of practices that could contribute to conservation and sustainable utilization of medicinal plant resources which included the use sustainable harvesting practices (96.3%), conservation of *in-situ* habitats (94.3%) and breeding for climate resilience (39.7%) (Fig. 3B). A quarter of the respondents (25%) reported the presence of community-led initiative to combat the effects of climate change whereas 75% believed no such initiatives existed in their areas.

Key informants noted that the limited access to communal land hindered collective conservation efforts leading to most medicinal plants being conserved in home gardens. Nonetheless, they acknowledged the substantial efforts by the district administration to conserve wetlands, a key habitat of many medicinal plants. When asked about the existence of laws regarding the collection, processing and selling of medicinal plants, 38.7% believed that such laws existed while a large number (61.3%) were unaware. A vast majority of the respondents (98%) expressed the need for increased awareness about conservation of medicinal plants. Key informants reported that formal environmental conservation awareness programs were largely lacking. They also noted that district leaders have proposed launching awareness initiatives through community dialogues, radio talk shows, and enhancement of wetland restoration efforts.

Perceptions on conservation of medicinal plants

Most respondents expressed positive perception towards the importance of conserving medicinal plants for future generations and showed a willingness to support community-based conservation initiatives (Table 4). Additionally, 85.7% of respondents agreed or strongly agreed that cultivation of medicinal plants could support the conservation of medicinal plant species. However, 31.4% reported non-compliance with regulations on medicinal plants conservation, and 33.3% indicated that current laws and policies are inadequate. An overwhelming majority (99.3%) of respondents believe that climate change impacts the conservation of medicinal plants. Furthermore, 69.7% agreed or strongly agreed that cultural and socio-economic factors influence their perceptions towards conservation. Most respondents (89.3%) believe that community-based initiatives are essential for the conservation of medicinal plants and emphasized the need for community involvement in the design and implementation of conservation strategies (Table 4).

Key informants called for the involvement of government in the conservation of medicinal plants. They recommended strict enforcement of regulations on harvesting medicinal plants, promotion of *ex-situ* conservation efforts and establishment of demonstration farms for medicinal plants cultivation by government. They further highlighted the need for the formal integration of herbal medicine into national healthcare system, training of traditional healers, sensitization on sustainable harvesting practices and value addition techniques to increase shelf life of medicinal plants. Increase in staffing and funding for research and development in the forestry sector were also recommended. Key informants further stressed the need for herbalists to collaborate with the local council to identify and conserve the endangered or vulnerable medicinal plant species. Reforestation was also strongly recommended with each individual urged to plant at least 10 trees during each rainy season.

Table 4
Respondents' perceptions (%) towards conservation of medicinal plants (n = 300)

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Overall Perception	
						Positive	Negative
It is important to conserve for future generations	--	--	--	16.7	83.3	100.0	--
I am willing to support community conservation	--	--	--	25.0	75.0	100.0	--
Conservation should be prioritized over resource use	--	--	4.0	37.7	58.3	96.0	--
I am concerned about declining populations of medicinal plants	--	9.0	6.7	30.7	53.7	84.4	9.0
I am willing to volunteer in medicinal plant conservation efforts	--	0.3	2.3	25.3	72.0	97.3	0.3
Trade threatens the conservation of medicinal plants	--	2.3	17.3	32.0	48.3	80.3	2.3
Community-centered interventions leads to sustainability of medicinal plants	--	0.3	16.0	38.0	45.7	83.7	0.3
There is need for strict licensing to regulate the	0.3	9.0	41.0	19.7	30.0	49.7	9.3

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Overall Perception	
access and use of medicinal plants							
Existing policies are adequate to address conservation and sustainable utilization of medicinal plants	14.3	19.0	43.0	12.3	11.3	23.6	33.3
There is need for medicinal plant conservation awareness campaigns	--	--	11.7	38.3	50.0	88.3	--
My community values medicinal plant conservation	9.3	10.3	26.3	30.3	23.7	54.0	19.6
Medicinal plants obtained from the wild plants are more effective than those cultivated	11.3	1.7	14.3	28.3	44.3	72.6	13.0
Climate change has an impact on the availability and conservation of medicinal plants	--	0.3	0.3	12.3	87.0	99.3	0.3

Relationship between social demographic factors and selected perceptions towards medicinal plant conservation policies

The statistical analysis revealed a significant association between respondents' age and their willingness to support medicinal plant conservation (Chi square test, $\chi^2 = 14.20$, $df = 4$, $p = 0.0067$).

The highest level of willingness to support medicinal plants conservation was observed among individuals aged 41–50, with 113 respondents agreeing or strongly agreeing (Fig. 4). High levels of medicinal plant conservation support were also recorded among those aged 31–40 and 51–60 (Fig. 4).

The statistical analysis also revealed a significant association between respondents' sex and their perception of the adequacy of existing policies and laws on medicinal plant conservation (Chi square test, $\chi^2 = 14.47$, $df = 4$, $p = 0.0059$) (Fig. 5A). A higher proportion of females (32.8%) compared to males (21.2%) considered the policies adequate, suggesting greater confidence in the legal framework among women (Fig. 5A).

We report a significant association between sex and the perception of community awareness and compliance with laws related to the collection, processing, and sale of medicinal plants ($\chi^2 = 15.41$, $df = 4$, $p = 0.0039$) (Fig. 5B). Similar to the adequacy of conservation policies, although more males agreed overall, a greater proportion of females (50.0%) than males (43.2%) agreed or strongly agreed, indicating relatively higher confidence in the policies among women (Fig. 5B).

Cultural beliefs on conservation of medicinal plants

A substantial proportion of the respondents (86.7%) affirmed the existence of cultural beliefs that influence medicinal plant conservation. About 89.3% of the respondents acknowledged the existence of taboos related to the harvesting or use of certain medicinal plants.

Concerning the role of traditional knowledge and practices on the sustainable utilization of medicinal plants, majority of the respondents (82%) expressed the view that these practices contribute positively to sustainability. Conversely, 8.7% believed that traditional practices do not support sustainable use, and 9.3% indicated lack of awareness regarding such practices. Furthermore, 76% of the respondents believed that traditional healers play a role in ensuring the sustainable utilization of medicinal plants. Key informant interviews revealed limited awareness of cultural practices explicitly aimed at medicinal plant conservation. However, some informants acknowledged that certain traditional customs indirectly promote medicinal plants conservation efforts. These include the use of specific medicinal plant species as landmarks, planting of medicinal plants around water sources, and cultivation of medicinal plants by elderly community members who recognize their therapeutic value.

Majority of respondents (86.3%) reported the use of medicinal plants in rituals or ceremonies. A large proportion of the respondents (87.3%) have observed changes in the cultural beliefs related to medicinal plant use over the past decade. When asked about the impact of modernization and globalization on cultural beliefs associated with medicinal plants, 88% of the respondents acknowledged a significant impact. Most of the respondents (86%) further

believed that conflicts exist between cultural beliefs and contemporary conservation efforts. Key informants highlighted that certain cultural beliefs, such as *Milicia excelsa* trees harboring malevolent spirits, hindering conservation initiatives. Additionally, it was noted that some religious leaders actively preach against the use of medicinal plants, which could further impede conservation efforts.

An overwhelming majority (92.3%) of the respondents acknowledged the use of rituals before the harvesting, use and processing of medicinal plants. Furthermore, 88.3% of the respondents believed that certain medicinal plants should not be cultivated but only used from wild collections. Interestingly, when asked whether customers would be willing to buy cultivated medicinal plants, a significant proportion of the respondents (86.3%) believed customers would accept. A small proportion (2.3%) believe customers would reject cultivated medicinal plants, while 11.3% were uncertain.

DISCUSSION

Socio-demographic characteristics of the respondents

In this study, a vast majority of the respondents (78.7%) were males indicating their dominance in the traditional herbal industry in Namutumba District. The dominance of males in the herbal industry was reported in some parts of Uganda such as Butaleja district (Ssenku et al., 2022) and in other African countries such as Malawi (Ajak et al., 2018). Comparable trends were also observed in China (Liu et al., 2021) and Nepal (Pyakurel et al., 2018). In most African societies, traditional knowledge is passed through patrilineal lineage which could explain the higher involvement of males in the herbal industry. However, female dominance in the traditional herbal industry have been reported elsewhere, for example in Ghana (Van Andel et al., 2012) and Benin (Quiroz et al., 2014). These studies confirm that gender disparities in herbal sector are not universal rather they are socially and culturally constructed. Therefore, there should be programs to increase women participation in the herbal industry in male dominated herbal sectors like Namutumba district to ensure inclusivity development. In this study, majority of the respondents (70%) were aged 41 or older indicating an increasing role of the elderly in the medicinal plant industry. Elderly people aged greater than 40 were found to have significant knowledge about medicinal plants than those aged between (18–40) years in Ethiopia (Giday et al., 2003). In addition, Abera (2014) reported that the young generation in the Chimbi district, Ethiopia, showed little interest in sharing knowledge about the use of medicinal plants.

Medicinal plant conservation amidst climate change and proliferating trade

Many of the respondents in this study emphasized the need to conserve medicinal plants. The major reason for conserving medicinal plants was to increase their availability and accessibility while other ecosystem services were minimally mentioned. The minimal citation

of ecosystem services could be associated with limited understanding of broader ecological roles of the ecosystems where medicinal plants are habited. Thus, the current conservation efforts are mainly motivated by the utilitarian values while undervaluing the long-term ecological functions of medicinal plants. This could in the near future lead to exploitation of medicinal plants to levels that may accelerate medicinal plants depletion and further weaken climate adaptation systems. Thus, there is need for targeted campaigns that go beyond these immediate values.

A vast majority of respondents reported the use of sustainable harvesting to conserve medicinal plants. These self-reported statistics on sustainable harvesting practices are promising but may not be relied on. For sustainable medicinal plants utilization to be guaranteed in Namutumba, there is a need for well-designed community structures, monitoring, and incentivization. In this study, 75% of the respondents believed that there were no community based initiatives to protect medicinal plants from effects of climate change and trade. This reflects a significant gap in environmental protection and thus there is need to empower communities to address effects of climate change and trade on the availability and sustainability of medicinal plants.

While 98% of respondents supported the need for increased conservation awareness, key informants pointed out the absence of formal education programs, noting that awareness efforts currently occur informally during social events such as community gatherings or funerals. This indicates strong community willingness but institutional failure in Namutumba district. Furthermore, 61.3% of respondents in this study believed that there are no laws regarding the collection, processing and selling of medicinal plants. This gap in legal awareness suggests poor policy communication or enforcement. In the face of climate change, strong legal frameworks are essential to prevent overharvesting, promote cultivation and regulate trade routes. Therefore, there is a need for adoption of climate-adaptive medicinal plant conservation strategies.

Perceptions on conservation of medicinal plants

Interestingly, all respondents in this study demonstrated positive attitudes towards conservation of medicinal plants for future generations and they supported community-based conservation. This is in line with Khan et al. (2022) who reported that 70% of the respondents supported natural resource conservation with 98% preferring the adoption of community-based strategies. This study shows poor knowledge and compliance to regulatory guidelines such as licensing. Only 44.7% of the respondents believed that it was important to be compliant with regulations involved in the medicinal plant industry. Poor compliance to regulatory guidelines is not unique to Namutumba district but a phenomenon that was similarly reported by Ouoba et al. (2022), where vast majority of herbalists (82%) and herbal medical centers (92%) did not have licenses to operate. Key informants in this study emphasized the need for the government to play a major role in conservation of medicinal plants and also called for increased collaboration between herbalists and the government.

The Ministry of health in Uganda has proposed a Bill to establish a National Council for Indigenous and Complementary Medicine Practitioners to foster collaboration between traditional practitioners and modern healthcare, regulate traditional practice, and protect intellectual property rights, aiming for better integration, standardized practices, and preservation of traditional knowledge (De Coninck, 2019). In this study, social demographic factors did not influence attitudes towards medicinal plant conservation policies. Although social-demographic factors may not directly influence policy, they are important in preserving ethnobotanical knowledge (Tamene et al., 2024).

Cultural beliefs on conservation of medicinal plants

The findings from the study reveal that cultural beliefs and traditional knowledge systems could play a pivotal role in shaping conservation attitudes and practices towards medicinal plants in Namutumba. With 86.7% of respondents affirming that cultural beliefs influence conservation, it is evident that local beliefs and value systems, such as the protection of spiritually significant forests may act as informal but powerful medicinal plant species conservation mechanisms. This is consistent with findings from a similar study by Ssenku et al. (2022), in the neighboring district of Butalejja with similar cultural settings where sacred groves and taboos protect medicinal plants biodiversity hotspots. Moreover, there is a strong belief in the contribution of traditional knowledge to sustainable utilization of medicinal plants. This underscores the importance of blending relevant traditional knowledge and practices for development of strategies for climate change adaptation and mitigation leading to sustainable solutions to medicinal plant biodiversity loss. Traditional knowledge and practices develop adaptive capacity of the communities to collectively respond to stressful conditions and thus heighten their resilience (Mukhopadhyay & Roy, 2015). Rooted in generations of lived experience, such knowledge not only foster responsible harvesting but also offers adaptive strategies for climate resilience (Buriro et al., 2024; Jakes, 2024). As such, conservation strategies that ignore these embedded systems risk being misaligned with local realities and are unlikely to gain meaningful community support.

However, the study also highlights significant threats to these established traditional knowledge systems. The majority of respondents (87.3%) reported changes in cultural beliefs over the past decade, and 88% attributed this shift to modernization and globalization. We observed rapid urbanization and changing lifestyles that are known to erode ethnobotanical knowledge and disruption of traditional conservation practices. Aswani et al. (2018) observed that traditional knowledge persists only when it is intentionally maintained or integrated into hybrid systems, often incentivized by economic opportunities. This finding is crucial in the context of Namutumba, where increased trade in medicinal plants (both formal and informal) is rising amidst broader developmental transitions.

The use of medicinal plants in rituals and ceremonies by 86.3% of respondents also points to the multifunctional role of these species, not only as health remedies, but also as cultural and spiritual symbols. This aspect must be prioritized when drawing conservation strategies, in

order to balance economic use and cultural preservation. The belief among 88.3% of respondents that certain medicinal plants should not be cultivated due to cultural taboos mirrors findings in South Africa, where 68 plant species were reportedly protected from cultivation due to spiritual or traditional norms (Karunamoorthi & Tsehay, 2012). Such perspectives challenge western-based conservation programs, which may inadvertently undermine cultural norms if implemented without community participation.

Conclusions and recommendations

This study underscores the urgent need for conservation efforts to protect medicinal plant species in Namutumba district, Uganda. Our findings reveal that several highly traded medicinal plants are vulnerable or critically endangered, with over 70% of respondents selling above 1 kg of herbal medicine per week. The study highlights the importance of community-led initiatives, sustainable harvesting practices, and awareness campaigns to ensure the long-term conservation of medicinal plants. Moreover, our results show that cultural beliefs and traditional practices can both positively and negatively impact conservation efforts.

Therefore, we recommend species-specific conservation interventions, strict enforcement of regulations, and formal integration of herbal medicine into the national healthcare system. Effective conservation strategies will require collaboration among stakeholders, including herbalists, local communities, and government agencies. Ultimately, our study provides valuable insights for policymakers and conservationists working to protect medicinal plant resources in Uganda. We therefore recommend a multi-stakeholder engagement involving herbalists, herbal medicine traders, local government officials, policy makers and herbal medicine association leaders in coming up with evidence-based and community-led medicinal plant conservation strategies that are climate-adaptive to ensure sustainable utilization and availability for generations to come.

Declarations

Ethics approval and consent to participate

Ethical approval of the study was obtained from the Research Ethics Committee of Uganda Christian University (UCU) and the Uganda National Council for Science and Technology (UNSCT), under reference number UCUREC-2024-1057 and SS3825ES, respectively. A consultative meeting with various stakeholders was held during a pre-visit in Namutumba District for in-depth discussions of the research study and to seek permission to conduct research in the District. Prior to participation, all the respondents were taken through the informed consent process, and all the ethical guidelines governing research on human participant were followed. The study purpose and objectives were clearly explained and each of the study participant signed the informed consent form before the interviews were conducted ensuring their voluntary participation and awareness. The study participants were informed of their rights to participate, to refuse to participate and to withdraw at any time

without giving a reason. Additionally, written consent was obtained from all key informants prior to conducting the key informant interviews.

Consent for publication

Informed consent was obtained from all the study participants for the publication of the anonymized data collected.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

ASM, JES and PT conceived the research idea, conducted the survey and collected data; ASM, JES, PT and FK analyzed the data; wrote the original draft of the manuscript; SA and AW reviewed and edited the manuscript; ASM, JES, PT, SA, AW and FK made final manuscript review, journal selection and approved submission.

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Data availability

The authors confirm that the data supporting the findings of this study are available within the article.

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Figures

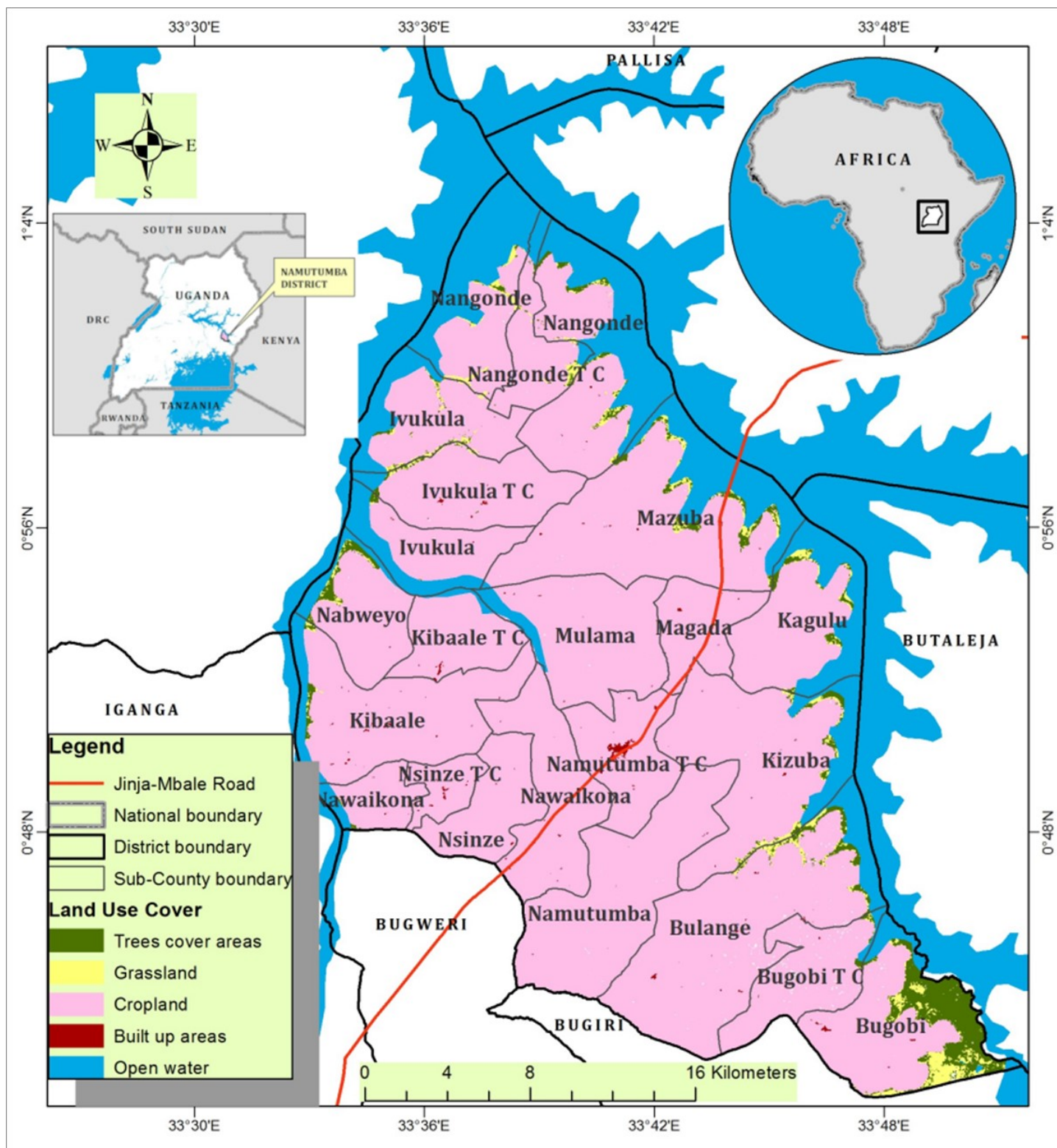


Figure 1

Study areas in Namutumba district

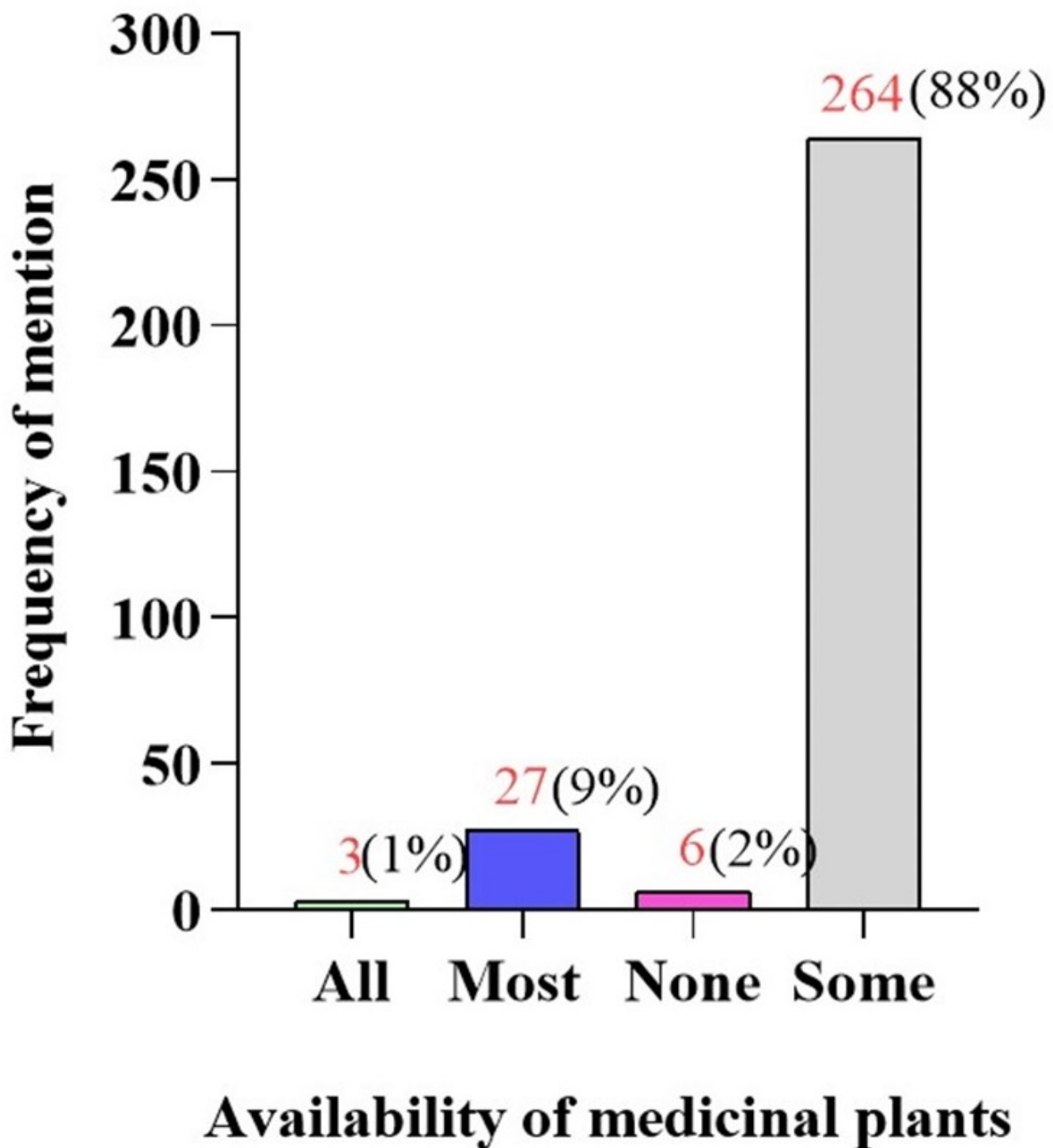


Figure 2

Assessing the availability of traded medicinal plants in Namutumba district

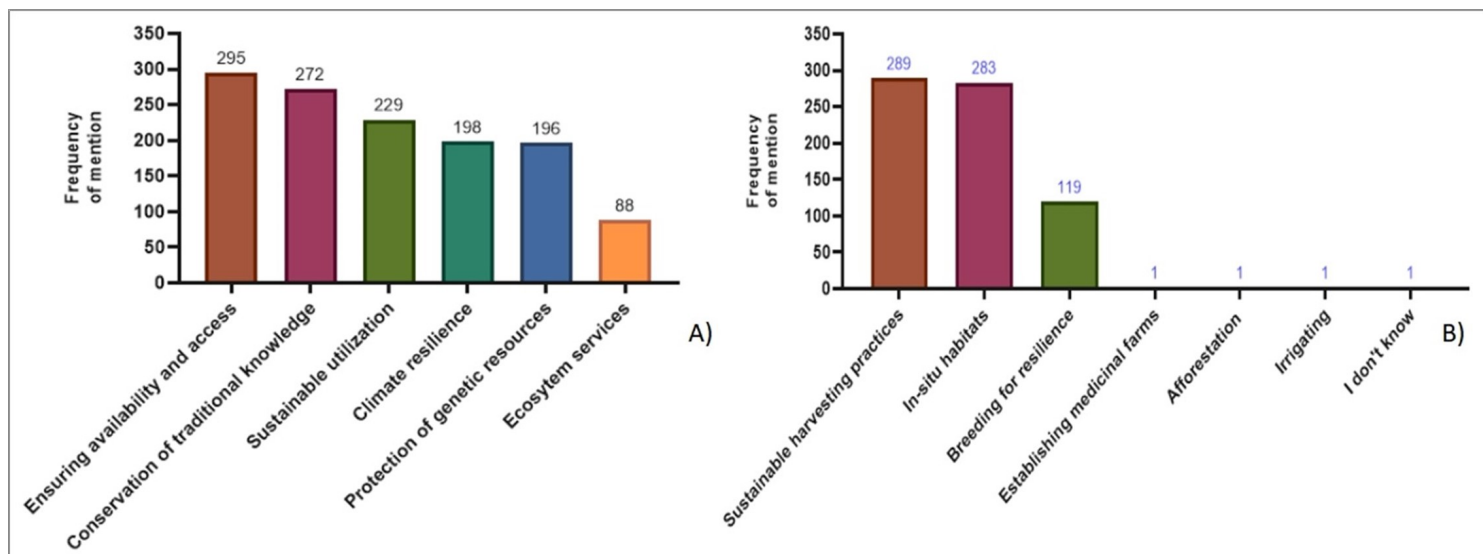


Figure 3

Importance of conserving medicinal plants (A) and Strategies for protecting of medicinal plants amidst climate change (B).

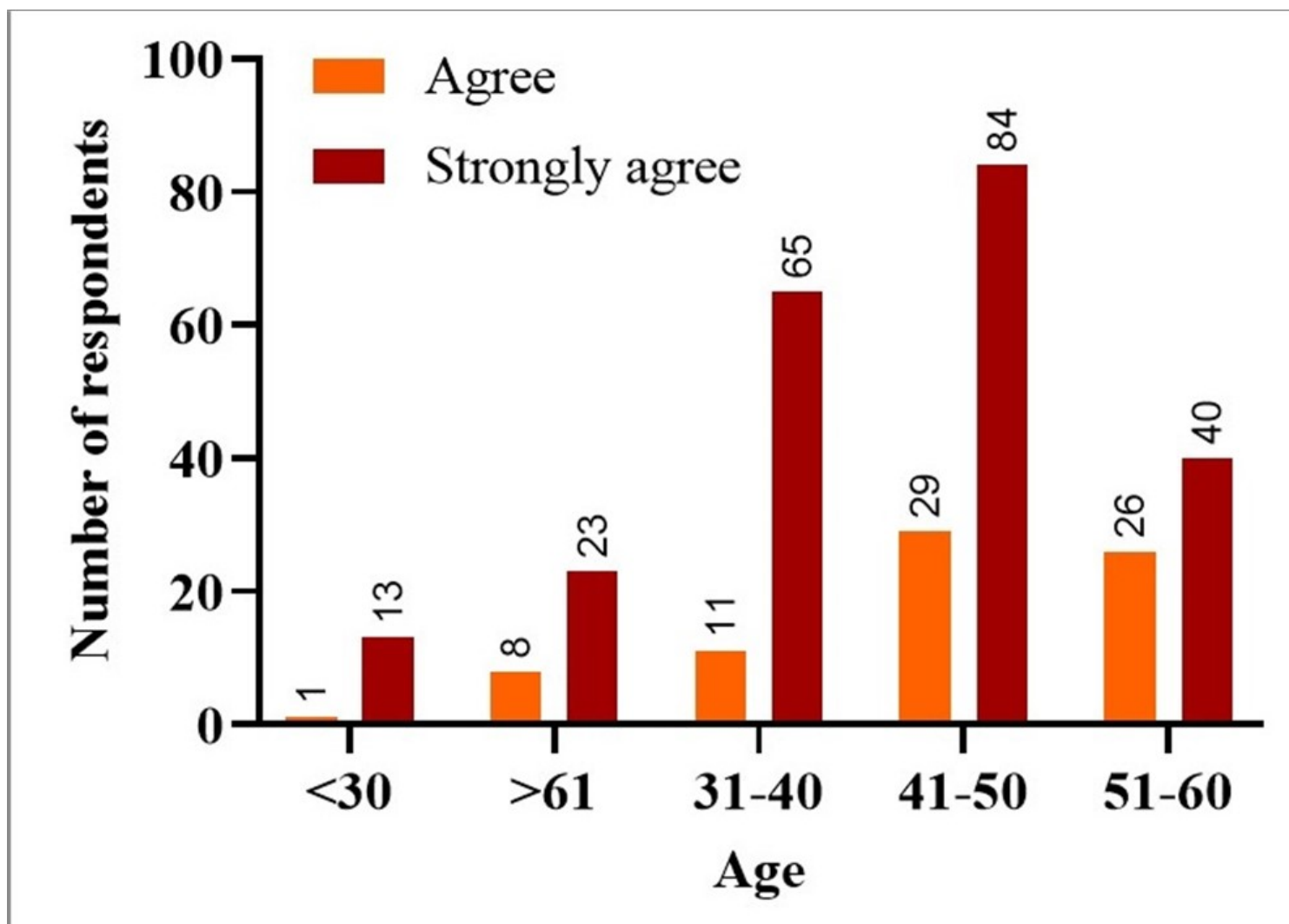


Figure 4

Relationship between respondents’ age and their willingness to support medicinal plant conservation

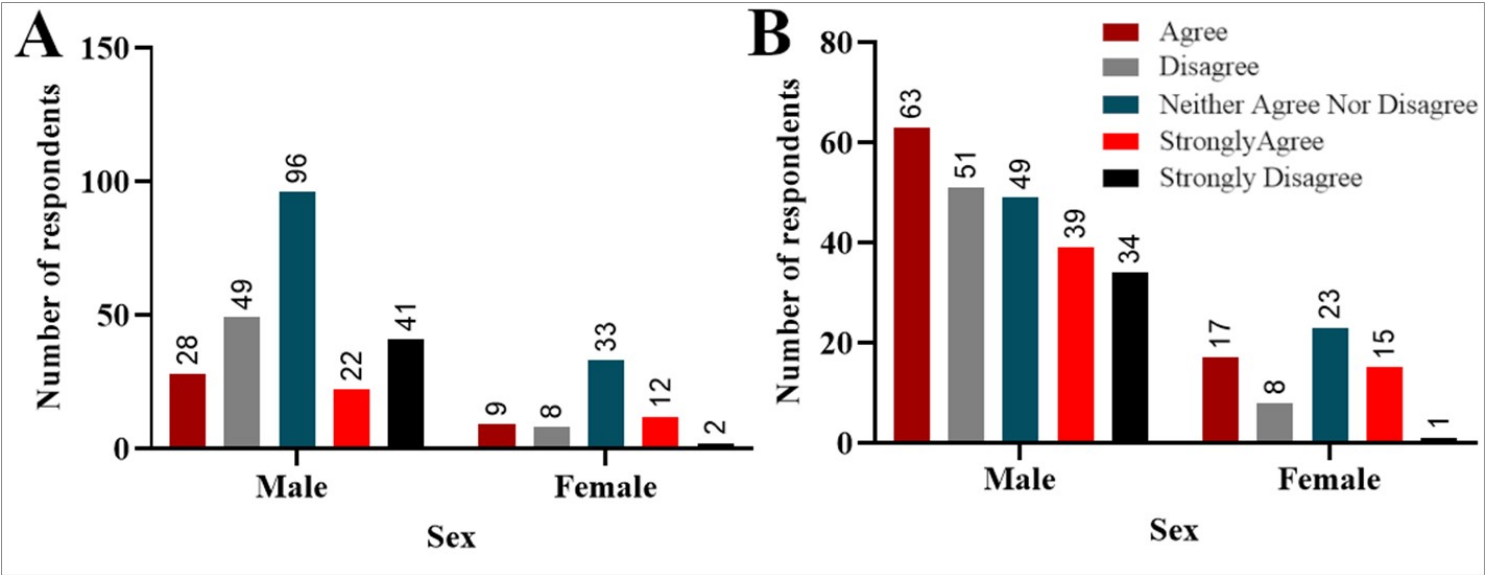


Figure 5

Relationship between respondents’ gender and the perceptions that: A) the existing regulatory policies are adequate for medicinal plant conservation, and B) there is community awareness and compliance with the laws governing the collection, processing and selling of medicinal plants