Medicinal indigenous knowledge acquisition, sharing and integration into the health system in Uganda

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Research

Abstract

Background: Snakebite envenoming is a significant public health challenge in rural Uganda. Limited access to formal healthcare increases reliance on Medicinal Indigenous Knowledge on Snakebites (MIKS). However, MIKS contributes to local snakebite management; studies have largely focused on documenting plant-based treatments, with limited attention to how MIKS is acquired, shared, and sustained among snakebite herbalists. This study examined pathways of MIKS acquisition; analysed MIKS-sharing practices and constraints; explored implications for documentation and health system integration, contributing to Sustainable Development Goal 3 and literature on indigenous knowledge systems.

*Methods***:** An ethnographic design was employed in Pallisa and Kamuli districts of Eastern Uganda through focus group discussions, semi-structured interviews, and observation techniques involving 13 District Health Team members, 19 hospital and Health Centre IV medical professionals, 12 public and 4 private Health Centre III medical professionals, 10 Village Health Team members, and 29 herbalists. The data were analysed thematically using ATLAS.ti 24.

Results: MIKS is a family-and ancestry-based practice. It is acquired and shared through observation, apprenticeship, collaborative practice, and experiential learning. Knowledge transfer is regulated by trust and selective succession; lineage-based controls, spiritual beliefs, and selective disclosure constrain sharing. Documentation and health system integration require formal recognition of herbalists, collaboration with systems actors, provision of accessible and culturally appropriate documentation tools, capacity and literacy building, incentives and sustained awareness.

Conclusions: MIKS sustainability needs structured documentation backing, stronger collaboration between herbalists and formal health systems, and inclusive documentation practices to preserve MIKS, improve snakebite management, and inform responsive health policy and practice.

Keywords: Snakebite, Snakebite herbalists, Snakebite knowledge sharing, Antivenom herbs, Uganda.

Background

Globally, people in rural communities are using medicinal indigenous knowledge on snakebite (MIKS) in their innovative management (Santosh *et al*. 2019). The herbalists' MIK used in the management of snakebite contributes to better health in rural communities against snakebites (Santosh *et al*. 2019); however, some empirical literature states that the efficacy of MIKS in managing poisonous cases of snakebite remains largely unestablished. The majority of people in rural communities who use MIKS pay little or no attention to the specified procedures of poisonous snakebite management using biomedical medicine (Ralph *et al*. 2019). Snakebite envenomation is a crucial global health concern and has been categorically highlighted by the World Health Organisation (WHO) as an undesirable neglected tropical disease (Martins *et al*. 2022; Araujo *et al*. 2022). It is argued that snakebites are challenging public health conditions (Martins *et al*. 2022). If MIKS herbalists' knowledge management practices, including acquisition, sharing, transmission, and sustainability, were formally structured and known in communities, it would increase its access and contribute to reducing incidences, which are leading to universally approximately 83 000-138 000 deaths of people every year (WHO 2026).

The burden of snakebite is disproportionately higher in tropical regions, where both the diversity of venomous species and the lack of effective treatment options are most pronounced (Araujo *et al*. 2022; Santosh *et al*. 2019). In Africa, snakebites affect more than 20% of the people (Chippaux *et al*. 2019). Despite the severity of the issue, snakebite, along with herbalists' practices, remains under-researched and inadequately documented, particularly in less developed regions (Orimi *et al*. 2023). This underscores the need for the current study to examine how MIKS is acquired, shared, transmitted, and sustained among the MIKS herbalists in Pallisa and Kamuli districts.

It is significant to distinguish between ethnobotanical documentation and indigenous knowledge sharing modes, management, and transmission because they are fundamental aspects in contemporary snakebite studies (Okot *et al*. 2020; Ojuka *et al*. 2025; Mishra *et al*. 2021; Nonaka & Takeuchi 1995). The variations are mainly in epistemological purposes or objectives, methodological strategies, and their implications for scientific investigation and community resilience (Ojuka *et al*. 2025; Okot *et al*. 2020).

Ethnobotanical and ethnopharmacological studies contribute to the systematic documentation of medicinal plants used in traditional healthcare, including plant species, taxonomic families, plant parts, preparation methods, dosages and modes of application (Ojuka *et al.* 2025; Dean 2024; Okot *et al.* 2020; Sagliker & Kocer 2025). This documentation provides a basis for further scientific investigation and may support the identification of plants with potential pharmacological properties (Kumar *et al.* 2025; Ojuka *et al.* 2025). However, reported or community use should not be equated with demonstrated therapeutic effectiveness. The identification of a plant used in snakebite management does not, by itself, establish its ability to neutralise snake venom, improve clinical outcomes or be used safely in humans. Such claims require appropriate scientific evaluation. Although ethnobotanical documentation contributes to research, biodiversity conservation and the preservation of indigenous knowledge, its primary focus on medicinal plants and their uses may not adequately capture the social and cultural processes through which indigenous knowledge is maintained and transmitted.

In contrast, the acquisition, management, sharing and transmission of medicinal indigenous knowledge on snakebite (MIKS) are embedded in the social and cultural practices of herbalists. These processes help determine who acquires the knowledge, which aspects are shared, and the conditions under which knowledge is preserved and passed to future generations (Ojuka *et al*. 2025; Ijatuyi et al. 2025; Constant & Tshisikhawe 2018). Knowledge transmission may occur through apprenticeship and intergenerational relationships, often involving selected family members. Cultural norms, trust, ownership and secrecy may also influence access to medicinal plants, preparation procedures and dosage information (Ojuka *et al.* 2025). Although these practices may protect knowledge from unauthorised access, they may also restrict its transmission beyond selected individuals. Furthermore, generational differences, declining interest among younger people, urbanisation and the influence of formal education may create additional challenges for knowledge continuity (Ojuka *et al*. 2025).

Ethnobotanical documentation and the study of indigenous knowledge acquisition, management, sharing and transmission therefore address different but complementary aspects of MIKS. While ethnobotanical research provides systematic information about medicinal plants and their reported uses, examining knowledge transmission helps explain how herbalists acquire, protect, reproduce and transfer this knowledge within their communities. Understanding both dimensions is important for developing documentation approaches that preserve not only information about medicinal plants but also the cultural and social processes that sustain indigenous knowledge. Nevertheless, the extent to which existing documentation approaches address these processes, particularly among snakebite herbalists, remains an important question. This study

therefore examines the knowledge-sharing practices of MIKS herbalists and the implications of these practices for documenting and preserving their knowledge in selected districts of Eastern Uganda.

The SECI model developed by Nonaka and Takeuchi (1995) provides a useful theoretical perspective for examining knowledge creation and conversion through socialisation, externalisation, combination and internalisation. It is relevant to this study because MIKS acquisition, sharing, transmission and documentation involve interactions between people, practical knowledge and the potential conversion of orally transmitted knowledge into recorded forms. The model therefore helps frame the examination of these processes, while the cultural and social conditions governing indigenous knowledge require consideration within the specific context of the herbalists.

Statement of the problem

Snakebite envenomation continues as an unrecognised public health challenge in rural Eastern Uganda, especially in Pallisa and Kamuli districts, where ecological exposure to venomous snakes is high, and access to antivenom is extremely minimal (Omara *et al*. 2020; Chippaux *et al*. 2019; Tusabe et al. 2025). In these settings, management of medicinal indigenous knowledge on snakebite (MIKS), held by indigenous herbalists, constitutes a primary healthcare response for both humans and livestock. Although some ethnobotanical studies have documented medicinal plants used by MIKS herbalists in snakebite treatment, limited attention has been given to the processes through which it is acquired, shared, transmitted, and sustained among herbalists themselves (Malapane *et al*. 2024; Okot *et al*. 2020; Omara *et al*. 2020; Musah *et al*. 2019). The Socialisation, Externalization, Combination, and Internalization (SECI) model developed by Nonaka and Takeuchi (1995) provides a theoretical perspective for examining how knowledge is shared and converted between tacit and explicit forms. Its relevance to this study lies in the opportunity to examine knowledge practices such as apprenticeship, observation, practical instruction and documentation. However, the extent to which these processes explain MIKS knowledge acquisition, sharing and transmission, particularly within the cultural and social practices of herbalists, requires empirical investigation.

MIKS is predominantly tacit, orally transmitted through apprenticeship, lineage, and spiritual validation, situating it largely within the socialisation stage of the SECI knowledge-creation model (Bandera *et al*. 2017; Nonaka & Konno 1998). The lack of MIKS-structured documentation and governance mechanisms threatens the continuity of this knowledge amid ageing practitioners, environmental degradation, and institutional marginalisation (Ssenku *et al*. 2022). Within the One Health context, this erosion undermines inclusive health strategies essential for achieving Sustainable Development Goal 3, which emphasises equitable access to effective healthcare for all populations (Martins *et al*. 2019; WHO 2019).

Despite the recognition of MIKS in local snakebite management, there remains a need to understand how herbalists acquire this knowledge, determine the conditions under which it is shared, transmit it to others and sustain it over time. This limited understanding constrains the development of documentation approaches that take account of both the medicinal knowledge held by herbalists and the social and cultural processes through which it is preserved. Therefore, this study examines MIKS knowledge acquisition, sharing and transmission among herbalists in Pallisa and Kamuli districts of Eastern Uganda, with particular attention to the implications for documentation and health system integration.

Specifically, it sought to:
(1) examine pathways of knowledge acquisition;
(2) analyse knowledge-sharing practices and constraints; and
(3) explore implications for documentation and health system integration.

Materials and methods

Research paradigm and design

The study adopted an interpretivist paradigm and a critical ethnographic design to understand how medicinal indigenous knowledge on snakebite (MIKS) is acquired, shared, managed and transmitted among herbalists in Pallisa and Kamuli districts of Eastern Uganda. The interpretivist paradigm was appropriate because the study sought to understand participants' experiences, meanings and culturally situated practices. Critical ethnography provided a lens for examining these practices in relation to the social and institutional conditions that influence access to, control over and continuity of indigenous knowledge. In particular, the study considered how lineage, cultural norms, secrecy and institutional recognition shape knowledge sharing and preservation among MIKS herbalists. The critical orientation was therefore intended to extend the analysis beyond describing cultural practices to examining the conditions that influence their continuation and documentation. Critical ethnography was considered appropriate insofar as these relationships formed part of the study's analytical focus (Jones & Smith 2017).

The ethnographic design enabled an in-depth examination of the social and cultural contexts in which MIKS knowledge practices occur in Kasodo sub-county in Pallisa district and Kisozi sub-county in Kamuli district. Data were collected through semi-structured interviews, focus group discussions and non-participant observation. Interviews were conducted in Lugwere, Lusoga and English, while focus group discussions were conducted in English. These methods provided complementary accounts of participants' experiences and practices, enabling the study to examine knowledge acquisition, sharing and transmission from different perspectives.

The study used inductive reasoning to develop an understanding of MIKS knowledge practices from the empirical data. During thematic analysis, the coding process also drew on the research objectives, the SECI model, and relevant literature. These initial codes provided a starting point for organising the data, while additional codes were developed from participants' accounts where the data presented issues not adequately captured by the initial categories. The analysis therefore combined theoretically informed coding with attention to patterns arising from the data. This approach enabled the study to examine the relevance of existing theoretical concepts while remaining attentive to the cultural and social experiences of MIKS herbalists.

Study setting

The study was conducted in Pallisa and Kamuli districts in Uganda's Eastern Region. In Buzaaya County, Kamuli District, the study covered the sub-counties of Kisozi, Nawanyago, and Kamuli Town Council, and the parishes of Kiyunga, Kakunyu, Magogo, Nakandulo, Namaganda, Izaniro, and Nawanyago. It covered the villages of Bulonda-Bubooka, Bukiika, Bubale, Bukaaya A, Nawanyago, Bulamuka, Bukyatifu, Busige, and Budungu. In Pallisa County, Pallisa District, the study covered Kasodo Sub-County, Pallisa Town Council and the parishes of Kasodo, Najeniti and Nabitende, including the villages of Nakibuya, Kasodo Central, Bukenye B, Bukenye A, Kasuleta and Kasanvu A. Wafula and Opio (2021) noted that there were 186 snakebite cases reported in Kamuli District, and this figure was reported to be high in a period of one year. In addition, the belief in MIKS knowledge and its use is common in rural communities; hence, it was necessary to establish how such herbalists' knowledge is being managed in Kamuli District and in its neighbouring district of Pallisa. This was the rationale under which Kamuli District was selected for the study. Uganda is geographically located in East Africa, and it is a landlocked country. It is situated along latitude 4° N and 1° S of the Equator and 29° E and 35° of the Greenwich Meridian (WorldAtlas 2026).

The constituencies with the highest reported snakebite burden were identified using District Health Officers' (DHOs) reports from both districts (Kamuli District Health Office, 2025; Pallisa District Health Office, 2025). These reports also guided the selection of Health Centre IIIs (both public and private) that participated in the study. The study was conducted in three languages: English, Lusoga, and Lugwere. The fourth language, Ateso, was dropped because no participants were encountered. The English data-collection instruments were translated into Lusoga, Ateso, and Lugwere to accommodate respondents who were anticipated to have limited literacy in English. The translation was carried out by the Department of Languages and Communication Skills at Kyambogo University. All data obtained in the Lusoga and Lugwere local languages were transcribed verbatim into English for analysis. The verbatim approach helped to capture the actual statements and meaning as intended by the research respondents. The inclusion of Lusoga and Lugwere local languages during data collection using the translated research protocols was essential because these are the most used local languages in the two study areas.

Uganda is divided into four politically defined geographic regions: Central, Western, Eastern, and Northern. Uganda has 15 sub-divisions within the 121 districts. It also has 146 counties, 1 City council, and 13 municipalities (Google Maps 2026). It covers an area of 85,391 sq. km, and the Northern region covers the largest area. It is a landlocked country found in the East-Central African Great Lakes region. It is also part of the Eastern Hemisphere. It is one of the countries crossed by the Equator. It is bordered by South Sudan to the North, Kenya to the East, Tanzania to the South, the Democratic Republic of the Congo to the West, and Rwanda to the southeast (WorldAtlas 2026).

Study population

Data were collected from a wide range of 87 female and male participants. The study included 13 District Health Teams (DHTs) members (DHOs, health managers, and members from other departments of the districts), 19 medical professionals from district hospitals (doctors, medical specialists, nurses, laboratory assistants, health assistants, pharmacists, and medical records personnels (MRPs)) and Health Centre IV (doctors, clinical officers, nurses, nursing assistants, laboratory assistants, and MRPs), 12 staff from public Health Centre IIIs (HC III) (Clinical officers, nurses, nursing assistants, health assistants, laboratory assistants, and the MRPs), 4 staff from private Health Centre IIIs (HC III) (Clinical officers, Nurses, Health assistants,

laboratory technician), and 10 Village Health Teams (VHTs) members. The duties of the DHTs include planning, budgeting, recruitment, and supervising the health services in the districts. Furthermore, it is their duty to maintain the quality of healthcare services rendered within the district. The medical health workers, together with the medical records personnel in the various health facilities, were selected because of their formal knowledge in health issues, including snakebites in Pallisa and Kamuli districts. The involvement of the DHTs, health workers, medical practitioners and the VHTs was significant in the exploration of the implications for documentation and health system integration based on the examined pathways of knowledge acquisition and the analysis of knowledge-sharing practices and constraints, and the VHTs played a key role in the identification and access of the MIKS herbalists to take part in the study. In addition, the study also included 29 MIKS herbalists/practitioners who had a minimum of four years or more of experience. The MIKS herbalists provided essential information on knowledge acquisition pathways, and knowledge-sharing practices and constraints. They also provided information about themselves and years of practice, documentation of snakebite victims, plants or herbs they use (see Supplementary Tables S1 and S2), their sources/acquisition of knowledge, information about other herbalists, and views about their collaboration and incorporation into the healthcare system in the management of snakebites.

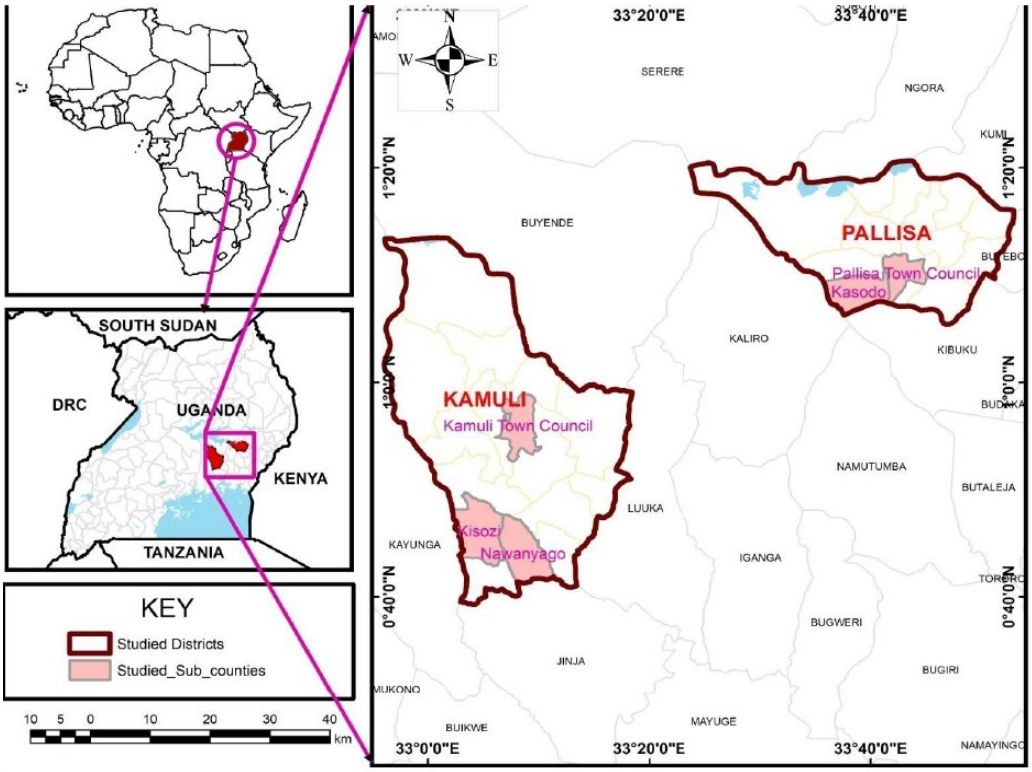


Figure 1. Geographical position of Pallisa and Kamuli districts of Eastern Uganda and the location of Uganda in Africa.

Sampling techniques and justification

Cluster sampling

The participants were selected through purposive, cluster, convenience, and snowball sampling. Cluster sampling was used to select DHTs, medical practitioners at district government hospitals, HC IV health workers, and HC IIIs in public health facilities. A cluster sampling plan was used to select members at the different administrative levels (DHTs, district hospitals, county, sub-county, and village levels) of Pallisa and Kamuli districts. These categories of respondents included medical administrators and medical practitioners in the health facilities. Cluster sampling involves successive sampling of selected units or clusters, progressively from bigger units to smaller ones (Tashakkori *et al*. 2021). They live in the same study districts, are close and can be easily accessed to participate in the study. The study population is spread over a large geographic area, and the cost of studying such a population would be high; therefore, the researcher opted to use the cluster sampling strategy (Tashakkori *et al*. 2021). It is an easy sampling tactic and a good strategy for conducting field individual interviews (Kothari & Garg 2021). The researcher used a single-stage cluster sampling. This sampling procedure enabled the researcher to meet the respondents directly (Kothari & Garg 2021; Kumar 2014). The researcher first created a cluster of DHTs in the district.

Convenience sampling

The researcher employed convenience sampling method(s) to select an accessible county and an HC IV for the study. This is because the HC IVs provide the same health services and medical practitioners deployed in them have similar characteristics.

Convenience sampling was also used to select the study village and the VHT participants. This is because the villages and the VHTs are believed to have similar characteristics. VHTs are unqualified health workers but are supervised by the HC IIIs at the parish level. Furthermore, convenience sampling techniques were used to select private medical practitioners from the two study districts to participate in the study.

Snowball sampling

Snowball sampling was used to involve the MIKS herbalists in the study; the researcher used snowball and convenience sampling methods with the help of the VHTs. Saturation is one of the bases in qualitative studies for determining the number of respondents, and it guides researchers to investigate small samples in depth to achieve high research rigour (Rahimi & Khatooni 2024; Tashakkori, Johnson & Teddlie 2021). Saturation information is essential in describing and supporting whether the identified sample size is adequate and suitable in the investigation of the research phenomena. The researchers used saturation to ascertain and ensure that the study sample used was adequate in terms of its diversity, depth of the investigation, and collected views of the respondents (Braun & Clarke 2021). This helped the researchers to locate 29 MIKS herbalists in the study from the two study districts (Tashakkori *et al*. 2021; Edmonds & Kennedy 2020).

Purposive sampling

The study employed purposive sampling and a homogeneous strategy to select participants (herbalists) with similar characteristics to take part in the study. This facilitated the researcher in gaining a better understanding of the participants and their MIKS practices. The researchers also collected essential data for the study from participants with similar characteristics (Tashakkori *et al*. 2021). The different views collected from participants on similar aspects led to a valid qualitative study in the end. The researchers sought permission from the CAO of the study district(s) and the consent of the respondents before recruiting and engaging them in the study (Creswell & Clark 2018).

Data collection

Observation, focus group discussions, and interviews were used to obtain primary data from the respondents for the study. In addition, the researchers used photography as a data collection method (see Supplementary tables S1 and S2). The observation method was conducted of the MIKS herbalists. The observation method allowed the researchers to gain access to important information from the sites, including verbal and non-verbal communication of the participants, MIKS herbalists' activities (like the process of managing snakebites) and herb processing, and observation of herbalists' workspace(s) (Barrett & Twycross 2020). The researchers employed a non-participant observation strategy and viewed and recorded aspects of the herbalists and their work environment in their natural appearance (Creswell & Poth 2018). The observation criteria included the choice of site, the requirements for accessing the herbalist site, identification of the items to be observed, and the required period of observation. The focus group discussion method was conducted with the DHTs, MRPs, and the medical practitioners. The researcher used FGDs to collect data from 13 DHTs and from the 36 medical practitioners in the selected health facilities (district hospitals, HC IV, and public HC IIIs) of the study districts. The researchers obtained information on snakebites, snakebite management, antivenom supplies, their views on MIKS and explicit MIKS knowledge, MIKS inclusion into the healthcare system in the management of snakebite, and also information on MIKS knowledge documentation in the form of responses to answer the specific research questions of the study. The interviews were conducted with the MIKS practitioners and VHT respondents who were anticipated to have difficulties in reading and writing (Paradis *et al*. 2016). The interviews with the VHTs generated information about snakes and snakebite management, MIKS herbalists, and popularly used awareness methods on snakebites and information on snakebite problem-solving. Lastly, interviews were also conducted with the private HC III facilities practitioners in the two study districts because there are few employees, and only two participants from each site were needed to take part in the study. After the interviews and getting the consent of the herbalists, the researchers photographed some of the herbs used (see the supplementary Tables S1 and S2 for some of the herbs photographed) and workspaces of the practitioners. MIKS herbalists' herbs and workspace information can also be managed through photographs.

Data analysis

The data analysis of the study was guided by Finlay (2021) thematic analysis technique. Data from the semi-structured interviews and the focus group discussions were transcribed verbatim. Atlas.ti 2024 software was used in the data analysis. With support from Atlas.ti, the transcripts and the notes from the non-participant observations were coded inductively and grouped into categories from which the data analysis themes were created. The chapter presents the themes along with illustrative quotations from the respondents and interprets the findings in relation to the set research objectives.

Transcription was done independently by two PRA and KRA research assistants. PRA was responsible for English, Lugwere and Ateso languages, while KRA was responsible for English and Lusoga languages. No data were collected or transcribed from the Ateso-speaking participants in Pallisa district because no participants were identified.

Data quality was ensured through an additional verification process, cross-referencing of the research transcripts with the original audio recordings, the data collection protocols, the data from the non-participant observations, and the herbal photographs collected during fieldwork (see supplementary tables S1 and S2). This iterative review ensured the consistency and completeness of the transcribed materials. Following verification, the data transcripts were systematically organised and sequentially uploaded into ATLAS. ti 24 according to participant categories.

Coding was conducted sequentially across transcripts to strengthen analytic rigour and facilitate the identification of recurring patterns within the dataset. Based on the study objectives and a priori codes, the researcher employed thematic analysis to examine the pathways of MIKS herbalists' knowledge acquisition, their knowledge sharing practices, and the implications for documentation and integration into formal health systems. The use of ATLAS.ti 24 supported the systematic management of large volumes of qualitative data and enabled a transparent and structured analytic process (Soratto *et al*. 2020). Its methodological clarity enhances the transparency, coherence, and interoperability of qualitative findings compared to other qualitative analytical tools (Flick 2018).

PRA is a Ugandan of Etesot/Mugwere with a background in Development Studies and over five years' experience serving as a Community-Based Officer (CBO) in Pallisa District. He is a resident by birth, a graduate social worker, and is fluent in English, Ateso and Lugwere. KRA is a Ugandan of Musoga origin and a graduate social worker with a good research background. KRA is fluent in English and Lusoga. Their academic background, linguistic competencies, and familiarity with the local context supported the professional and objective conduct of the research. The composition of the research team also contributed to minimising potential biases that could have influenced the study findings. While presenting data, the findings from Pallisa and Kamuli were pooled together. This helped the researchers to avoid repeating the data presentation section.

Trustworthiness (Credibility, transferability, dependability, and confirmability)

The data quality standards in qualitative research include credibility, transferability, dependability, and confirmability (Ravitch & Carl 2021; Amin *et al*. 2020). They were used to assess the quality of this study, the data collection instruments to be used and the trustworthiness of the findings. The credibility of this study was ensured by employing triangulation as a technique to enhance the trustworthiness and credibility of the research findings (Buschle *et al*. 2022; Noble & Heale 2019; Stahl & King 2020). In order to ensure the credibility, dependability, and confirmability of this study, the researcher worked with the supervisors to validate the data collection tools, and changes were made accordingly (Stahl & King 2020). The researchers further benchmarked the data collection tools of similar studies to enhance their trustworthiness and credibility (Iwata 2018). The study recruited and trained two research assistants. The research assistants were equipped with skills on how to identify potential research participants, establish their relationship with the purpose of the study, and how to avoid biases in the process of collecting data both on the side of the research participants and on the part of the researchers. This whole process shaped the data collection and interpretation and ensured its trustworthiness. This justifies the relevance of choices taken by the researchers while creating tools drawn from the research study questions (Ravitch & Carl 2021; Miles *et al*. 2020). This was achieved by collecting data relevant to the research questions sought by the study (Ravitch & Carl 2021). As a result, the researchers collected uniform and consistent data for the study.

Ethics, permissions, and compliance

The researchers followed the University of South Africa (UNISA) ethical guidelines and obtained ethical approval. Since the research study was conducted in Uganda, the research protocol was also reviewed by the Uganda Christian University Research Ethical Committee (UCU-REC), registration number UCU-REC-2024-2025, which is a reputable local research ethics committee, and later, it was forwarded to the Uganda National Council of Science and Technology (UNCST) for ethical clearance.

The researchers sought ethical clearance from the Uganda Christian University Research Ethical Committee (UCU-REC). Ethical clearance was also obtained from both UNISA NHREC registration number Rec-240816-052 and UNCST registration number SS3517ES after the proposal's approval. Permission to conduct the study was also sought from the offices of Pallisa and Kamuli District Health Officers (DHOs), the Chief Administrative Officers (CAOs) of Pallisa district and the CAO of Kamuli district before data collection. Participation in the study by the respondents was voluntary and not mandatory or for payment. Before engaging the research participants, the researchers first explained the implications of participating in the study and

then sought informed consent from the study respondents. The privacy and confidentiality of all the study respondents were protected. The collected data were used only for academic purposes.

The research data containing private information were anonymised by the researchers for the safety purposes of the respondents.

Results

Eighty-seven participants took part in the study in seven categories, as shown in Table 1. Findings are reported by participant group, and herbalists contributed through semi-structured interviews and non-participant observation, with consented photography of herbs and workspaces (see supplementary tables S1 and S2). District Health Team (DHT) members, district hospital and health canter (HC) IV staff and public HC 111 staff contributed through focus group discussions. The size of the FGD clusters ranged between 6-8 participants. Private HC 111 staff and Village Health Team (VHT) contributed through interviews. Data from Palisa and Kamuli were pooled.

Table 1. Demographic information of the respondents

Category of Participants	**Method of data collection used**	**Male**	**Female**
DHTs	FGD (2)	10	3
District hospital health workers	FGD (2)	8	4
HC IV	FGD (1)	4	3
HC III-Public	FGD (2)	6	6
HC III-Private	Interviews (4)	2	2
VHTs	Interviews (10)	6	4
MIKS herbalists	Interviews, observation guide, and Photography (29)	23	6
Total		59	28

The above table shows the different categories of the population of the study. The biggest category was the MIKS herbalists, and most herbalists were male. Acquisition and sharing (objectives 1 and 2) were examined mainly through the herbalists because they hold and transmit the knowledge. Documentation and integration (objective 3) were examined through all groups. Table 2 shows which group informed which objective.

Table 2. Contribution of each participant group to the study objectives

Participant group	**Data source**	**Objective 1: acquisition pathways**	**Objective 2: sharing practices and constraints**	**Objective 3: documentation and health system integration**
MIKS herbalists	Interviews; non-participant observation; photography	Principal source	Principal source	Views on collaboration and fears of state action; disclosure behaviour during photography
DHT members	FGDs	Not a source	Not a source	Principal source: what should be documented, drug safety, inclusion of MIKS.
District hospital and HC IV staff	FGDs	Not a source	Not a source	Principal source: efficacy questions; clinical information needs
Public HC 111 staff	FGDs	Not a source	Not a source	Source: documentation and referrals

Private HC 111 staff	Interviews	Not a source	Not a source	Source: documentation and referral
VHT members	Interviews	Helped identify and access herbalists	Awareness methods on snakebites	Source: community-level view of herbalists and snakebite problem-solving

Herbalist data were analysed separately from health-system data first and then compared.

Knowledge acquisition pathways

This section reports data from herbalist interviews. MIKS herbalists in Pallisa and Kamuli mainly acquired their knowledge from family and ancestors (Fig. 3). Many reported learning from fathers, grandfathers and other close relatives such as uncles, through observation, apprenticeship and taking part in herb collection, preparation and identification (Fig. 3). Transfer was selective and depended on trust, discretion and the successor's perceived ethical suitability (Fig. 3, Fig. 5). In some cases it was reinforced by ceremonial initiation (Fig. 3).

A smaller number of herbalists described other sources. A few said they had learned from **tree vendors** (herb sellers), a clanmate or a friend, which shows that markets and peer relationships also served as routes to knowledge for some. One herbalist described receiving knowledge from a **'mother in the spirit world'**, and others reported spiritual or ritual validation of their practice. Such spiritual origins were rare (Fig. 3).

> *"Yes, my father. That is why I said it is a family thing. He is over eighty years old"* (Kamuli_Herbalist_05 2025*).*

Another herbalist who confirmed acquiring knowledge from the grandfather stated that:

> *"My Paternal grandfather used to train me. The father to my father"* (Pallisa_Herbalist_06 2025).

Whereas another herbalist underscored the significance of passing his knowledge to a friend for emergency reasons and thus stated that:

> *"Yes, I thought of the possibility that if a snake bite happens in my absence and any one of these two should be able to help arrest the situation. One of them is my friend while the other is my brother"* (Pallisa_Herbalist_08 2025).

The data demonstrate that MIKS herbalists' herbal knowledge is mostly acquired, preserved and conveyed within familial networks, exemplifying a culturally embedded system of hereditary knowledge transmission among MIKS herbalists (Fig. 3, Fig. 5). The sources of the MIKS herbalists' knowledge acquisition are presented in Figure 3.

Knowledge sharing practices

The findings show that the primary method/practice of sharing the MIKS herbalists' knowledge and experiences on snakebite treatment is through intergenerational and family-based medium which includes immersive apprenticeships characterised by observation, participation, and experiential learning (Fig. 4). MIKS herbalists' trainees collaborate with seasoned MIKS herbalists to acquire skills in identifying, collecting, preparing, and administering treatments to snakebite victims utilising botanical and other resources (Fig. 4). The MIKS herbalists' share knowledge on both indigenous technical competencies and clinical expertise with trainees' through continuous practice and exposure to actual management of snakebite victims' cases (Fig. 4). They share knowledge through experiential and apprenticeship-based learning. They also share knowledge through oral and memory-based sharing which includes naming herbs and dosage explanations. Knowledge is also shared by community members during emergencies through treatment-centered public learning in community gatherings. Some herbalists also reported that they share knowledge with fellow herbalists through consultations, reciprocal learning, or practitioner networks. Furthermore, knowledge is shared through selective and conditional disclosure which includes sharing of secret herbs, sacred knowledge, guarding against the fear of theft, loss of clients, the need to gain some payment or gifts after training. Their knowledge transfer is rooted in lineage and occasionally influenced by spiritual concepts (Fig. 4). Certain MIKS herbalists' practitioners prioritise ancestral validation and symbolic practices to provide therapeutic power. In this regard, there are some verbatim quotations from the interviews with the herbalists in support of their knowledge-sharing practices. One of the herbalists on intergenerational knowledge sharing noted that:

> *"It is important to share the MIKS knowledge and experiences with the family because one day "you may not be there to help someone". Therefore, it is dangerous for MIKS practitioners/herbalists not to share their knowledge with the family"* (Pallisa_Herbalist_13 2025).

In support of herbalists' knowledge sharing with fellow practitioners, during the face-to-face interviews one stated that:

> *"If he/she is a fellow MIKS practitioner and handles me well, I do share"* (Kamuli_Herbalist_14 2025).

In the same vein, another herbalist emphasised that:

> *"Yes, I do share but only with fellow MIKS herbalists"* (Pallisa_Herbalist_15 2025).

In support of the herbalist who shares knowledge with a friend, one of the practitioners argued that:

> *"Yes, I thought of the possibility that if a snake bite happens in my absence and any one of these two should be able to help arrest the situation. One of them is my friend while the other is my brother"* (Pallisa_Herbalist_08 2025).

The MIKS herbalists' system uncovers differences in therapeutic methodologies and patient care formalities, demonstrating the diverse beliefs within the herbalists' healing tradition. Significantly, transmission encompasses substantial moral education, with snakebite treatment treated as a moral obligation rather than a commercial endeavour. Figure 3 presents pathways of MIKS herbalists' knowledge-sharing practices.

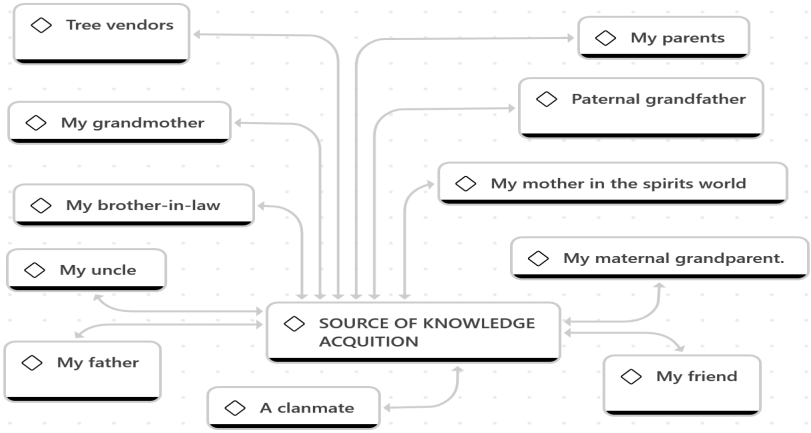


Figure 3. Pathways of MIKS herbalists' knowledge acquisition in the two study districts.

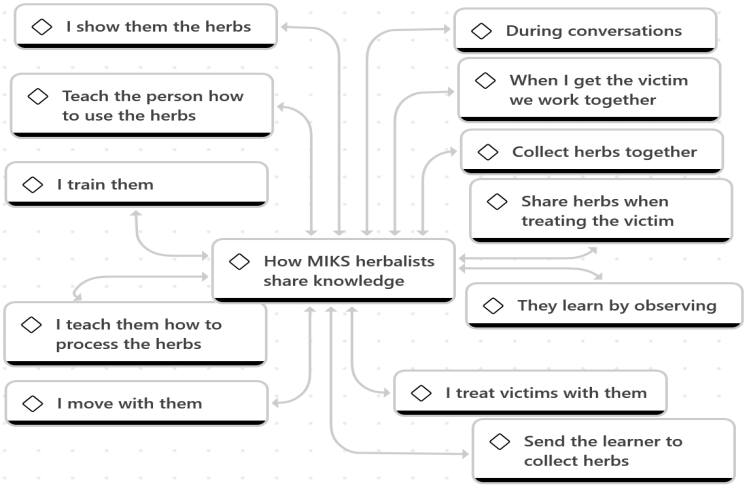


Figure 4. Pathways of MIKS herbalists' knowledge-sharing.

MIKS herbalists' knowledge-sharing practices and constraints

The findings of the study indicate that MIKS herbalists exceptionally share knowledge with recognised individuals and are familiar with them (Fig. 5). Transmission primarily occurs inside families, specifically aimed at chosen children, most especially the "boy" child or trusted relatives deemed reliable and ethically suitable (Fig. 3, Fig. 5). One of the herbalists stated that:

> *"As a parent you can show to two of your children and keep an open ear to hear if any one of them shares with the outside community. This is aimed at testing the level of confidentiality by my children"* (Kamuli_Herbalist_07 2025).

The herbalist further clarified that:

> *"One has to be my own child"* (Kamuli_Herbalist_07 2025).

This behaviour shows a lineage-focused and confidentiality-driven approach to MIKS herbalists' knowledge sharing and inheritance. Some MIKS herbalists in the districts of Pallisa and Kamuli collaborate with trusted friends, community members, or fellow MIKS herbalist practitioners for purposes such as providing emergency assistance, engaging in professional cooperation, or supporting the community, often without financial transactions or demand (Fig. 5). In strengthening this finding, one of the herbalists during the interview noted:

> *"Yes, I thought of the possibility that if a snake bite happens in my absence and any one of these two should be able to help arrest the situation. One of them is my friend while the other is my brother"* (Pallisa_Herbalist_08 2025).

Conversely, some individuals deliberately restrict or completely conceal their information to preserve confidentiality, professional esteem, and authority. During the interviews, one of the herbalists clearly reported that:

> *"I don't share my medicinal knowledge with anybody, not even my children"* (Pallisa_Herbalist_01 2025).

He further emphasised that:

> *"MIKS medicine ceases to be medicine when everybody knows it because nobody will appreciate me for the treatment"* (Pallisa_Herbalist_01 2025).

The transmission of knowledge among MIKS herbalists is influenced by their relational trust, moral judgement, perceived duty, and contextual factors such as payment or anticipated tokens afterwards and interest (Fig. 3, Fig. 5). Societal influences regulate the knowledge systems of MIKS herbalists. In this respect, one of the herbalists pointed out that for one to be chosen, he/she has to:

> *"Be humane and compassionate to be able to benefit community"* (Kamuli_Herbalist_01 2025).
>
> Similarly, another participant in a separate interview emphasised that:
>
> > *"Yes. An inhuman person does not touch dirty people. Someone might come to be attended to without money"* (Kamuli_Herbalist_04 2025).

There were very few male herbalists who showed interest in sharing their knowledge with their spouses or the girl child. Furthermore, most MIKS herbalists revealed that they charge for knowledge sharing but not for treatment. There were very few herbalists who reported that they share knowledge for free. One noted that:

> *"I cannot say that "my friend, you first pay me this much and I share with you my knowledge". I have not been asking them to pay. I share with them at no cost. I have just been sharing with them the MIKS knowledge and experiences"* (Pallisa_Herbalist _13 2025).

Figure 5 presents whom the MIKS herbalists train/share knowledge with.

The research revealed that MIKS herbalists in Pallisa and Kamuli districts disseminate indigenous medical knowledge regarding snakebite treatment to assist others, hold to cultural beliefs, and for financial gain. In Pallisa and Kamuli districts, some of the MIKS herbalists willingly disseminate their knowledge, particularly among family members or for the benefit of the community. Conversely, some individuals choose remuneration in cash or in kind, with prices varying from UGX 10,000 (USD 2.45) to UGX 30,000 (USD 7.34) for local trainees and UGX 200,000 (USD 48.95) to UGX 1,000,000 (USD 244.77) for external participants. They may also request culturally suitable gifts such as goats or hens. Figure 6 presents charges for knowledge and experience sharing.

Challenges affecting MIKS herbalists' knowledge sharing, documentation and integration

The findings indicate that some MIKS herbalists are unable to exchange information due to a variety of interconnected challenges, encompassing ecological, social, institutional, and economic factors. The increasing scarcity of medicinal plants used by MIKS herbalists, attributable to environmental degradation and agricultural expansion such as sugarcane plantations, complicates their ability to treat snakebite victims and exchange knowledge. In this regard, one of the herbalists during the interview noted that:

> *'Because of the sugarcane plantations, the herbs are becoming scarce.'* (Kamuli_Herbalist_04 2026).

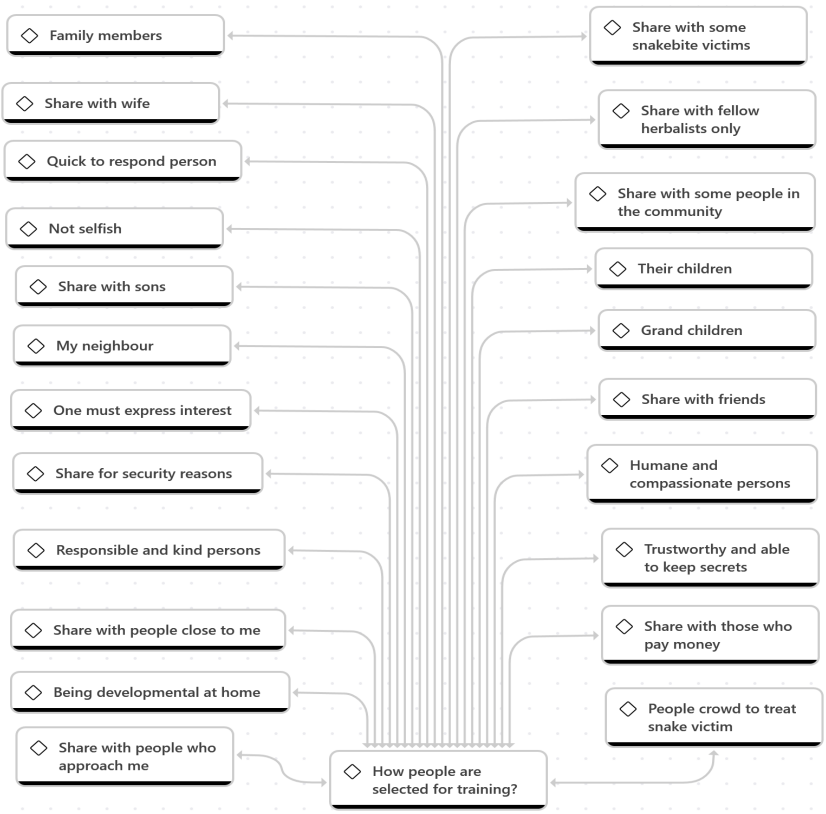


Figure 5. Shows whom the MIKS herbalists train/share knowledge with.

MIKS herbalists' charges for knowledge and experience sharing

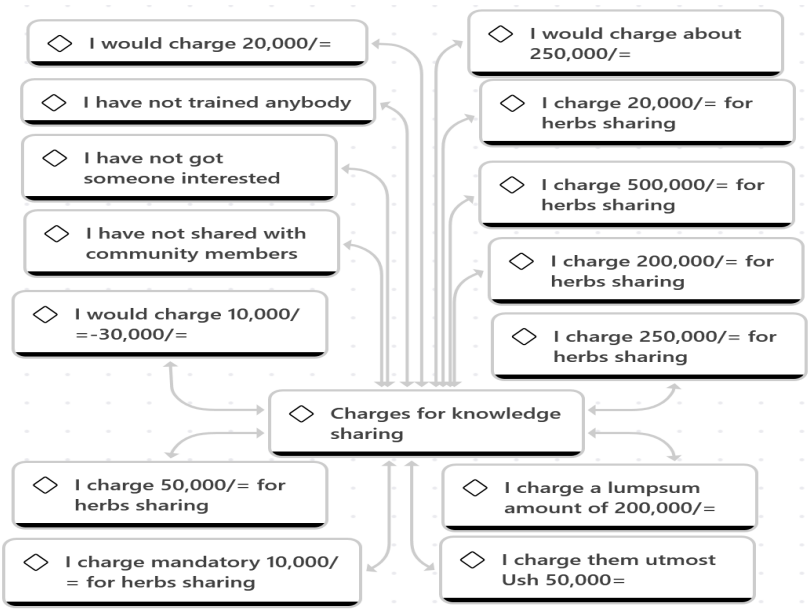


Figure 6. MIKS herbalists' charges for knowledge and experience sharing.

The inadequate survival of MIKS herbalists' herbal plants, coupled with community members' periodic theft of the herbs planted at home by the herbalists, exacerbates the challenges of MIKS herbalists' herb cultivation and undermines their sustainability. One of the herbalists during the interview was observed expressing that he planted herbs:

'But people uprooted them from his home surroundings.' (Pallisa_Herbalist_01 2025).

Simultaneously, MIKS herbalists assert that government authorities and biomedical practitioners mistreat herbalists and pursue them. This shows ongoing tensions between indigenous systems, such as those of the MIKS herbalists, and Western medical systems. Several herbalists disliked the way government authorities handle them, and one reported that:

> *'Fears the government ways of doing things for instance shows or expresses that government can kill you when they discover that "you have the MIKS knowledge, and it works.'* (Kamuli_Herbalist_14 2025).

Internal barriers, including inadequate MIKS herbalists' understanding of botanical nomenclature and concerns regarding possible revenue decline due to increased competition, further impede the distribution of MIKS information. In view of these, one of the herbalists was observed expressing:

> *'Fear to lose knowledge and income.'* (Kamuli_Herbalist_05 2025).

The confluence of these factors creates a complex scenario that hinders the transmission of MIKS herbalists' knowledge regarding snakebite management across generations and jeopardises the long-term preservation/documentation and integration into the healthcare system. Figure 7 presents challenges affecting MIKS herbalists' knowledge sharing.

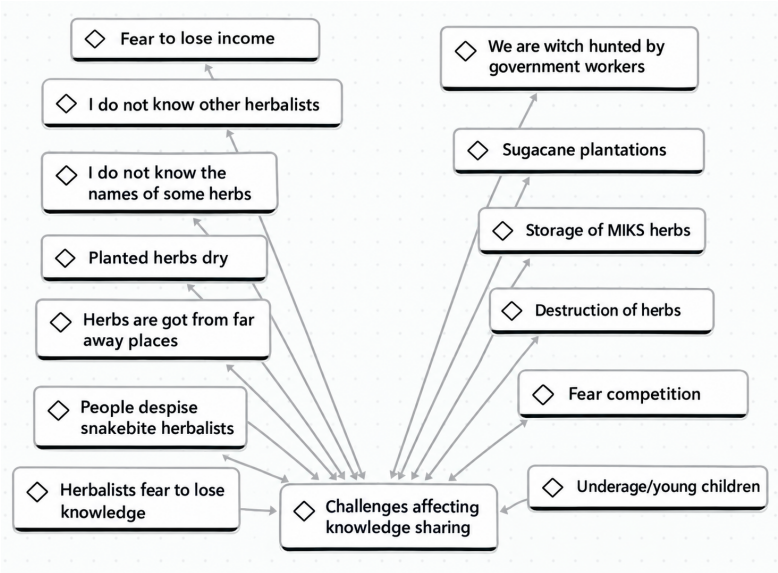


Figure 7. Challenges affecting MIKS herbalists' knowledge sharing.

Implications of the pathways of herbalists' knowledge acquisition and knowledge sharing practices for documentation and health system integration

The findings of the study reveal that MIKS herbalists in Pallisa and Kamuli districts predominantly acquire and share knowledge to treat snakebite victims from familial sources and ancestral teachings (Fig. 3). MIKS knowledge is acquired from fathers, grandfathers, and other close relatives, like uncles, through intergenerational knowledge transfer through observation, apprenticeship, and participation in herbal preparation and identification (Fig. 3). In this regard, some herbalists argued that:

> *'Even among my children I may choose one to share with my knowledge but not all of them.'* 'Kamuli_Herbalist_05 2025).

Another herbalist stated that:

> *'I only share with family, my child.'* (Kamuli_Herbalist_07 2025).

While another herbalist said that:

> *'Yes, I share with the person who approaches me but I cannot look for someone to share my knowledge with if she/he has not approached me. It is my knowledge.'* (Kamuli_Herbalist_02 2025).

The herbalists' knowledge transfer is usually selectively done. It depends on criteria like trust, self-discretion, and the perceived ethical suitability of the successor or apprentice (Fig. 3). Some herbalists share knowledge for free, whereas others charge some fee to share their knowledge. Other herbalists asserted that they obtained their knowledge from rare sources, including non-familial or spiritual origins (Fig. 3, Fig. 5).

Besides the MIKS herbalists' comprehensive accounts, the DHT members, health workers at the district hospital, HC IV, HC IIIs of public and private health service providers and the VHT members' understanding of the significant kind of information to be documented was mainly through the lens of health professionals. They identified information such as clinical symptoms, potency of the herbs to humans, treatment results, number of cases they receive, victims' follow-up, and the ways referrals should be done. Basically, the DHTs, health workers and medical practitioners, together with the VHTs, seemed to regard documentation as an instrument which could help them in their routine health services accountability and snakebite patient safety evaluation, but not as a medium for knowledge sustainability and incorporation into the main health system. In this regard, the DHT members during the FGD in Kamuli needed information about:

> *'The safety of that drug, the way they get it, because it can be contaminated, instead of curing again it causes another infection.'* (Kamuli_KDHTs 2025).

During the FGD with the health workers of Kamuli District Health Hospital, noted that:

> *'This will help us to see [if] this type of medicine works.'* (Kamuli_Hospital_KGH 2025).

Herbalists indicated issues such as lineage, trust, control over disclosure and the conditions under which knowledge could be shared. DHT and hospital accounts showed safety, possible contamination, treatment outcomes, and information needed for clinical evaluation. This shows that health professionals sought information for assessment and accountability, while herbalists described knowledge as culturally situated and sometimes restricted.

Discussion

This research section discusses the study's findings in line with the set objectives. The examination of pathways of knowledge acquisition is discussed first. It is followed by an analysis of knowledge sharing practices and constraints and concludes with the implications for documentation and health system integration.

MIKS herbalists' knowledge acquisition pathways

The findings show that MIKS herbalists' knowledge acquisition and sharing align with the socialisation facet of the SECI model, where tacit knowledge is shared or transferred through apprenticeship, observation, and shared experiences (Nonaka & Konno 1998; Nonaka & Takeuchi 1995). Consistent with previous studies, MIKS knowledge remains predominantly oral, lineage-based, and confined within trusted networks due to ethical obligations, secrecy, and fears of misappropriation (Nalubega *et al*. 2024; Ouma 2022; Steinhorst *et al*. 2022; Okot *et al*. 2020). Although some herbalists engage in traditional workshops and some elementary documentation, intergenerational and clandestine sharing remains the preferred method of knowledge acquisition and sharing (Aron *et al*. 2023; Farnese *et al*. 2019).

MIKS knowledge is also acquired through mentorship, peer interactions, and spiritual experiences, highlighting the socially and spiritually embedded nature of MIKS herbalists' knowledge systems (Agu *et al.* 2025; Olaitan *et al*. 2025; Jimenez-Fernandez *et al*. 2023; Mwaka *et al*. 2023; Xu *et al*. 2022). Emergency treatment settings, barter trade, sharing of herbs, and spiritual interactions function as informal spaces for learning, knowledge acquisition, and sharing (Bamogo *et al*. 2023; Ssenku *et al*. 2022). However, the current use of multiple herbal remedies and inconsistent preparation methods complicates efficacy and safety examinations, as noted in previous studies on traditional treatment (Tusabe *et al*. 2025; Sahoo *et al*. 2024; Schioldann *et al*. 2018). Whereas some practitioners are open to collaboration with health facilities, reliance on herbal treatments may delay access to formal healthcare (Tusabe *et al*. 2025; Pandey *et al*. 2023).

Generally, the study findings highlight the resilience and weaknesses of the MIKS herbalists' knowledge systems. Apprenticeship-based acquisition and sharing are central; however, commercialisation and institutional ambiguities threaten knowledge continuity (Mzimela & Moyo 2024; Ouma 2022). The co-existence of secrecy, selective openness, and emerging basic documentation practices among the herbalists highlights the need for structured knowledge management frameworks to facilitate preservation, ethical safeguarding, and integration into broader healthcare systems (Nalubega *et al*. 2024; Steinhorst *et al*. 2022). Therefore, socialisation is the dominant observed process; externalisation is found in limited research-mediated forms.

Knowledge-sharing practices and constraints

MIKS herbalists share knowledge through selective and socially mediated processes. It is mostly influenced by lineage, moral judgement, and spiritual authority. The primary beneficiaries are family members, including children (son(s)), grandchildren, and spouses in rare cases. The finding reflects affection, inheritance and apprenticeship as primary mechanisms via which knowledge is shared, which relates to the findings of other researchers (Duche-Perez et al. 2025; Olaitan *et al*. 2025; Mwaka

et al. 2023; Bulcha & Zepre 2021; Steinhorst *et al*. 2021). The finding also agrees with other studies that, before selection, the potential herbalists' successors are observed for their discipline, motivation, humility, and dedication to community welfare (Agize *et al*. 2022; Ouma 2022).

In some cases, the finding also shows that sharing is perceived as a spiritual embodiment rather than a technical instruction, hence limiting imitation and fostering secrecy (Ojuka *et al*. 2025; Bamogo *et al*. 2023). These behavioural patterns align with significant African research documenting lineage-based succession, oath-bound inheritance, and the belief that public disclosure diminishes therapeutic effectiveness (Jimenez-Fernandez *et al*. 2023; Agize *et al*. 2022; Bulcha & Zepre 2021). Knowledge sharing remains conditional and deliberately regulated, even beyond familial frameworks. Literature supports the finding that MIKS herbalists may share information with trusted colleagues, neighbours, or apprentices, sometimes through apprenticeship or symbolic exchanges involving ritualistic goods such as hens, goats, money, or both (Aron *et al*. 2023; Mwaka *et al*. 2023; Steinhorst *et al*. 2021, 2022). In view of the findings, studies opine that some MIKS herbalists often refuse to accept money in preference for non-monetary reciprocity to keep the moral integrity of their work (Aron *et al*. 2023; Steinhorst *et al*. 2021, 2022). Individuals frequently perceive knowledge as a clandestine, valued entity possessed by others (Nalubega *et al*. 2024; Oranga 2023; Ouma 2022; Steinhorst *et al*. 2021). However, in critical snakebite scenarios, public demonstration may temporarily override secrecy (Pandey *et al*. 2022). Nonetheless, this revelation is opportunistic rather than rigid. In many circumstances, studies agree with the finding that some MIKS herbalists entirely prohibit sharing, even among family members, due to apprehensions of overuse, reduced efficacy, or unworthy heirs (Jimenez-Fernandez *et al*. 2023; Agize *et al*. 2022; Bulcha & Zepre 2021).

The findings portray the knowledge-sharing among MIKS herbalists as an ethically governed, interest-motivated system that preserves equilibrium between continuity and regulation. Authentic expressions of interest facilitate mentorship, corresponding with thorough analyses of indigenous practices such as MIKS apprenticeship models and collective knowledge creation (Mwaka *et al*. 2023; Agize *et al*. 2022; Xu *et al*. 2022; Farnese *et al*. 2019). Nonetheless, the same procedures that safeguard integrity, confidentiality, selective succession, and spiritualisation concurrently engender structural weaknesses, particularly when the knowledge repository is predominantly oral rather than documented (Gitima *et al*. 2025; Ojuka *et al*. 2025; Ngulube & Lwoga 2008). The mortality of MIKS herbalists, youth disengagement, and the pressures of modernisation intensify this vulnerability, as documented in multiple African contexts (Tusabe *et al*. 2025; Mzimela & Moyo 2024; Nalubega *et al*. 2024). The study advocates for interest-based selective sharing or transmission as a dual-purpose sustainability strategy, highlighting the essential need for context-sensitive documentation and integrative frameworks before the onset of irreversible intergenerational discontinuity (Duche-Perez *et al*. 2025; Olaitan *et al*. 2025; Bamogo *et al*. 2023; Bulcha & Zepre 2021).

Implications of MIKS herbalists' knowledge acquisition pathways and sharing practices on documentation and health system integration

In the context of MIKS herbalists' knowledge acquisition and sharing practices and constraints, the findings provide insights into ingrained implications that can practically hinder MIKS herbal documentation and health system integration. MIKS herbalists predominantly acquire knowledge through intergenerational sharing within the family and kinship networks, and it is not universal. Knowledge is mostly acquired orally from fathers, grandparents, and close relatives through iterative apprenticeship, observation, and experiential learning from healing engagements, as underscored by the SECI model and other studies (Stern *et al*. 2021; Ngulube 2003; Nonaka & Takeuchi 1995). Some studies conclude that MIKS is at risk of being eroded through the traditional acquisition and sharing practices because their practices are inadequate and unable to safeguard MIKS from extinction (Bamogo *et al*. 2023; Mwaka *et al*. 2023; Agize *et al*. 2022; Ssenku *et al*. 2022). There is a need to sensitise the herbalists on the relevance of structured documentation and health systems integration. Policymakers should develop a strategy for structured documentation of MIKS.

Documentation must not be treated as an automatic good or as permission to disclose all knowledge. Concerns such as confidentiality, loss of income, recognition, and control showed that importance of consent and governance. The process should obtain free, prior and informed consent for the specific information, purpose, audience, storage, location and use. In addition, integration was regarded as a structured interface between community-based MIKS practitioners and formal health services.

Herbalists acquire knowledge through mentorship, peer networks, like vendors, and spiritual experiences. The practices are supported by the Socialisation facet of the SECI model (Nonaka & Takeuchi 1995). However, their methods of knowledge acquisition and sharing are conditional, limiting MIKS access and use by the public for snakebite management, although the

pharmacological compositions of most of the herbs are unknown. The study provides a comprehensive understanding of the herbalists' knowledge acquisition and sharing practices, and this is essential for policy development, integration into the health systems, health outcomes and structured documentation.

Despite the diversity of herbal remedies used, limited disclosure was a prominent characteristic among herbalists in Pallisa and Kamuli districts; for instance, seven herbalists reported using fresh roots and leaves but did not specify herbal names or species, reinforcing the secrecy surrounding MIKS herbalists' acquisition and sharing practices. In the socialisation facet of the SECI model, herbalists share their tacit knowledge with specific individuals (Nonaka & Takeuchi 1995). Family members could be asked to offer chicken or nothing at all. Non-family members could be asked to offer either chicken or money or both, whereas a few others shared their knowledge freely (Okot *et al*. 2020). This kind of behaviour could be associated with concerns over loss of income and risks of biopiracy, which in turn constrain efforts toward systematic documentation and integration into formal healthcare systems (Arbuckle *et al*. 2026; Aron *et al*. 2023; Nonaka & Takeuchi 1995). These findings support the need for a bottom-up approach that fosters trust and safeguards indigenous knowledge while enabling structured documentation. For instance, KMIKS 14 did not disclose the names or species of the herbs used, while KMIKS 05 disclosed the species but withheld its local name. KMIKS 13 reported two herbs without disclosing their names, although the species were photographed, and KMIKS 11 shared the local names of the herbs used but did not present them for photography. Notably, Diplopterys cabrerana (**kafulu**), mentioned by MIKS 11, was also reported by KMIKS 03, PMIKS 06 and PMIKS 13, while sweet potato (**ekijo**) use was also disclosed by PMIKS 13.

Engagement of varied participants in the study and their different roles in the community is believed to have led to the collection of essential information for the study; however, some limitations constrained the study. These included financial constraints, resistance from some participants to share specialised MIKS and experiential knowledge, and a general lack of awareness among the MIKS herbalists regarding the importance of managing tacit knowledge within Ugandan communities. Furthermore, bureaucratic procedures within both the MIKS and health practitioners posed potential obstacles to the timely completion of the research. The study is also based on only two cases, which is likely to cause challenges in generalising the results.

The researcher sought financial support from various supporters; the MIKS herbalists were sensitised on the purpose of the study, and authorisation was sought from the Chief Administrative Officers (CAOs) and the District Health Officers (DHOs) in the two study districts to enable the smooth conduct of the study. The above procedures were done to mitigate the anticipated challenges to the study (Theofanidis & Fountouki 2018).

Conclusions

The research indicates that MIKS herbalists in Eastern Uganda predominantly disseminate information via experiential, oral, and intergenerational learning within trusted social networks. The knowledge-sharing methodology of MIKS herbalists is centred on observation, engagement, and iterative practice. It resembles the socialisation mode of the SECI model (Nonaka &Takeuchi, 1995). Collaborative care during snakebite emergencies and herb-for-herb exchanges are further methods of knowledge dissemination. Certain MIKS herbalists impose charges for their expertise. Whereas financial assets influence the sharing of this knowledge, most herbalists' transfer of knowledge is governed by trust, ethical integrity, and cultural norms. This underscores the relational and culturally embedded attributes of MIKS herbalists' knowledge systems. Although these pathways ensure continuity within trusted circles, they also constrain wider knowledge diffusion due to lineage control, spiritual influences, and guarded sharing practices. Efforts to document MIKS are feasible but depend on building trust, formally recognising herbalists, and creating supportive, collaborative structures that accommodate varying literacy levels and sociocultural contexts. Governments should invest in capacity-building initiatives, such as basic literacy training and provision of standardised, locally adapted documentation tools, alongside incentives to sustain participation. Herbalists should be supported to gradually adopt documentation practices, while maintaining ethical safeguards and cultural integrity in knowledge acquisition and sharing. Further research should focus on herbalists' acquisition and sharing phases, collaboration and power dynamics in indigenous knowledge regulation, and combination models between herbalists and health facilities. The study contributes to managing the gap in unpacking the processes underpinning MIKS acquisition, sharing, and sustainability. It reveals the need for process-oriented and interdisciplinary scholarship beyond ethnobotanical inventories to examine knowledge systems, governance, and preservation techniques.

Declarations

List of abbreviations: CAO-Chief Administrative Officer; DHO-District Health Officer; FGD-Focus group discussion; KMIKS-Kamuli Medicinal Indigenous Knowledge on Snakebite Herbalist; KRA-Kamuli Research Assistant**;** MIKS-Medicinal Indigenous Knowledge on Snakebites; MRPs-Medical Records Personnel; PMIKS-Pallisa Medicinal Indigenous Knowledge on Snakebite Herbalist; PRA-Pallisa Research Assistant.

Ethics approval and consent to participate: The Uganda Christian University Research Ethics Committee (UCU-REC), registration number UCUREC-20242025, the University of South Africa (UNISA) NHREC registration number Rec-240816-052, and the Uganda National Council for Science and Technology (UNCST) registration number SS3517ES all approved the study. Informed written consent was obtained from the gatekeepers (Chief Administrative Officers (CAO)) from the two study districts of Pallisa and Kamuli. Furthermore, informed written consent was obtained from the participants in the field interviews and focus group discussions.

Consent for publication: Not applicable.

Availability of data and materials: All the data are presented in figures in the manuscript and are accessible through the corresponding author**.**

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

Funding: No funds were allocated.

Author contributions: JFM conceptualised the study and prepared the draft manuscript. JC and PN reviewed and updated the study manuscript. All the co-authors (JC and PN) contributed to, read, and approved the final copy of the manuscript**.**

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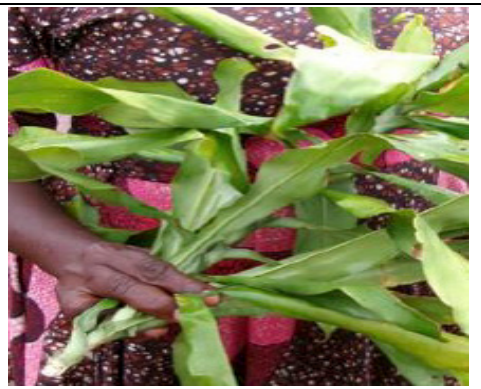
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Supplementary material

The supplementary Tables S1 and S2 show the photographic documentation of the disclosed and captured MIKS herbalist plant varieties used in snakebite treatment in Pallisa and Kamuli districts of Eastern Uganda.

Supplementary Table S1: List of names and photographs of MIKS herbalists' herbs used from Kamuli District field, 2025

Code of herbalist	Local herbs used by snakebite herbalists	Other minerals/Items used by snakebite herbalists	Medicinal name/photograph of plants used by snakebite herbalists
KMIKS_01	• Local Lusoga name: **luwani**.		 Figure 1: **luwani**. Photograph of a medicinal herbal plant species reported by a herbalist in Kamuli district of Eastern Uganda. The part used is the roots. Photographed by the researcher with consent from the herbalist, 2025.
KMIKS_02	• Lacal Lusoga name: **olubembe**. • Species name: Spear grass/Blady Grass (Imperata allang Jung). • The herbalist also reported that uses some tree roots for treatment.	The herbalist in Kamuli district reported using paraffin, a UGX 500/= coin, salt, and a black stone to treat snakebite victims. Captured by the researcher with consent from the herbalist, 2025.	 Figure 2: Spear grass (**olubembe**) The herbalist in Kamuli district reported using spear grass roots to treat snakebite victims. Photograph captured by the researcher with consent from the herbalist, 2025.

KMIKS_03	• Local Lusoga name: akaiyilizi or kafuga Nkande (Luganda).		 Figure 3: Local name: **akaiyilizi** (Lusoga) or **kafuga nkande** (Luganda). The part used is the roots. A medicinal plant photograph disclosed by the herbalist in Kamuli district, Uganda. It was taken by the researcher with the consent of the herbalist, 2025.
	• Local Lugwere name: **kafulu**.		 Figure 4: **kafulu** (local Lusoga name) A medicinal plant photograph used in snakebite treatment and was disclosed by the herbalist in Kamuli district, Uganda. The part used is the roots. It was taken by the researcher in 2025 with the consent of the herbalist.

			 Figure 4: **kafulu** (local Lusoga name)
KMIKS_04	• Local Lusoga name: **muvuvumila** (Luganda name: **kimalampaka**). • Preserved dry herbs for treating snakebites		 Figure 5: **muvuvumila** (Local Lusoga name).

			 Figure 5: **muvuvumila** (Local Lusoga name). Photograph of the herbal medicinal plant used in snakebite management as disclosed by the herbalist in Kamuli district, Uganda. The part used is the roots. It was photographed in the study by the researcher in 2025 with the consent of the herbalist.  Figure 6: Dried and processed herbs kept for treatment of emergency cases of snakebite victims. Photograph captured by the researcher, 2025 with consent of the herbalist.

KMIKS_05	• No name was provided by the herbalist for this plant. The herbalist declined to reveal the name of the plant.	Black stone and razor blade. The herbalist in Kamuli district reported using a black stone and razor blade in the treatment of snakebite victims. This information was captured by the researcher, 2025.	 Figure 7: No name was disclosed by the herbalist in Kamuli district for this medicinal plant, which he reported using to treat snakebite victims. The part used is the roots. The photograph of this medicinal plant was captured by the researcher, 2025 with consent from the herbalist.
KMIKS_06	• Local Lusoga name: *Amadhi* (Water). • English name: Water. • Medicinal herbs are infused into the body of the selected person and give that individual spiritual power to heal snakebites using plain water. • There are no artefacts used in the form of objects or words during the treatment process.	Uses plain water to treat snakebite and the spiritual power of the herbs infused into his body. The herbalist in Kamuli district reported that he uses palatable water and the spiritual power infused into his body to treat snakebite victims.	 Figure 8: Palatable water. The herbalist reported that uses palatable water with the power of the herbs infused in his body to treat snakebite. The participant explained that a set of herbs had been infused into his body, which he believes enables him to treat snakebites using only plain water. Although he stated that he knows the specific herbs involved in the infusion, he chose not to disclose them and has not shared this knowledge even with his brother. According to his account, the infusion is administered only once

			in a lifetime. Similarly, treatment of a snakebite victim is performed a single time, with one dose of water regardless of the species of snake involved.
KMIKS_07	• Local Lusoga name: **obulezi obukalu** *obwidhadaba abalumibwa omusota* (Preserved dry herbs for snakebite treatment.)	The herbalist reported using dry herbs preserved for snakebite treatment. Reported using a new razor blade to make incisions.	 Figure 9: Dry herbs preserved for snakebite treatment. The photograph of dry herbs used in snakebite treatment reported by the snakebite herbalist in Kamuli district, Uganda. The photograph was captured by the researcher, 2025 with the consent of the herbalist.
KMIKS_08	• Local Lusoga name: *Kasagala nsasi.* • Species name: Antbush/Senna Occidentalis or Coffee senna. • The herbalist reported that the roots of two main herbs are used. • The herbalist also reported that there are five types of herbs used for first aid.		 Figure 10: Coffee senna (kasagala nsansi (local Lusoga/Lugwere name). The part used is the roots. Photograph of the herbal medicinal plant used in snakebite management as disclosed by the herbalist in Kamuli district,

			Uganda. It was photographed in the study by the researcher in 2025 with the consent of the herbalist.
KMIKS_09	• Local Lusoga name of the herbs: Not disclosed/does not know the herbs because he was young during the time of initiation into the practice. He is a sibling to herbalist KMIKS_06. • Local Lusoga name of the herb: **amadhi** (Water). • English name: Water.	Uses plain water to treat snakebite and the spiritual power of the herbs infused into his body.	 Figure 11: Palatable water. The herbalist reported that palatable water is used to treat snakebite victims with the power of the herbs infused into his body. The participant reported that a set of herbs had been infused into his body, enabling him to use plain water in the treatment of snakebites. He explained that he does not know the specific herbs involved in the infusion process. According to his account, the infusion is performed only once and is believed to impart a lasting spiritual ability to the selected individual to treat snakebites using water alone.
KMIKS_10	• Local Lusoga name: **Neem tree**. • English name: **Neem tree**. • Local name: **matanta**. • English name: Human saliva.	• Human saliva. Herbalist in Kamuli district, Uganda reported using human saliva (or matanta in Lugwere) in the treatment of snakebite victims. This information was captured by the researcher during the FGD.	• No photographs obtained. The herbalist uses leaves of the Neem tree.
KMIKS_11	• 1. Local name: *Kajujula* (Uses the roots). • English name: unknown. • 2. Local Lusoga name: *Embooli*. • English name: Sweet potato (Uses the tuber and sweet potato vines). • 3. Local Lusoga name: **mukitimbo**. • 4. Local Lusoga name: **kafulu** *(see Figure 4)*.		• Kajujula (roots). No photograph was obtained from the herbalist. • **mukitimbo** (roots). No photograph was obtained, but it was reported to be known by the local people. • Sweet potato (emboli). No photographs obtained. • The herbalist in Kamuli district in Uganda reported the use of sweet potatoes in the treatment of snakebite victims. Information was captured by the researcher in 2025.

KMIKS_12	• 1. Local Lusoga name: **taaba** • Species name: Tobacco (Perique or Nicotiana tabacum).		 Figure 11: Tobacco (**taaba**). Photograph of the herbal medicinal plant used in snakebite management as disclosed by the herbalist in Kamuli district, Uganda. The parts used are the roots and leaves. The researcher obtained consent from the herbalist and photographed it in 2025.
	• 2. Local Lusoga name: **omupapali omusadha**. • Male pawpaw (Male papaya, Carica papaya or Mountain papaya).		 Figure 12: Male pawpaw. Photograph of the herbal medicinal plant used in snakebite management as disclosed by the herbalist in Kamuli district, Uganda. The part used is the roots. It was photographed in the study by the researcher in 2025 with consent from the herbalist.

KMIKS_13	• Local Lusoga name: Not provided		 Figure 13: Unnamed by the herbalist. Photograph of the herbal medicinal plant used in snakebite management as disclosed by the herbalist in Kamuli district, Uganda. The part used is the roots. It was photographed in the study by the researcher in 2025 with consent from the herbalist.
	• Local Lusoga name: Not provided.		 Figure 14: Unnamed by the herbalist.

			Photograph of the herbal medicinal plant used in snakebite management as disclosed by the herbalist in Kamuli district, Uganda. The part used is the roots. It was photographed in the study by a researcher in 2025 with consent from the herbalist.
KMIKS_14	Did not disclose the names and herbs used but reported that he uses roots.		No photographs obtained. The respondent was secretive in character.

Supplementary Table S2: List of names and photographs of MIKS herbalists' herbs used from Pallisa District field, 2025

Code of herbalist	**Herbs local name**	**Minerals/other items used**	**Photograph**
PMIKS_01	• Participant uses roots of plants and trees. • Herbalist has first aid herbs.		• No photographs obtained. The respondent was secretive in character.
PMIKS_02	• Local Lugwere name: **kasagala nsasi**. • Species name: Senna Occidentalis or Coffee senna. • Participant also uses blood of a special animal but did not disclose the name of the animal.	The herbalist uses cold water to mix the herbs. The herbalist uses blood from a special animal to treat victims.	 Figure 15: Coffee senna (**kasagala nsansi** (local Lusoga/Lugwere name). The part used is the roots. The herbal medicinal plant used in snakebite management was disclosed by the herbalist in Pallisa district, Uganda. It was photographed during the study by the researcher in 2025.

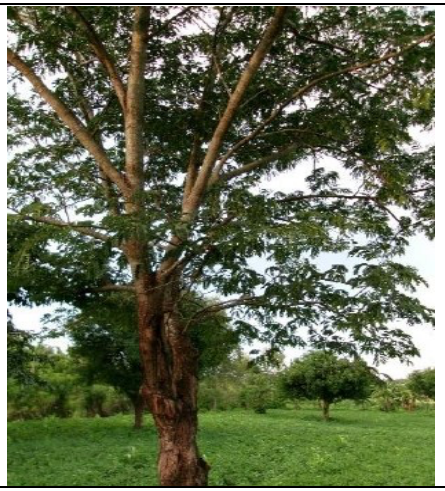
PMIKS_03	• Local Lugwere name: **kasagala nsasi**. • Species name: Senna Occidentalis or Coffee senna.	The herbalist ties/uses bands or threads. The herbalist uses cold water to mix the herbs.	 Figure 16: Coffee senna (**kasagala nsansi** (local Lusoga/Lugwere name). The part used is the roots. The herbal medicinal plant used in snakebite management was disclosed by the herbalist in Pallisa district, Uganda. It was photographed in the study by the researcher in 2025.
	• Lugwere name: **musita**.	The herbalist uses cold water to mix the herbs.	

			Figure 17: **musita.** (local Lusoga/Lugwere name). The parts used are the roots and the bark. The photograph of the herbal medicinal plant used in snakebite management as disclosed by the herbalist in Pallisa district, Uganda. It was photographed in the study by the researcher in 2025.
	• Local Lugwere name: **kakoda** or **kanakaibo /subiri**.		 Figure18: **kakoda/kanakaibo.** The part used is the roots. Photograph of the herbal medicinal plant used in snakebite management as disclosed by the herbalist in Pallisa district, Uganda. It was photographed during the field study by the researcher in 2025.
PMIKS_04	• Participant uses tree roots but did not disclose the name of the herbs (trees) used.	The herbalist uses cold water to mix the herbs.	• No photographs obtained. The respondent was secretive in character.
PMIKS_05	• Participant uses tree roots but did not disclose the names of the herbs and trees used.		• No photographs obtained. The respondent was secretive in character.

PMIKS_06	• Local Lugwere name: **kafulu**.	The herbalist uses milk to mix the herbs.	 Figure 19: **kafulu**.  Figure 19: **kafulu**. (local Lusoga/Lugwere name). The part used is the roots. A photograph of a medicinal plant used in snakebite treatment. It was disclosed by the herbalist in Pallisa District, Uganda. It was taken by a researcher in 2025.

PMIKS_07	• Local Lugwere name: **nandere** / **kabuluka**. • Species name: Euphobia grantii/African Milk Bush. • Species: Himatanthus drasticus (Janauba)		 Figure 20: **nandere/kabuluka** (Local Lugwere name). A medicinal plant photograph used in snakebite treatment and disclosed by the herbalist in Pallisa district. The part used is the roots. It was taken by the researcher in 2025.
PMIKS_08	• Local Lugwere name: **ekijjo** (Sweet potato). • English name: Sweet potato. • The herbalist also reported that uses leaves and roots of some trees but did not disclose them.	The herbalist uses cold water to mix herbs. Razor blade.	• No photographs obtained. The respondent was secretive in character. The herbalist also uses leaves and roots of some trees but did not disclose them. The information was captured by the researcher in Pallisa district, Uganda.
PMIKS_09	• Participant reported that roots of three different trees are used but did not disclose the names.	The herbalist uses cold water for mixing the herbs.	• No photographs obtained. The respondent was secretive in character. Participant reported that roots of three different trees are used but did not disclose the names. This information was captured in Pallisa district, Uganda.

PMIKS_10	• Participant reported that uses roots of three different trees but did not disclose the tree names.	The herbalist reported that cold water is used to mix the herbs. The herbalist also reported that uses paraffin and a razor blade to treat victims.	• No photographs obtained. The respondent was secretive in character. Participant reported that roots of three different trees are used but did not disclose the names. This information was captured in Pallisa district, Uganda.
PMIKS_11	• Local Lugwere name of the herb: **eisubi** (Grass). • English name: Grass. • Local Lugwere name of the parts used: **emirandira gyemisaale** (Grass/Tree roots). • English name of the parts used: Grass/Tree roots. But did not disclose the tree species and name of the grass/trees whose roots he uses. • God's help.	•	• No photographs obtained. The respondent was secretive in character. The respondent reported that relies on grass/tree roots and God's help in treating the snakebite victims. This information was collected by the researcher from Pallisa District, Uganda.
PMIKS_12	• Participant reported that uses fresh roots but did not disclose the trees and their name for identity.	The participant reported that cold water was used for mixing the herbs.	• No photographs obtained. The respondent was secretive in character. The respondent reported that relies on tree roots for treating the snakebite victims. This information was collected by the researcher from Pallisa District, Uganda.
PMIKS_13	Local Lugwere name: **katungulu komukisiko** (Lugwere) *or* (**kasotasota**). • Species name: Wild onion.		 Figure 21: katungulu komukisiko (local Lugwere name) or wild onion.

			 Figure 21: **katungulu komukisiko** (local Lugwere name) or wild onion. A medicinal plant photograph used in snakebite treatment and disclosed by the herbalist in Pallisa district. It was taken by researcher in 2025.
	• Local Lugwere name: *Mindi* or **kabowabowa / kanakaibo /subiri.** • Species name: Aristolochia elegans. Also commonly known as Calico Flower or Elegant Dutchman's Pipe.		 Figure 22: see Figure 18

	• Local Lugwere name: **nabirye**.		 Figure 23: nabirye (local Lugwere name.) A medicinal plant photograph used in snakebite treatment and was disclosed by the herbalist in Pallisa district. The part used is the roots. It was taken by the researcher in 2025.
	• Lacal Lugwere name: **kasagala nsasi**. • Species name: Senna Occidentalis or Coffee senna.		 Figure 24: see Figure 10, 15, and 16.

	• Local Lugwere name: **mbiriri.** • Species English name: Bitter leaf. Source of the English name: kcca.go.ug/tree-directory/1265 Accessed December 9, 2025.		 Figure 25: Bitter leaf (local Lugwere name: mbiriri). (local Lusoga name) A medicinal plant photograph used in snakebite treatment and was disclosed by the herbalist in Pallisa district. The part used is the leaves. The photograph was taken by the researcher in 2025.
	• Local Lusoga name: **kafulu**	Tie/bands or threads.	 Figure 26_1: see Figure 4 and 19. (local Lusoga/Lugwere name) A medicinal plant photograph used in snakebite treatment and was disclosed by the herbalist in Pallisa and Kamuli district. The part used is the roots. It was taken by the researcher in 2025.

			 see Figure 26.
	• Local Lugwere name of the herb: **ekijjo** (Sweet potato) or **embooli** (Local Lusoga name).		Sweet potato. No photograph was taken by the researcher but it is a common food item in homes.
	• Local Lugwere name of the herb: **eibembe** (Spear grass).		 Figure 27: see Figure 2. The herbalist in Pallisa district reported using spear grass roots to treat snakebite victims. Photograph captured by the researcher in Pallisa District, Uganda 2025.

PMIKS_14	• Local Lugwere name: **kasagala nsasi.** • Species name: Senna Occidentalis or Coffee senna. • Uses three different tree roots as herbs.	The herbalist reported that uses milk to mix some of the herbs. Consequently, the herbalist reported that cold water is not used to treat poison.	 Figure 28: Coffee senna (**kasagala nsansi** (local Lusoga/Lugwere name). see Figure: 10,15, and 16. The part used is the roots. The herbal medicinal plant used in snakebite management was disclosed by the herbalist in Pallisa district, Uganda. It was photographed in the study by the researcher with the consent of the herbalist in 2025.
	• Local Lugwere name: **kafulu**.	The herbalist uses milk and hot water to mix the herbs.	 Figure 29: see Figures 4, 19, and 26.

			 Figure 29: **kafulu** See Figures 4, 19 and 26. (local Lusoga/Lugwere name) A medicinal plant photograph used in snakebite treatment and was disclosed by the herbalist in Pallisa and Kamuli districts, Uganda. The part used is the roots. It was taken by the researcher in 2025.
PMIKS_15	• Local Lugwere name: **musita**. • Species English name: Albizia.	The herbalist uses a concentrated solution for first aid. The herbalist uses paraffin to treat snakebite victims.	Figure 30: **musita**. Lusoga/Lugwere name). See Figure 17. The parts used are the roots and the bark. The photograph of the herbal medicinal plant used in snakebite management, as disclosed by the herbalist in Pallisa district, Uganda. It was photographed in the study by a researcher with consent from the herbalist in 2025.

	• Local Lugwere name: **konta**. • Species English name: Yellow oleader or Cascabela.		 Figure 31: **nkonta** The parts used are the roots. The photograph of the herbal medicinal plant used in snakebite management, as disclosed by the herbalist in Pallisa district, Uganda. It was photographed in the study by a researcher with consent from the herbalist in 2025.
	• Local Lugwere name for the herb: **emichungwa emikamule** (Orange juice) oba (or) enimu ekamule (Lemon juice).		• No photographs obtained. The respondent reported that uses orange or lemon juice for first aid or concentrated salt solution in treating the snakebite victims. This information was collected by the researcher from Pallisa District, Uganda.