Medicinal plants used for peptic ulcer disease by traditional health practitioners in the Vhembe District Municipality, South Africa

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Research

Abstract

Background: Peptic ulcer disease (PUD) remains a major health burden, particularly in resource-limited settings where traditional medicines continue to play an important role. This study documented and quantitatively evaluated medicinal plants used by Traditional Health Practitioners (THPs) for PUD treatment in the Vhembe District Municipality (VDM), Limpopo Province, South Africa, and assessed variation in plant use across municipalities.

Methods: An ethnobotanical survey was conducted from February to March 2026 among 60 THPs selected through snowball sampling. Semi-structured interviews captured information on diagnosis, medicinal plants used, harvested parts, and preparation methods. Ethnobotanical indices, including ethnobotanicity index (EI), informant consensus factor (ICF), use value index (UVI), and relative frequency of citation (RFC), were calculated. A chi-square test assessed differences in plant use among municipalities ($p \leq 0.05$).

Results: A total of 27 species from 20 families were recorded, with Fabaceae, Asteraceae, Combretaceae, and Rhamnaceae as the most represented families. Remedies were primarily prepared as decoctions or infusions from roots and bark, consistent with commonly reported ethnomedicinal practices for the treatment of gastrointestinal disorders in the region. Most species (75%) were used singly; however, half of the THPs also prepared multi-plant remedies. While 21 species were listed as Least Concern, the dominance of destructive harvesting methods highlights sustainability risks. Culturally salient species included *Annona senegalensis* Pers., *Schkuhria pinnata* (Lam.) Kuntze ex Thell., *Peltophorum africanum* Sond., *Sclerocarya birrea* (A.Rich.) Hochst. and *Cissampelos torulosa* E.Mey. ex Harv. A low EI (3.47%) and high ICF (0.827) indicated a focused pharmacopoeia with strong practitioner agreement. No significant differences in plant use were observed across municipalities based on the chi-Square test ($p \leq 0.05$), suggesting shared district-wide therapeutic knowledge.

Conclusions: Peptic ulcer disease treatment in the VDM relies on a cohesive set of medicinal plants supported by high cultural consensus. Although most species are not currently threatened, reliance on roots and bark underscores the need for sustainable harvesting practices.

Keywords: Ethnobotany; Peptic ulcer disease; Medicinal plants, Traditional health practitioners

Background

The Traditional medicine continues to underpin global healthcare systems, with reports indicating that 40-90% of populations in many countries rely on traditional remedies as part of their primary healthcare (UN 2025). In South Africa, particularly within the Vhembe District Municipality (VDM) of Limpopo Province, Traditional Health Practitioners (THPs) remain indispensable in meeting community health needs (Mothibe & Sibanda 2019). They draw on centuries of indigenous knowledge to address a wide range of ailments, including peptic ulcer disease (PUD) (Costantine *et al*. 2025). These practices not only embody cultural heritage but also provide practical solutions in contexts where access to modern healthcare facilities remains limited.

Peptic ulcer disease (PUD) remains a major global health burden, affecting nearly 10% of the population as reported back in 2022 (Jaswanth *et al*. 2022). Its prevalence is higher in low-resource settings, where *Helicobacter pylori* (*H. pylori*) infections and the widespread use of non-steroidal anti-inflammatory drug (NSAIDs) are common (Ashinze *et al*. 2025). Clinically, PUD is characterized by symptoms such as epigastric pain, nausea, bloating, loss of appetite, and in severe cases, gastrointestinal bleeding manifested as haematemesis or melena (Kavitt *et al*. 2019). In rural South African communities, including those in the VDM, limited access to biomedical treatment and the high cost of conventional therapies contribute to sustained reliance on traditional medicinal plants for managing PUD-related symptoms. Across South Africa and other parts of sub-Saharan Africa, several ethnobotanical studies have documented the use of medicinal plants such as *Artemisia afra* Jacq. ex Willd., *Warburgia salutaris* (G.Bertol.) Chiov., and *Sclerocarya birrea* (A.Rich.) Hochst. for the treatment of gastrointestinal disorders, including ulcers and related conditions (Magwede *et al*. 2019, Van Wyk & Wink 2015). Similar patterns have also been reported in Asia and other developing regions, where plant-based remedies are widely used due to their accessibility, affordability, and long-standing cultural acceptance (Tangjitman et al. 2015, Wali et al. 2022). Despite this widespread dependence, there is currently no comprehensive ethnobotanical documentation of plant species specifically used for PUD treatment within VDM, presenting a clear gap in both scientific literature and local healthcare knowledge systems.

Despite their widespread use, the efficacy and safety of many traditional remedies have not been systematically validated, highlighting the need for rigorous scientific evaluation (Van Wyk & Wink 2015). Ethnobotanical surveys serve as a critical means of documenting medicinal plant use in a structured manner, preserving indigenous knowledge while generating empirical data that can be analysed for therapeutic relevance (Ralte & Singh 2024). By recording species, preparation methods, and frequency of use, such surveys establish a foundation for subsequent laboratory investigations including phytochemical and pharmacological studies, thus bridging oral traditions with scientific inquiry.

Recent studies underscore the importance of quantitative approaches in ethnobotany, demonstrating how statistical perspectives enhance reliability, reduce subjectivity, and enable meaningful cross-community comparisons (Baruah *et al*. 2024, Ndhlovu *et al.* 2023). Applying data-driven methodologies ensures that traditional knowledge is preserved and evaluated in ways that strengthen its potential integration into biomedical research. This transition from narrative records to measurable analysis allows for a more rigorous assessment of medicinal plants used in local healthcare systems.

Ethical considerations remain integral to ethnobotanical research. Respect for indigenous knowledge holders, informed consent, and appropriate recognition of THPs are essential for ensuring credible and equitable research outcomes (Vandebroek *et al*. 2025). Embedding these principles within a statistically informed framework safeguards cultural integrity while enhancing the legitimacy and acceptance of research findings. This study aims to conduct an ethnobotanical survey in the VDM to document and characterise medicinal plants traditionally used by THPs for the treatment of PUD. It further seeks to compare the four local municipalities by examining the plant species each relies upon, identifying both areas of overlap and points of divergence in their traditional healing practices. Ultimately, the study intends to compile a comprehensive inventory of plants employed in the traditional treatment of PUD within the district.

Materials and Methods

Study area

The study was conducted in the four local municipalities of the VDM in Limpopo Province, South Africa (Figure 1). Vhembe District Municipality covers approximately 25,596 km² and is situated in the northernmost part of South Africa, bordering Zimbabwe and Mozambique. The district has a population of about 1.65 million people as of 2022, predominantly composed of Vhavenda and Tsonga communities, with a strong cultural reliance on traditional medicine (Ramarumo 2020). The region is characterized by a subtropical climate, with warm temperatures and summer-dominant rainfall, exhibiting considerable spatial and temporal variability (SAWS 2024, Shikwambana *et al*. 2021). Vegetation is dominated by savanna woodlands and riverine forests, which host a rich diversity of medicinal plant species (SANBI 2023). The left panel of Figure 1 shows Africa with South Africa highlighted in red, the middle panel shows South Africa's provincial boundaries with Limpopo outlined in red with Vhembe District shaded in light grey. The right panel presents an enlarged view of Vhembe District and its four local municipalities (Musina, Makhado, Thulamela and Collins Chabane).

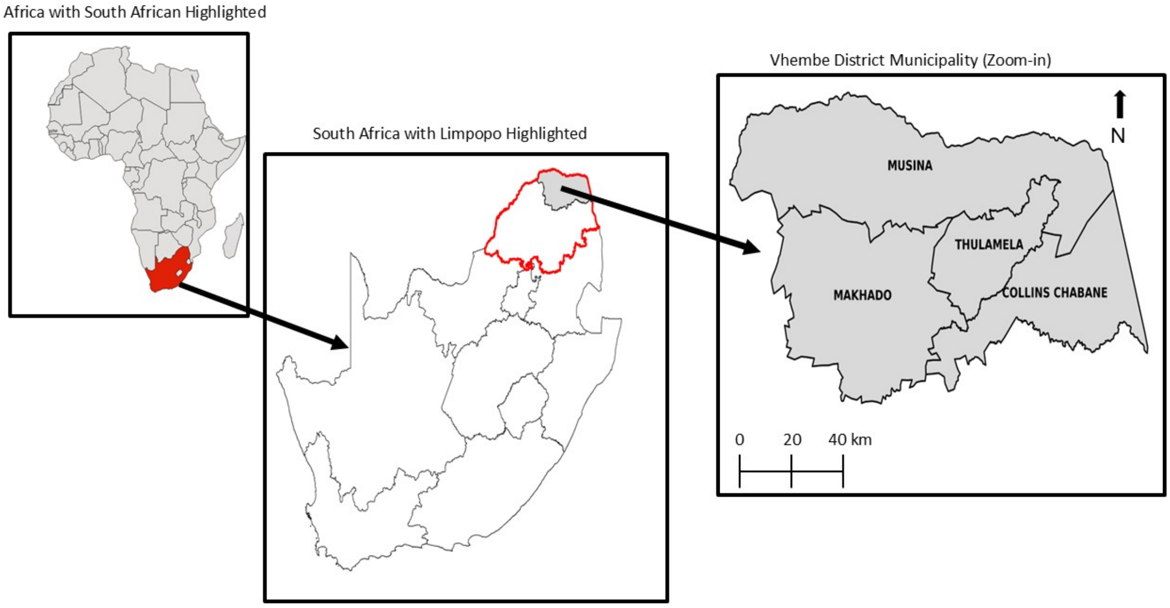

Figure 1. Location of the Vhembe District Municipality within Limpopo Province, South Africa. Data Source: Africa country boundaries obtained from Natural Earth (Free vector data - Admin 0 Countries), and South Africa administrative boundaries from MapOG GIS Data - (accessed on 7 June 2026).

Ethnobotanical survey

Sampling and data collection

The snowball sampling technique (Goodman 1961, Naderifar et al. 2017) was used to identify and select 60 THPs, with 15 participants selected from each local municipality of the VDM. The study was conducted between February and March 2026. Data was collected using a semi-structured questionnaire, focusing on symptomatic diagnosis of peptic ulcers, plant species used, plant parts, and the use of single or combined medicinal plant remedies. To ensure clarity and cultural sensitivity, interviews were conducted in the local language, with responses recorded in writing. All participants were briefed on the purpose of the study, their rights, and the voluntary nature of participation, with informed consent obtained prior to data collection and confidentiality maintained. Ethical approval for the study was granted by the Turfloop Research Ethics Committee (TREC), University of Limpopo with reference number TREC/67/2026: PG, ensuring compliance with institutional and national guidelines for research involving human participants.

Plant collection and identification

The information obtained from the interviewees was utilized to guide specimen collection and specimen of each mentioned plant species was collected during organised field tours accompanied by THPs. Collections were conducted in the presence of THPs, who assisted in identifying the plants directly in the field, thereby ensuring accuracy and alignment with indigenous knowledge systems. For scientific accuracy, specimens were subsequently subjected to detailed taxonomic examination by a qualified taxonomist at the Larry Leach Herbarium (UNIN), University of Limpopo. Voucher specimens of each plant were then prepared, labelled, and deposited at the herbarium.

Data Analysis

Data analysis involved the application of quantitative ethnobotanical indices to evaluate the cultural significance, frequency, and consensus of medicinal plant use within the study area. Additionally, a chi-square test was employed to determine whether significant differences existed in the types of plants used across the four local municipalities at a significance level of $p \leq 0.05$.

Ethnobotanicity index (EI)

The ethnobotanicity index (EI) was calculated to determine the proportion of the regional flora used medicinally. Following (Zatout *et al*. 2021), EI was calculated as:

$$EI = \frac{\text{(Number of medicinal species)}}{\text{(Total flora)}} \times 100$$

where the Number of medicinal species refers to all species cited for medicinal use in this study, and Total flora is the number of plant species documented for the VDM, as reported by Magwede *et al*. (2019). Higher EI values indicate greater incorporation of local biodiversity into medicinal practice.

The informant consensus factor (ICF)

As per Estrada-Castillón *et al*. (2021), the informant consensus factor (ICF) was calculated using the formula:

$$ICF = \frac{n_{ur} - n_t}{n_{ur} - 1}$$

where n_{ur} represents the total number of use-reports for a given ailment category, and n_t is the number of plant species cited within that category. ICF values approaching 1 indicate a high level of agreement among informants, whereas values closer to 0 suggest low consensus and greater variation in the species selected for treatment.

Use value index (UVI)

The use value index (UVI) was calculated to assess the relative importance and versatility of each plant species. Following Estrada-Castillón *et al*. (2021), UVI was calculated as:

$$UVI = \frac{\sum U_i}{n}$$

where U_i is the number of uses mentioned by each informant for a given species, and n is the total number of informants. Higher UVI values indicate greater use versatility and the presence of richer ethnomedicinal knowledge associated with that species.

Relative frequency of citation (RFC)

The relative frequency of citation (RFC) was calculated to determine the level of recognition of each plant species among informants. RFC was computed following Tardio & Pardo-de-Santayana (2008) as:

$$RFC = \frac{FC}{N}$$

where FC is the number of informants who mentioned a given species, and N is the total number of informants. RFC values range from 0 to 1, with higher values indicating that a species is widely known and frequently cited within the study population.

Results and Discussion

Diagnosis methods and key symptoms identified

The findings of this study show that THPs in the VDM rely on a dual diagnostic system in which spiritual and empirical approaches are used complementarily. As shown in Table 1, 40% of THPs rely primarily on bone divination, 35% diagnose PUD using observable symptoms, and 25% employ both methods.

When combined, this indicates that 65% of practitioners use bones in some capacity, while 60% incorporate symptom-based assessment (Table 1), demonstrating that both diagnostic pathways are widely integrated within THP practice. This distribution suggests that, although divination continues to hold strong cultural authority within Vhembe healing traditions, a substantial proportion of practitioners also incorporate direct observation of bodily signs into their diagnostic reasoning. Such integration reflects a pluralistic diagnostic framework in spiritual guidance and empirical observation operate side by side. These diagnostic patterns are not unique to VDM but align with a broader ethnomedical model documented globally. Rainey (2024) reported that divination systems such as Ifá and Dilogún are used alongside biomedical consultations in the Afro-Cuban Lucumí tradition. In Nigeria, Anyikwa (2024) observed that THPs routinely combine spiritual insight with physical symptom evaluation to diagnose their patients. Similarly, Shange & Ross (2022) described South African THPs employing bone throwing, observation, and patient history in combination, demonstrating parallel practices. Global ethnomedicine reviews (Berhe *et al*. 2024) further affirm that pluralistic diagnostic systems, remain central to many cultural interpretations of illness.

Table 1. Diagnosis methods and key symptoms of peptic ulcer disease reported by Traditional Health Practitioners in the Vhembe District Municipality

Category	Variable	Frequency (n)	Percentage (%)
Diagnosis method (N = 60)	Bones	24	40.00
	Symptoms	21	35.00
	Bones and symptoms	15	25.00
Symptoms (N = 35)	Stomach or abdominal pain	29	82.86
	Dark or bloody stool	26	74.29
	Loss of appetite	12	34.23
	Haematemesis	9	25.71
	Weight loss	8	22.86

From the subset of 35 THPs who relied on symptoms alone or in combination with bones, stomach or abdominal pain was the most frequently cited symptom (82.86%), followed by dark or bloody stool (74.29%), loss of appetite (34.23%), haematemesis (25.71%), and weight loss (22.86) (Table 1). These symptoms closely align with biomedical manifestations of PUD as described by Kavitt *et al*. (2019), indicating that THPs recognise both early and severe clinical signs of ulcer disease. However, several of these symptoms are nonspecific and may occur in other gastrointestinal or systemic disorders, including gastritis, gastrointestinal bleeding of non-ulcer origin, parasitic infections, or malignancy (Ford *et al*. 2020). This overlap increases the risk of misdiagnosis, particularly in settings lacking confirmatory diagnostic tools such as endoscopy or *H. pylori* testing (Gralnek *et al*. 2021). While dual diagnostic pathways may enhance cultural resonance and patient trust (Shange & Ross 2022), reliance on nonspecific symptomatology highlights a critical gap with implications for treatment accuracy and clinical outcomes.

Taxonomic composition and utilisation patterns of medicinal plants against PUD

A total of 27 species, representing 20 botanical families were recorded (Table 2). The total of 27 species represents a moderate level of diversity, relative to ethnobotanical studies in southern Africa that focus on single ailment categories, which commonly report between 20 and 40 species (Ndhlovu *et al*. 2023). The Fabaceae emerged as the most dominant family (five species), followed by Asteraceae, Combretaceae and Rhamnaceae each represented by two species, while all other families were represented by single taxon. The prominence of Fabaceae is unsurprising given its ecological abundance and well-documented medicinal versatility within African savanna biomes (Cornelius & Van Wyk 2024). This taxonomic distribution is consistent with patterns reported in prior ethnobotanical surveys conducted in VDM and the broader Limpopo Province, where Fabaceae and Asteraceae frequently constitute the core of useful or medicinal plant assemblages (Magwede *et al.* 2019, Mahwasane *et al*. 2013, Nelwamondo *et al*. 2013).

Growth form and parts use

The species recorded in this study were dominated by woody plants, particularly trees (50%) and shrubs (29%), while the vine and herbaceous plants were the least cited. Traditional health practitioners primarily harvested roots and bark for remedy preparation, which together accounted for 62% of all plant parts used, whereas leaves and other above-ground tissues comprised the remaining 38% (Table 2). The circular chord diagram (Figure 2) provides an integrated representation of plant-part utilisation. The diagram shows a strong clustering of connections around roots and bark, confirming their predominance as the most frequently harvested tissues. This is of particular concern, as removal of these tissues is inherently destructive and often lethal to the plant (Patel *et al*. 2023), especially for slow-growing woody species. Conservation statuses recorded in Table 2 were predominantly Least Concern (LC, n = 20), alongside several Not Evaluated species (NE, n = 6), suggesting that THPs in the VDM primarily utilise medicinal plants that are naturally widespread and ecologically abundant. However, despite most species being classified as LC or NE, the heavy dependence on roots and bark raises sustainability concerns, as continued destructive harvesting may compromise long-term population viability. The presence of a Protected Plant (PP), *Zanthoxylum capense* (Thunb.) Harv., in the documented *materia medica* (Table 2) further highlights the need for targeted conservation awareness, as ongoing harvesting pressures may eventually elevate risk levels for currently stable species. These findings underscore an urgent need for sustainability interventions, including the promotion of alternative plant-part use such as leaves, cultivation of high-demand species, and the development of community-based resource management strategies to ensure the continued availability of these medicinal plants.

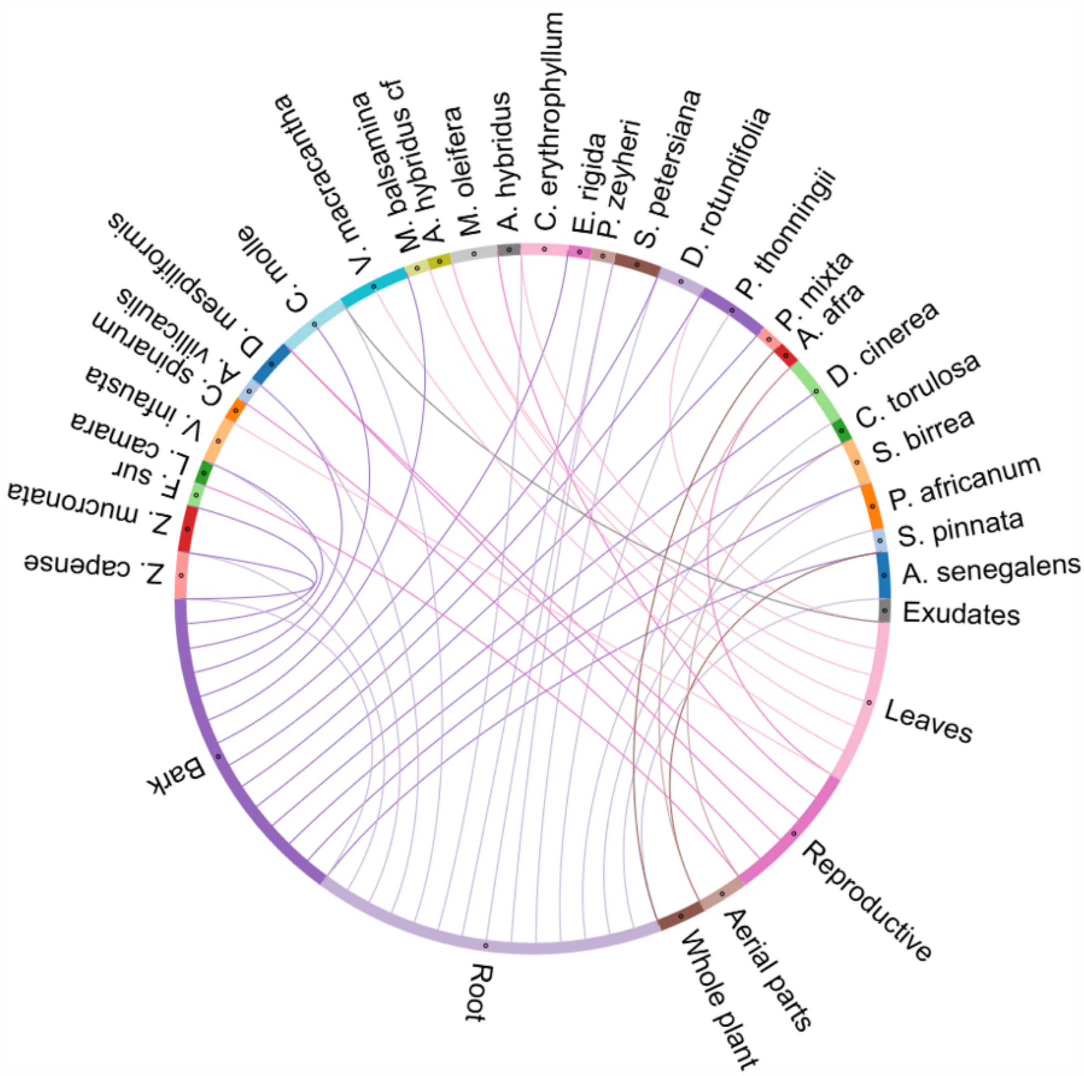

Figure 2. Chord diagram illustrating the relationships between medicinal plant species and the plant parts utilized in the treatment of peptic PUD in the VDM.

Table 2. Medicinal plants used to treat peptic ulcer disease by traditional health practitioners of Vhembe District Municipality

Voucher No.	**Species name**	**Family**	**Local/ common names**	**Habit**	**Used part**	**Combination or single**	**Mode of preparation**	**Status**	**RFC**	**UVI**
UNIN120 675	*Annona senegalensis* Pers.	Annonaceae	Muembe (V), Wild custard-Apple (E)	Shrub	Bark and root	Both	Decoction	LC	0.67	0.25
UNIN1220 697	*Schkuhria pinnata* (Lam.) Kuntze	Asteraceae	Mutshutshu (V), Dwarf Marigold (E)	Herb	Whole plant	Both	Infusion or decoction	NE	0.53	0.12
UNIN1220 696	*Peltophorum africanum* Sond.	Fabaceae	Musese (V), Weeping Wattle (E)	Tree	Bark and root	Single	Decoction, infusion or chewing bark	LC	0.48	0.12
UNIN1220 676	*Sclerocarya birrea* (A.Rich.) Hochst.	Anacardiaceae	Mufula (V), Elephant tree (E)	Tree	Bark and root	Both	Decoction	LC	0.43	0.16
UNIN1220 681	*Cissampelos torulosa* E.Mey. ex Harv.	Menispermacea e	Gandululo (V), Kidney-leaf (E)	Vine	Aerial parts	Both	Infusion or decoction	LC	0.43	0.19
UNIN1220 684	*Dichrostachys cinerea* (L.) Wight & Arn.	Fabaceae	Murenzhe (V), Sickle bush (E)	Tree	Pods, bark and root	Single	Infusion or decoction	LC	0.40	0.18
UNIN1220 672	*Artemisia afra* Jacq. ex Willd.	Asteraceae	Tshidomedza (V), African wormwood (E)	Shrub	Aerial parts	Both	Infusion/ tea, chewed and decoction	LC	0.40	0.18
UNIN1220 682	*Pouzolzia mixta* Solms	Urticaceae	Muthwanzwa (V), soap nettle (E)	Shrub	Whole plant	Both	Infusion and decoction	LC	0.35	0.14
UNIN1220 694	*Piliostigma thonningii* (Schumach.) Milne-Redh.	Fabaceae	Mukolokote (V), monkey bread (E)	Tree	Leaves, root and bark	Single	Decoction, infusion and maceration	LC	0.32	0.13
UNIN1220 695	*Dombeya rotundifolia* (Hochst.) Planch.	Sterculiaceae	Tshiluvhari (V), Wild Pear (E)	Tree	Root and bark	Single	Infusion, chewed and decoction	LC	0.28	0.13
UNIN1220 687	*Senna petersiana* (Bolle) Lock	Fabaceae	Munengeledzi (V), Monkeypod (E)	Shrub	Root and bark	Both	Decoction and infusion	LC	0.28	0.07
UNIN1220 689	*Phyllogeiton zeyheri* (Sond.) Suess	Rhamnaceae	Muniye (V),Red ivorywood (E)	Tree	Root	Single	Decoction	LC	0.25	0.08
UNIN1220 680	*Ehretia rigida* (Thunb.) Druce	Boraginaceae	Guvhazwivhi (V), Puzzle Bush (E)	Shrub	Root	Single	Decoction	LC	0.20	0.10
UNIN1220 691	*Combretum erythrophyllum* (Burch.) Sond.	Combretaceae	Muvuvhu (V), River bushwillow (E)	Tree	Root and bark	Single	Decoction	LC	0.15	0.12

UNIN1220 698	*Amaranthus hybridus* L.	Amaranthaceae	Mukango (V), Smooth Pigweed (E)	Herb	Leaves	Single	Cooked or lightly boiled	NE	0.13	0.10
UNIN1220 699	*Moringa oleifera* Lam.	Moringaceae	Muringa (V), Moringa (E)	Tree	Leaves, and pods	Single	Infusion, chewed and decoction	NE	0.13	0.08
UNIN1220 679	*Amaranthus hybridus* L. (cf.)	Amaranthaceae	Vowa (V), Smooth Pigweed (E)	Herb	Leaves	Single	Cooked	NE	0.10	0.07
UNIN1220 677	*Momordica balsamina* L.	Cucurbitaceae	Lugu (V), Bitter melon (E)	Vine	Leaves	Both	Cooked, infusion, and decoction	LC	0.10	0.07
UNIN1220 674	*Vachellia macracantha* (Humb. & Bonpl. ex Willd.) Seigler & Ebinger	Fabaceae	Munye (V), Long-spine Tree (E)	Shrub	Gum, leaves and bark	Single	Infusion, and decoction	NE	0.08	0.08
UNIN1220 685	*Combretum molle* R.Br. ex G.Don	Combretaceae	Mugwithi (V), Velvet bushwillow (E)	Tree	Seed, bark and root	Single	Infusion, and decoction	LC	0.08	0.07
UNIN1220 690	*Diospyros mespiliformis* Hochst. ex A.DC.	Ebenaceae	Musuma (V), Jackal-berry (E)	Tree	Bark and fruit	Single	Decoction	LC	0.07	0.15
UNIN1220 678	*Acalypha villicaulis* Hochst. ex A.Rich.	Euphorbiaceae	Tshitondovhe (V), Hairy Acalypha (E)	Herb	Root	Single	Decoction	LC	0.07	0.13
UNIN1220 688	*Carissa spinarum* L.	Apocynaceae	Muthungulu (V), Bush plum (E)	Shrub	Fruit	Single	Chewed	LC	0.05	0.13
UNIN1220 686	*Vangueria infausta* Burch.	Rubiaceae	Muzwilo (V), Wild medlar (E)	Shrub	Bark and leaves	Single	Infusion, and decoction	LC	0.05	0.12
UNIN1220 673	*Lantana camara* L.	Verbenaceae	Tshidzimba (V), Lantana (E)	Shrub	Root	Single	Infusion	NE	0.03	0.07
UNIN1220 693	*Ficus sur* Forssk.	Moraceae	Muhuyu (V), Wild fig (E)	Tree	Fruit	Single	Chewed	LC	0.02	0.08
UNIN1220 692	*Ziziphus mucronata* Willd.	Rhamnaceae	Mukhalu (V), Buffalo thorn (E)	Tree	Root and bark	Single	Decoction	LC	0.02	0.10
UNIN1220 683	*Zanthoxylum capense* (Thunb.) Harv.	Rutaceae	Munugwani (V), Small knobwood (E)	Tree	Root and bark	Single	Decoction	PP	0.02	0.08

V= Venda common name, E= English common name, PP= protected plant, LC= least concern and NE= not evaluated. The abbreviation *(cf.)* indicates a specimen that could not be conclusively identified due to the absence of diagnostic features but closely resembles the named species.

Preparation methods

Preparations methods were dominated by decoctions (23 mentions) and infusions (16), followed by chewed (six), cooked (four) and maceration (one). This pattern is consistent with broader Limpopo ethnomedicinal practices, in which gastrointestinal and stomach-related disorders are predominantly managed using water-based extraction prepared from roots and bark (Rankoana 2022). The combined dominance of decoction/infusion and extensive root utilisation reflects a well-established regional motif in ethnobotanical treatments of gastrointestinal ailments (Balkrishna *et al*. 2025). Most species (75%) were administered as mono-herbal remedies, while the remaining plants were used both singly and in combination, depending on the healer preference and symptom severity.

Only 38.3% of the 60 THPs reported using medicinal plants interchangeably, whereas 61.7% did not (Figure 3). Interchangeability at the plant-part level was even less common, with only 31.7% allowing substitution and 68.3% insisting on the use of specific parts, such as roots or bark.

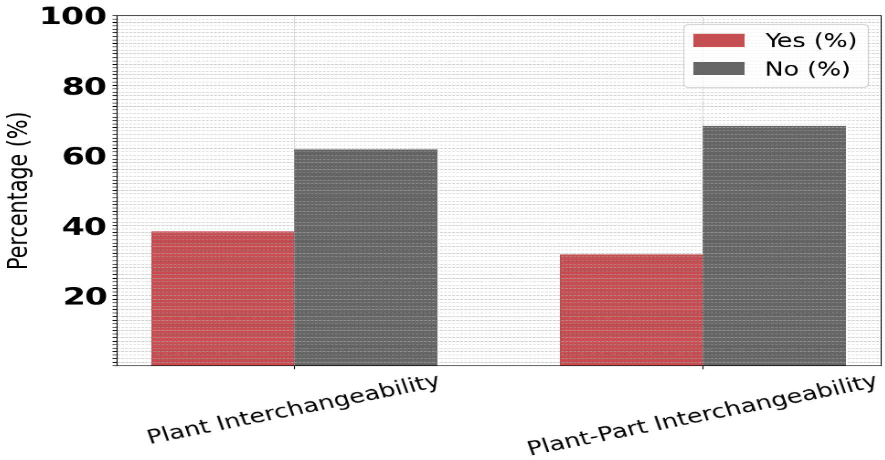

Figure 3. Percentages of traditional health practitioners reporting plant-level and plant-part-level interchangeability. "Yes" indicates respondents who allow substitution, whereas "No" indicates respondents who do not.

This pattern suggests a healing system that permits substitution when necessary but maintains strong restrictions around certain culturally or therapeutically important plants and parts. Comparable findings have been documented across several Venda villages, where THPs show limited but strategic substitution based on availability or shared therapeutic roles (Magwede *et al*. 2019, Mahwasane *et al*. 2013). Masevhe *et al*. (2015) emphasize that THPs managing candidiasis rely on multiple plant species that fulfil similar therapeutic roles, while still prioritizing a small group of core species considered essential for treatment. Beyond South Africa, global ethnobotanical research also reports that communities often substitute plants during scarcity but maintain strict adherence to certain primary species or specific parts considered most potent, indicating that selective rather than free interchangeability is a widespread feature of traditional medical systems (Leonti *et al*. 2020).

Patterns in multi-plant remedy use and cultural consensus

Out of the 60 THPs interviewed, 30 provided multi-plant remedies, including details on formulation, ratios, preparation methods, and the circumstances under which these mixtures are used as recorded in Table 3. This means that half of all participating practitioners actively rely on composite herbal formulations rather than single-plant remedies, indicating a culturally embedded belief in synergistic therapeutic action within the VDM. The majority of these multi-plant remedies, however, were mentioned by only one practitioner each, demonstrating a high diversity but low repetition of formulations within the pharmacopoeia. Only three remedies appeared more than once as shown in Table 3, with citation frequencies ranging from two to four THPs. This suggests that while multi-plant therapies are common, shared consensus around specific formulations is relatively limited.

The fact that only three remedies achieved repeated citation implies the presence of a small core set of culturally reinforced and trusted formulations, while the remaining mixtures may represent idiosyncratic, lineage-based, or mentor-specific knowledge rather than widely shared practice. The top-cited remedy *S. birrea* + *A. senegalensis* + *S. petersiana*, is a strong decoction used for more severe symptoms, which aligns with ethnobotanical theory suggesting that remedies repeatedly used for acute conditions tend to gain higher cultural salience (Gaoue *et al*. 2017). By contrast, the second-ranked formulation, a mild infusion of aerial or leafy parts, is applied for less intense presentations, illustrating that practitioners differentiate mixtures not only by plant selection but by intended therapeutic strength. The limited recurrence of most combinations further indicates a flexible knowledge system, where THPs tailor mixtures to individual patients while still maintaining a small, shared corpus of trusted multi-plant remedies.

Table 3. Most-cited multi-plant remedies for peptic ulcer disease among Traditional Health Practitioners in the Vhembe District Municipality.

Rank	Combination and Part used	Ratio	Preparation Method	No. of Citations
1	*S. birrea* (B) + *A. senegalensis* (R) + *S. petersiana* (R)	1 : 2 : 1	Decoction (strong)	4
2	*P. mixta* (L) + *S. pinnata* (A) + *C. torulosa* (A)	1 : 1 : 1	Infusion (dry material), mild strength	3
3	*A. senegalensis* (R or B) + *P. mixta* (R or B)	2 : 1	Decoction	2
Note: B= Bark, R= Root, L= Leaves, and A= Aereal parts. n=30				

Cultural salience and consensus in PUD medicinal plant use

Relative frequency of citation and culturally prominent species

Cultural salience, expressed through the RFC, ranged from 0.02 to 0.67 (median 0.14), with *A. senegalensis* emerging as the most culturally prominent species (0.67), followed by *S. pinnata* (0.53), *P. africanum* (0.48), *S. birrea* and *C. torulosa* (0.43 each), and subsequently *D. cinerea* and *A. afra* (0.40). Several of these species recur in other ethnomedicinal studies from the region such as Donhouedé *et al*. (2022) (*A. senegalensis*, intestinal worms) and Maroyi (2019) (*C. torulosa*, gastro-intestinal (GI) problems), reinforcing their centrality in regional GI-focused traditional healing systems.

Ethnobotanicity Index and Informant Consensus Factor

Based on the regional flora baseline of 574 useful plant species (Magwede *et al.* 2019), the EI for PUD was calculated at 4.70%, reflecting the targeting of a small, culturally validated subset of the broader flora specifically for PUD management. In parallel, the ICF for PUD was 0.833, derived from 157 use-reports across 27 species, indicating strong agreement among THPs regarding which plants are most appropriate for PUD treatment. These values collectively highlight a highly structured, culturally filtered pharmacopoeia in which THPs consistently draw upon a limited, recognisable core of taxa for this specific GI condition, precisely the interpretive pattern expected when EI and ICF are examined in tandem. The combined evidence of a low EI (4.70%) and high ICF (0.833) characterises a mature, consensus-driven knowledge system: THPs are not drawing randomly from the local flora but instead repeatedly employing a restricted, culturally reinforced set of species for PUD. This mirrors findings from Limpopo and sub-Saharan Africa more broadly, where GI categories, such as diarrhoea and gastritis (Olajuyigbe & Afolayan, 2012), dysentery (Degu *et al*. 2022) and general stomachache frequently yield high consensus values and concentrated species lists, indicative of stable intergenerational transmission of therapeutic knowledge.

The prominence of *A. afra*, one of the species characterized by high RFC value in this study, also warrants mention. This species has a long history of use across South Africa for both respiratory (Mjiqiza *et al*. 2013) and digestive complaints (Van Wyk & Wink 2015) and is increasingly supported by pharmacological evidence demonstrating antimicrobial, anti-inflammatory, and antioxidant properties (Molokoane *et al*. 2023). Its prominence therefore reinforces the potential value of prioritising high-RFC species for future phytochemical and biological evaluation.

Use value index and therapeutic versatility

The pattern of UVI values across the 27 recorded species provides important insight into the perceived therapeutic versatility of each plant within the Vhembe traditional medicinal system. UVI scores in this study ranged from 0.07 to 0.25 (mean ≈ 0.111), indicating that although certain species hold notable cultural and therapeutic prominence, the PUD pharmacopeia as a whole is characterised by moderate use versatility, reflecting its ailment-specific focus. Species presenting higher UVI values, such as *A. senegalensis* (0.25), *D. mespiliformis* (0.15), *D. cinerea* (0.18), *A. afra* (0.18), and *P. africanum* (0.12), are those cited by THPs as serving multiple functions within the context of ulcer management, typically addressing not only ulceration itself but also associated symptoms such as abdominal discomfort, indigestion, inflammation, or appetite disturbances. These high-UVI species also tend to correspond with those ranking prominently in RFC, suggesting that plants viewed as therapeutically versatile are also widely recognised across THPs. In contrast, species showing lower UVI scores (0.07-0.10) appear to serve more specialised or narrow roles within ulcer treatment, which is expected in a single-ailment ethnobotanical study where broader medicinal uses are not captured. Overall, the UVI results complement the RFC and ICF patterns, highlighting a pharmacopeia in which a few culturally important species combine high consensus with high versatility, while the remainder serve narrower but still culturally validated therapeutic roles.

Comparison of plant use among VDM Local municipalities

A Chi-Square test of independence was performed to assess whether the distribution of medicinal plant species cited for managing PUD differed significantly across the four municipalities of the VDM. The analysis was based on the species-municipality contingency table presented in Appendix 1. The results showed no statistically significant difference in plant-use patterns between the four municipalities at the $p \leq 0.05$ level, $\chi^2(81, N = 220) = 32.74$, $p = 0.9999$. This finding indicates that THPs across local municipalities draw upon a broadly similar and culturally consistent set of medicinal plant species for the treatment of PUD. Such homogeneity reflects strong cultural continuity, shared THPs training pathways, and comparable ecological availability of key species across the district. These results are consistent with similarly reports within the region that reported minimal intra-regional variation in the selection of medicinal plants for gastrointestinal conditions. Constant & Tshisikhawe (2018), found that THPs across multiple Vhembe villages relied on largely overlapping species for treating various ailments, while Semenya & Maroyi (2018) reported comparable species-use patterns for pneumonia across different areas of Limpopo province. Likewise, Magwede *et al*. (2019) documented that a small, culturally entrenched group of species including *A. senegalensis*, *S. pinnata*, *P. africanum*, and *S. birrea* is consistently used throughout the region. The non-significant Chi-Square result thus reinforces broader evidence that medicinal plant knowledge and use in Vhembe is culturally cohesive, ecologically informed, and widely shared among THPs, particularly in the context of PUD management.

Conclusion

This study demonstrates that Traditional Health Practitioners in the Vhembe District employ a highly structured and culturally consistent medicinal plant system to manage Peptic Ulcer Disease. Although 27 species were recorded, therapeutic practice is anchored in a restricted core set of culturally salient taxa, most notably *A. senegalensis, S. pinnata, P. africanum, S. birrea, and C. torulosa.* Water-based preparations, particularly decoctions and infusions, and the predominant use of roots and bark align with long-standing Limpopo gastrointestinal treatment patterns. The finding that THPs exhibit limited but strategic plant and part interchangeability, alongside selective use of multi-plant formulations, reflects a healing system that is adaptive but maintains strict adherence to culturally validated species.

Quantitative indices reinforce these patterns: the high ICF indicates strong practitioner agreement, while the low EI confirms that only a small subset of the regional flora is culturally validated for PUD. The absence of inter-municipality variation further highlights the cohesive and widely shared nature of this knowledge system. Although most species are classified as Least Concern, the heavy reliance on destructive harvesting methods and the use of one Protected Plant species (*Z. capense*) raise sustainability concerns. This underscores the need for conservation-focused interventions, including promoting alternative plant parts, encouraging cultivation, and strengthening community-based resource management. Overall, this study provides a comprehensive and culturally grounded documentation of PUD-related ethnomedicinal knowledge in the VDM and establishes a clear foundation for future phytochemical validation and conservation planning.

Declarations

List of abbreviations: PUD - Peptic Ulcer Disease; THPs - Traditional Health Practitioners; VDM - Vhembe District Municipality; EI - Ethnobotanicity Index; ICF - Informant Consensus Factor; RFC - Relative Frequency of Citation; UVI - Use Value Index; NSAID - Non-Steroidal Anti-Inflammatory Drug; LC - Least Concern; NE - Not Evaluated; PP - Protected Plant; NT - Near Threatened; SANBI - South African National Biodiversity Institute; TREC - Turfloop Research Ethics Committee; UNIN - Larry Leach Herbarium, University of Limpopo; GI - Gastrointestinal.

Ethics approval and consent to participate: The study followed ethical and legal guidelines for research involving indigenous knowledge and human participants. Ethical approval was obtained from the Turfloop Research Ethics Committee (TREC), University of Limpopo, under reference number TREC/67/2026: PG. All participating Traditional Health Practitioners were informed about the purpose of the study, their right to withdraw at any stage, and the intended use of the information provided. Participation was voluntary, and written informed consent was obtained from all participants prior to data collection.

Consent for publication: Not applicable

Availability of data and materials: Access to raw data may be granted by the corresponding author upon reasonable request and subject to appropriate ethical considerations and data-sharing restrictions. Voucher specimens of all recorded plant species were collected, identified, and deposited at the Larry Leach Herbarium (UNIN), University of Limpopo.

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Author contributions: M.L. conceptualised the study, conducted fieldwork, collected and analysed the data, and drafted the manuscript. M.J.P. provided methodological guidance, supervised the research. M.K.M. contributed to study design refinement and manuscript revision.

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Plant Species vs Municipality Frequency contingency Appendix Table 1

Species name	Thulamela	Collins Chabane	Makhado	Musina
Annona senegalensis	12	10	11	7
Schkuhria pinnata	9	9	10	4
Peltophorum africanum	7	7	9	6
Sclerocarya birrea	5	5	6	8
Cissampelos torulosa	7	9	4	6
Dichrostachys cinerea	9	5	4	6
Artemisia afra	6	5	6	7
Pouzolzia mixta	8	9	0	4
Piliostigma thonningii	6	7	1	5
Dombeya rotundifolia	3	4	9	1
Senna petersiana	3	8	3	3
P.hyllogeiton zeyheri	5	3	5	2
Ehretia rigida	4	4	1	3
Combretum erythrophyllum	1	3	3	2
Amaranthus hybridus	3	4	1	0
Moringa oleifera	1	0	4	3
Amaranthus hybridus	1	1	3	1
Momordica balsamina L.	2	2	2	0
Vachellia macracantha	1	0	3	1
Combretum molle	1	0	4	1
Diospyros mespiliformis	3	0	1	0
Acalypha villicaulis	0	1	3	0
Carissa spinarum	2	0	0	1
Vangueria infausta	1	0	2	0
Lantana camara	0	0	1	1
Ficus sur	0	1	0	0
Ziziphus mucronata	1	0	0	0
Zanthoxylum capense	0	0	0	1