

Ethnoveterinary Medicinal Plants in Maji District, Mirab Omo Zone, Southwest Ethiopia

Jewar Safeno Jara

jewarsafeno@mtu.edu.et

Mizan Tepi University

Biniam Assefa Alemu

Mizan Tepi University

Article

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Title:

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Running title

Ethnoveterinary medicinal plants of Kulbo Forest

Authors:

Jewar Safeno Jara^{1*}, Biniam Assefa²

¹ College of Agriculture and Natural Resources Management, Mizan-Tepi University, P.O. Box 260, Mizan Aman, Ethiopia

² Department of Forestry Science, Mizan-Tepi University, P.O. Box 260, Mizan Aman, Ethiopia

Corresponding Author:

Jewar Safeno

Email : jewarsafeno@mtu.edu.et ; jewar04@gmail.com

Abstract

Background: Ethnoveterinary medicine plays a crucial role in livestock healthcare in rural communities where access to modern veterinary services is limited. This study aimed to document ethnoveterinary medicinal plant knowledge and assess its cultural importance and conservation status in the Kulbo Forest area of southwest Ethiopia.

Methods: Data were collected from 138 informants using semi-structured interviews, guided field walks, and group discussions. Quantitative ethnobotanical indices, including Informant Consensus Factor (ICF), Use Value (UV), Relative Importance (RI), and Fidelity Level (FL), were applied to evaluate the cultural salience and reliability of reported plant-based remedies. Statistical analysis, including Kruskal-Wallis tests and Jaccard similarity indices, was conducted to assess differences in knowledge distribution and cross-regional therapeutic overlap.

Results: A total of 42 medicinal plant species belonging to 38 genera and 27 families were documented for the treatment of 31 livestock ailments. Fabaceae, Asteraceae, and Euphorbiaceae were the most represented families. Shrubs and herbs were the dominant growth forms, and most

plants (68%) were harvested from wild forest habitats. Leaves (41%) and roots (33%) were the most frequently used plant parts. High ICF values were recorded for gastrointestinal (0.87), respiratory (0.84), and ectoparasitic (0.81) disease categories, indicating strong cultural agreement. Ethnoveterinary knowledge was significantly higher among older informants ($p < 0.001$, $\epsilon^2 = 0.13$). Cross-regional Jaccard indices revealed higher similarity with ecologically comparable moist Afromontane regions than with distant dryland areas.

Conclusions: Ethnoveterinary knowledge in the Kulbo Forest area is rich but unevenly distributed and highly dependent on natural forest resources. The observed reliance on wild plant species, combined with threats such as agricultural expansion and overharvesting, poses risks to both plant diversity and knowledge continuity. Community-based conservation strategies, including domestication and sustainable harvesting, alongside integration into One Health frameworks, are essential to ensure the long-term availability of ethnoveterinary resources.

Keywords: ethnoveterinary medicine; medicinal plants; indigenous knowledge; quantitative ethnobotany; conservation; Kulbo Forest; Ethiopia

1. Background

Across sub-Saharan Africa, ethnoveterinary medicine (EVM) constitutes an adaptive knowledge system embedded within pastoral and smallholder livestock economies. Studies from West, North, and Southern Africa have documented extensive ethnoveterinary pharmacopoeias structured around ecological availability, cultural transmission, and disease ecology (Solazzo et al., 2024). These systems are neither static nor purely traditional; rather, they represent dynamic responses to constrained access to biomedical veterinary infrastructure. Increasingly, ethnoveterinary knowledge is being recognized within conservation and One Health frameworks as a strategic approach to safeguarding ecosystem health, livestock productivity, and community wellbeing (Pieroni 2023).

Ethiopia's exceptional biological and cultural diversity has fostered rich ethnomedicinal traditions (Friis et al., 2011; Maffi, 2005). Comparable ethnomedicinal documentation among southern Ethiopian ethnic groups has been reported elsewhere for both human ailments (Jara et al., 2024; Jara and Alemu, 2026; Jara, 2026) and livestock diseases (Giday et al., 2007; Jara et al., 2026a). Numerous ethnoveterinary studies conducted over the past two decades have documented medicinal plant species and associated practices across the country (Lulekal et al., 2014; Tolossa et al., 2013; Hankiso et al., 2024; Jara et al., 2026a). However, most studies remain largely descriptive, emphasizing species inventories rather than hypothesis-driven approaches, quantitative analysis, or cross-regional comparison (Pieroni 2023). In response, contemporary ethnobiological research increasingly calls for analytical, comparative, and conservation-oriented approaches to meet international scientific standards (Albuquerque et al. 2014), particularly in the context of livestock disease management.

Southwest Ethiopia contains some of the country's last remaining moist Afromontane forest ecosystems and is recognized as a biodiversity hotspot (Friis et al. 2011). Recent ethnobotanical assessments in this same forest have documented the extensive use of medicinal plants for human healthcare (Jara and Alemu, 2026), highlighting the deep biocultural reliance of the local community on this ecosystem. Livestock keeping—particularly cattle, goats, sheep, poultry, and equines—is central to subsistence and income generation, yet access to formal veterinary services remains limited. In this context, ethnoveterinary medicine functions as the primary, and often the only, livestock healthcare system, including the management of infectious and parasitic diseases. However, agricultural expansion, timber extraction, and sociocultural change are accelerating forest degradation and disrupting the intergenerational transmission of traditional knowledge.

Despite its ecological and cultural importance, no prior ethnoveterinary study has been conducted in Kulbo Forest, leaving a clear gap in Ethiopia's ethnobiological record. Evidence from other Ethiopian regions indicates that ethnoveterinary plant-use patterns are shaped by ecological conditions and cultural history (Tolossa et al. 2013; Kidane et al. 2018). Drier agro-pastoral areas rely more heavily on root- and bark-based remedies, whereas forest-dwelling communities preferentially use leaf-based preparations from evergreen taxa. Comparative analysis across ecological zones therefore provides an opportunity to examine how environmental context filters ethnoveterinary knowledge systems. In addition, generational changes in education, livelihood strategies, and access to modern veterinary services may influence knowledge retention, with younger cohorts often demonstrating reduced familiarity with traditional practices (Kidane et al. 2018).

Beyond their cultural relevance, ethnoveterinary practices have important public health and conservation implications. Several medicinal plants used in livestock treatment exhibit documented antimicrobial and antiparasitic properties (Heinrich et al. 1998; Gensa et al. 2023), potentially contributing to the control of infectious and zoonotic diseases and reducing reliance on commercial veterinary drugs. Conversely, unsustainable harvesting of wild medicinal species—particularly roots and bark—poses increasing threats to forest integrity and biodiversity (Kidane et al. 2018). Although Ethiopia is recognized as a center of biocultural diversity, forest-dependent ethnoveterinary systems remain comparatively underexplored relative to highland agro-pastoral systems. Kulbo Forest, a moist Afromontane ecosystem inhabited predominantly by Dizi communities, therefore offers a valuable setting to examine how ecological structure shapes therapeutic selection and disease management practices.

Research Questions

This study therefore addresses three interrelated questions:

(i) Which taxa are prioritized within the local veterinary pharmacopoeia?

(ii) How does ecological similarity influence cross-regional therapeutic overlap?

(iii) Is knowledge distribution structured by age cohort?

Accordingly, the objectives were to document ethnoveterinary medicinal plants and practices, quantitatively evaluate cultural agreement and plant importance, conduct cross-regional comparisons, and assess conservation implications for livestock health and community resilience.

2. Materials and Methods

2.1 Study Area

Kulbo Forest is in Maji District (Woreda), Mirab Omo Zone, within the Southwest Ethiopia Peoples' Region in southwestern Ethiopia. Geographically, the forest lies between 6°06'–6°18'30" N latitude and 35°24'–35°39' E longitude (Figure 1), with an altitudinal range of approximately 1,929 to 2,500 meters above sea level.

The area experiences a unimodal rainfall pattern, with a main rainy season extending from April to October. The mean annual rainfall ranges between 1,300 and 1,500 mm, while mean annual temperatures vary from 15 to 18 °C, based on records from the National Meteorological Agency and field observations (NMA 2023).

Ecologically, Kulbo Forest is classified as a moist Afromontane forest, typical of the highlands of southwestern Ethiopia (Friis et al. 2010; Teketay et al. 2018). The vegetation is dominated by characteristic Afromontane tree species such as *Albizia gummifera*, *Schefflera abyssinica*, *Syzygium guineense*, *Croton macrostachyus*, and *Dracaena afromontana*, with a diverse understory of shrubs and herbaceous species. These ecosystems provide essential services,

including biodiversity conservation, soil stabilization, and local climate regulation (MEA 2005; Teketay et al. 2018).

Local livelihoods are primarily based on mixed farming systems integrating crop cultivation and livestock production, a common practice in southwestern Ethiopia (CSA 2013; Abebe et al. 2021). Livestock species include cattle, goats, sheep, poultry, and equines, which are central to food security and household income. In this context, ethnoveterinary medicine plays a crucial role in maintaining animal health, particularly where access to modern veterinary services is limited (McCorkle 1995; Yineger et al. 2007). Livestock population trends are consistent with recent national agricultural surveys (CSA 2023).

The majority of the population belongs to the Dizi ethnic group, with minority representation from Amhara, Oromo, and Me'en communities. The primary local language is Dizin (Glottocode: dizi1239), while Amharic and Afaan Oromo are widely used for interethnic communication (Hammarström et al. 2024). Religious affiliations include Orthodox Christianity, Protestant Christianity, and traditional belief systems, reported voluntarily in accordance with ethical research standards (ISE 2006).

2.2 Surveyed Settlements and Site Metadata

Ethnoveterinary data were collected from four rural kebeles adjacent to Kulbo Forest: Chayit, Kerisi, Chigit, and Kubit (Table 1). These sites were selected to capture variation in elevation, proximity to forest resources, and land-use patterns, following established ethnobiological sampling approaches (Alexiades 1996; Martin 2010).

For each settlement, site-level metadata were recorded, including geographic coordinates (WGS84), altitude, ecological characteristics, self-identified ethnicity, languages spoken (classified according to Glottolog), declared religious affiliation, estimated population size, and

141 number of study participants disaggregated by gender. The standardization of these variables
 142 facilitates comparison with other ethnoveterinary studies (Albuquerque et al. 2014).

143 **Table 1. Characteristics of surveyed settlements in and around Kulbo Forest.**

Settlement (Kebele)	Latitude (°N)	Longitude (°E)	Altitude (m)	Ecology	Dominant ethnicity	Languages (Glottocode)	Religion	Estimated population	Total participants	Male	Female
Chayit	6.10	35.40	2100	Moist Afro-montane forest	Dizi (dominant), minor Amhara & Oromo	Dizin (dizi1239), Amharic (amha1245), Oromo (west2823)	Orthodox, Protestant, Traditional	1250	35	21	14
Kerisi	6.08	35.38	2000	Moist Afro-montane forest	Dizi (dominant), minor Me'en	Dizin (dizi1239), Bodi/Me'en (meen1242)	Orthodox, Protestant, Traditional	1100	34	20	14
Chigit	6.12	35.42	2200	Upper montane forest margin	Dizi (dominant), minor Amhara & Oromo	Dizin (dizi1239), Amharic (amha1245), Oromo (west2823)	Orthodox, Protestant, Traditional	1300	35	22	13
Kubit	6.05	35.45	1950	Forest-farmland mosaic	Dizi (dominant), minor Me'en	Dizin (dizi1239), Bodi/Me'en (meen1242)	Orthodox, Protestant, Traditional	1050	34	20	14

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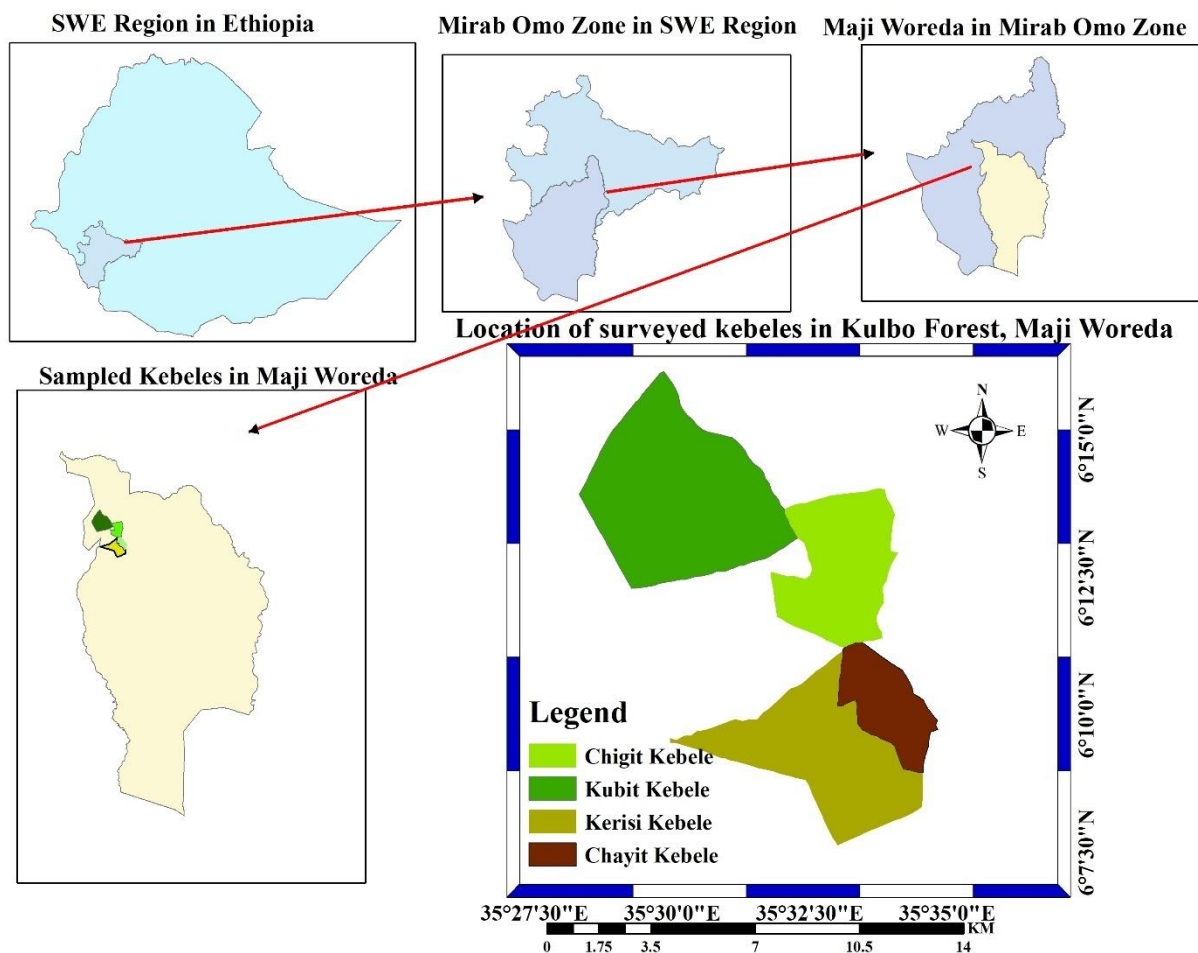


Figure 1. Location of Kulbo Forest and surveyed kebeles (Chayit, Kerisi, Chigit and Kubit) in Maji Woreda, Mirab Omo Zone, Southwest Ethiopia Peoples' Region.

2.3 Informant Selection and Socio-demographic Profile

A total of 138 informants was selected using purposive sampling to ensure representation across age groups, gender, and livestock ownership status. Inclusion criteria required participants to have resided in the study area for at least ten years and to be actively engaged in livestock management. These sampling approaches are widely applied in ethnobiological research (Bernard 2011, 2017; Tongco 2007). Participation was voluntary and based on prior informed consent.

The socio-demographic characteristics of participants, including gender, age group, education level, occupation, marital status, source of ethnoveterinary knowledge, and self-identified ethnicity—are summarized in **Table 2**.

Table 2. Socio-demographic characteristics of study participants

Variable	Category	Number	Percentage (%)
Gender	Male	83	60.1
	Female	55	39.9
Age group	18–30 years	26	18.8
	31–50 years	49	35.5
	>50 years	63	45.7
Education	No formal education	102	73.9
	Elementary	36	26.1
Occupation	Farmer	125	90.6
	Merchant/other	13	9.4
Marital status	Married	97	70.3
	Widowed	41	29.7
Source of knowledge	Parents/Elders	91	65.9
	Herbalists	31	22.5
	Friends	16	11.6
Ethnicity (self-defined)	Dizi	118	84.9
	Amhara	13	9.4
	Oromo	4	3.1
	Me'en	3	2.6

2.4 Data Collection Procedures

Ethnoveterinary data were collected between March and October 2024 using multiple complementary qualitative methods commonly applied in ethnoveterinary research (Martin, 2010; Albuquerque et al., 2014).

A semi-structured interview guide was developed by the authors specifically for this study based on the research objectives and relevant ethnobiological literature. The English version of the interview guide is provided as Supplementary File S1.

Data were collected using the following approaches:

- **Semi-structured interviews** were conducted with informants to document local plant names, plant parts used, preparation methods, dosage, routes of administration, livestock ailments treated, and perceived therapeutic effectiveness.
- **Focus group discussions** (six groups consisting of 6–10 participants each) were carried out to validate shared knowledge, local disease classification, and the reliability of reported remedies.
- **Guided field walks** were undertaken with key informants to enable in situ identification and collection of medicinal plant specimens. The ethnobotanical data collection framework was adapted from previous methodological approaches successfully applied by the authors in similar ecological zones in Ethiopia (Jara et al., 2024; Jara et al., 2026b)

Collected plant specimens were pressed, dried, and assigned field collection numbers (MTU–EVP–001 to MTU–EVP–042), corresponding to the taxa reported in the Results section.

2.5 Plant Identification and Taxonomic Verification

Plant specimens were identified using regional Ethiopian floras and **formally identified and verified by the corresponding author, Jewar Safeno Jara (BSc in Forestry, MSc in Biodiversity Conservation and Management), a qualified taxonomist at Mizan-Tepi University**. Botanical nomenclature was standardized, and taxonomic status confirmed using World Flora Online, following current best practices in ethnobotanical research (WFO 2023).

2.6 Herbarium Deposition and Voucher Codes

Voucher specimens were deposited at the Mizan-Tepi University Herbarium (MTU), Mizan Aman, Ethiopia. Field collection codes (K01–K42) assigned during sampling were subsequently linked to permanent herbarium voucher numbers (MTU–EVP–001–042). As all specimens were

collected and retained within Ethiopia, no international access and benefit-sharing (ABS) permits were required.

2.7 Access and Benefit-Sharing (ABS) and Plant Collection Guidelines

Ethiopia is a signatory to the Nagoya Protocol on Access and Benefit-Sharing, implemented through Proclamation No. 1184/2020. All plant materials were collected, identified, and stored within Ethiopia, and no genetic resources were transferred abroad; therefore, no international ABS permit was required. Furthermore, all field studies and the collection of wild plant materials complied with relevant institutional, national, and international guidelines and legislation. Specifically, this research was conducted in strict accordance with the IUCN Policy Statement on Research Involving Species at Risk of Extinction and the Convention on the Trade in Endangered Species of Wild Fauna and Flora (CITES). None of the plant species collected for this study are listed as threatened or endangered under the IUCN Red List or CITES appendices, and all harvesting was conducted sustainably with permission from local forestry authorities.

2.8 Ethical Considerations

Ethical approval was obtained from the Research Ethics Committee of Mizan-Tepi University (Approval No. MTU/CA/2024/EVP/013). Prior informed verbal consent was obtained from all participants per the International Society of Ethnobiology Code of Ethics (ISE 2006).

2.9 Quantitative Ethnobotanical Data Analysis

Quantitative approaches in ethnobotany follow established frameworks for assessing knowledge distribution and cultural salience of plant use (Phillips & Gentry, 1993). In this study, selected ethnobotanical indices were calculated to explore patterns of agreement and prominence among recorded taxa, following widely used methods (Heinrich et al., 1998; Trotter & Logan, 1986).

The **Informant Consensus Factor (ICF)** was used to evaluate the level of agreement among informants for specific disease categories:

$$ICF = \frac{N_{ur} - N_t}{N_{ur} - 1}$$

where N_{ur} is the total number of use reports in each disease category and N_t is the number of taxa used for that category.

The **Fidelity Level (FL)** was calculated to determine the relative healing potential of individual species for specific ailments:

$$FL(\%) = \frac{N_p}{N} \times 100$$

where N_p is the number of informants who independently reported the use of a species for a particular ailment and N is the total number of informants mentioning that species.

The **Use Value (UV)** was used as a measure of the relative importance of plant species:

$$UV = \frac{\sum U_i}{N}$$

where U_i is the number of use reports cited by each informant for a given species and N is the total number of informants.

The **Relative Importance Index (RI)** was calculated to reflect the diversity of uses attributed to each species:

$$RI = \frac{PP + AC}{2}$$

where PP represents the number of pharmacological properties attributed to a species and AC is the number of ailment categories treated.

To avoid redundancy and overinterpretation, these indices were calculated primarily for the most frequently cited species and are presented in a summarized form in the Results section.

Although widely applied, the interpretative limitations of such indices have been emphasized in recent methodological discussions (Leonti, 2022; Zenderland et al., 2019). Accordingly, in this study, quantitative indices are used strictly as descriptive tools to support qualitative findings rather than as direct indicators of medicinal efficacy.

Differences in ethnoveterinary knowledge among age groups were evaluated using the Kruskal–Wallis test due to non-normal distribution of species counts per informant (Shapiro–Wilk test, $p <$

0.05). Post hoc pairwise comparisons were performed using Dunn's test with Bonferroni correction. All statistical analyses were conducted at a significant level of $p < 0.05$.

2.10 Species Accumulation and Sampling Adequacy

A species accumulation curve was constructed to assess sampling completeness and adequacy of the ethnobotanical survey (Fig. 2). The curve approached an asymptote, indicating that the sampling effort was sufficient to capture the majority of ethnoveterinary medicinal plant diversity in the study area, consistent with established ecological sampling theory (Gotelli & Colwell, 2001).

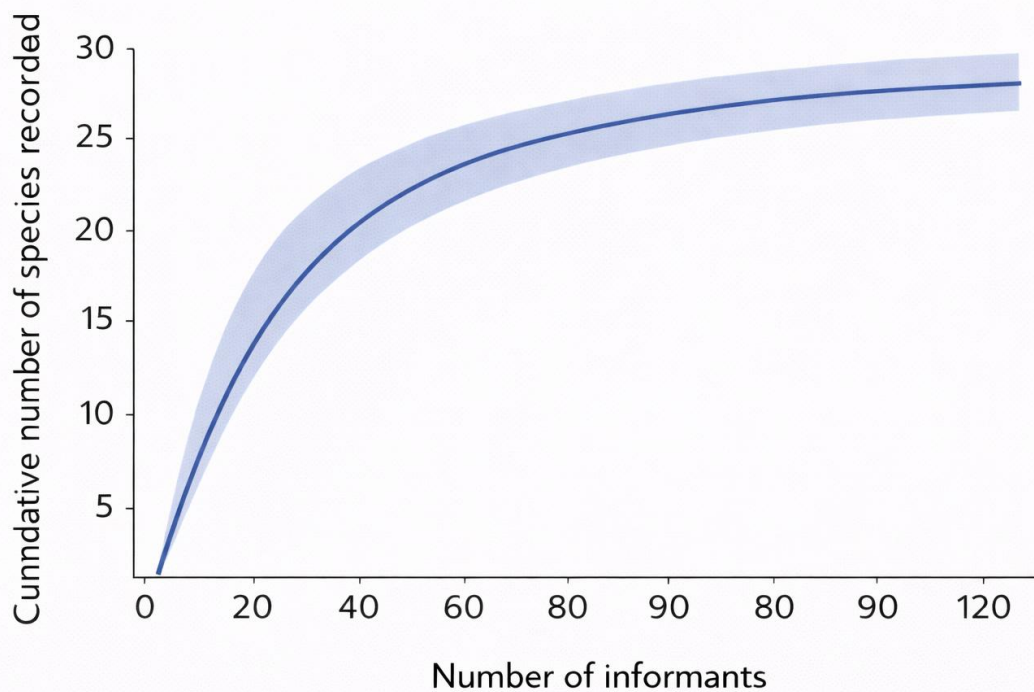


Figure 2. Species accumulation curve for ethnoveterinary medicinal plants recorded in Kulbo Forest.

3. Results

3.1 Socio-demographic characteristics of informants

252 A total of 138 informants (83 males and 55 females) participated in the ethnoveterinary survey
253 conducted across four kebeles surrounding Kulbo Forest: Chayit, Kerisi, Chigit, and Kubit (Table).
254 Most participants were farmers (90.6%), reflecting the dominance of mixed crop–livestock
255 production systems in the study area.

256 The age distribution was skewed toward older individuals, with 45.7% of informants aged above
257 50 years, whereas only 18.8% were below 30 years. Educational status was characterized by a high
258 level of illiteracy (73.9%), indicating that ethnoveterinary knowledge is predominantly maintained
259 and transmitted through oral traditions rather than formal education.

260 In terms of ethnic composition, the Dizi group constituted the majority of participants (84.9%),
261 followed by Amhara (9.4%), Oromo (3.1%), and Me'en (2.6%). Knowledge transmission
262 pathways were primarily vertical, with 65.9% of informants reporting that they acquired
263 ethnoveterinary knowledge from parents or elders, while 22.5% obtained it from traditional
264 herbalists.

265 Differences in ethnoveterinary knowledge among age groups were evaluated using the Kruskal–
266 Wallis test due to non-normal distribution of species counts per informant (Shapiro–Wilk $p <$
267 0.05). Post hoc pairwise comparisons were conducted using Dunn's test with Bonferroni
268 correction. The analysis revealed a statistically significant difference in the number of species
269 reported per informant ($H = 18.47$, $df = 2$, $p < 0.001$), with elders (>50 years) reporting a higher
270 median number of taxa than middle-aged (30–50 years) and younger (<30 years) participants.
271 Pairwise comparisons indicated that elders differed significantly from younger informants ($p <$
272 0.01), while differences between middle-aged and younger groups were less pronounced.

273 These findings demonstrate that ethnoveterinary knowledge in the Kulbo Forest area is not
274 uniformly distributed across generations but is strongly concentrated among older individuals,

reflecting age-structured knowledge retention and the continued importance of intergenerational transmission within family lineages (Table 2).

3.2 Diversity of ethnoveterinary medicinal plants

A total of 42 ethnoveterinary medicinal plant species, belonging to 38 genera and 27 botanical families, were recorded from Kulbo Forest and surrounding landscapes.

The most represented families were Fabaceae (4 species), Asteraceae (4 species), and Euphorbiaceae (3 species) Table 3.

Growth forms were dominated by shrubs (38%), followed by herbs (33%) and trees (29%) Figure 3.

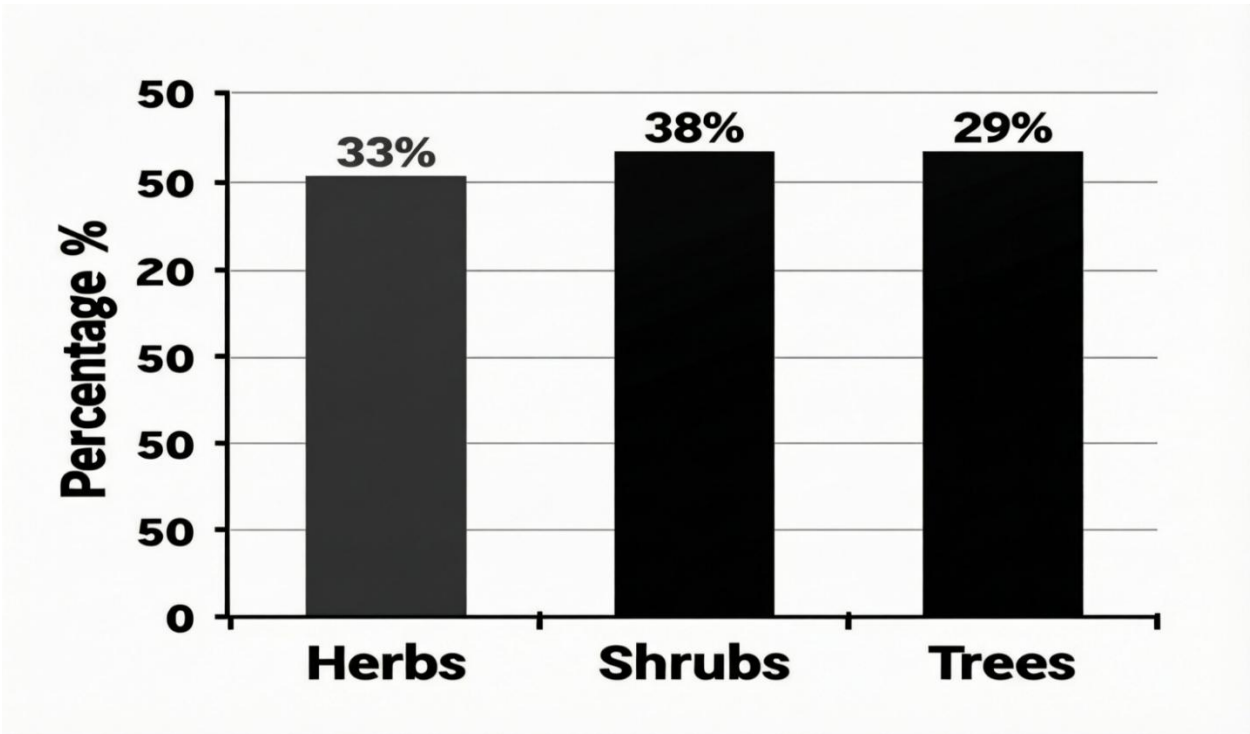


Figure 3. Growth-form distribution of ethnoveterinary medicinal plants in Kulbo Forest.

Most medicinal plants (68%) were harvested from wild forest habitats, while only 19% were collected from farmland edges and 13% from home gardens (Table 3). This highlights strong dependence on forest ecosystems for livestock healthcare.

289 **3.3 Central taxa table: ethnoveterinary medicinal plants recorded in Kulbo Forest**

290 Table 3. Ethnoveterinary medicinal plants recorded in Kulbo Forest.

VC	Scientific name	Fam	G F	LocN	PP U	Pre p	Ad m	LA T	F L	U V	RI	H a b	Th	Con sRec
K0 1	<i>Acanthus sennii</i>	Acanth	S h	Kosoru	Lf	Fr	D m	Wound	6 5	0. 4 2	0.5 8	W	AE	CA
K0 2	<i>Achyranthes aspera</i>	Amaran	H	Darguu	Rt	Fr	Or	Joint	6 0	0. 3 8	0.5 5	F	O H	SH
K0 3	<i>Acokanthera schimperi</i>	Apo cyn	S h	Qararu u	Rt	Fr	Or	Fever	7 2	0. 4 4	0.6	W	RE	CU
K0 4	<i>Agave sisalana</i>	Asparag	S h	Qaca	Lf	Fr	Sm	Res p	5 5	0. 3 2	0.5	F	HL	DO
K0 5	<i>Ajuga integrifolia</i>	Lamiac	H	Armagusa	W p	Fr	Or	GI	5 0	0. 3 8	0.4	W	O C	AW
K0 6	<i>Albizia schimperiana</i>	Fab	T	Ziinu	Rt	Fr	Or	Wound	6 8	0. 4 1	0.6 2	W	DF	FP
K0 7	<i>Allium sativum</i>	Amaryll	H	Qulubii	Bu	Fr	Or	Infection	7 0	0. 4 5	0.6 3	H	LT	PR
K0 8	<i>Allophylus abyssinicus</i>	Sapind	T	Xhiyas hi	Lf, Bk	Fr	Or	GI	6 4	0. 3 9	0.5 7	W	BS	LH
K0 9	<i>Apodytes dimidiata</i>	Mett en	T	Calalaa qa	Lf	Fr	Or	Fever	6 2	0. 3 7	0.5 5	W	HL	FP
K1 0	<i>Arisaema enneaphyllum</i>	Arace	H	Carana	Rt	Fr	Or	Poison	5 8	0. 3 4	0.5 2	W	R H	DO
K1 1	<i>Asparagus africanus</i>	Asparag	H	Uutn gorkn	Rt	Fr	Or	Ret Plac	8 2	0. 6 1	0.7 8	W	O H	CU
K1 2	<i>Bartsia trixago</i>	Orob	H	—	W p	Fr	Or	Poultry	5 3	0. 3 3	0.5	W	HL	FP
K1 3	<i>Bersama abyssinica</i>	Meli an	T	Zokukn aabuchuo	Lf	Fr	Or	Fever	6 7	0. 4 9	0.5	W	DF	RF

VC	Scientific name	Fam	G F	LocN	PP U	Pre p	Ad m	LA T	F L	U V	RI	H a b	Th	ConsRec
K1 4	<i>Bothriocline schimperi</i>	Aster	Sh	Uleehare	Rt, Lf	Fr	Or	Wood	60	0.38	0.56	W	RE	PH
K1 5	<i>Brassica carinata</i>	Brass	H	Gomanzara	Sd	Dr	Or	Infection	55	0.34	0.51	F	LT	PR
K1 6	<i>Brucea antidysenterica</i>	Simar	Sh	Diyagn	Fr	Fr	Dim	Skin	62	0.36	0.54	W	OH	CU
K1 7	<i>Calpurnia aurea</i>	Fab	Sh	Hirshun	Rt, Lf	Fr	Or	Blackleg	75	0.59	0.77	W	RE	LS
K1 8	<i>Capsicum annuum</i>	Solan	H	Barbarr	Fr	Dr	Or	GI	57	0.35	0.52	H	LT	PR
K1 9	<i>Celtis africana</i>	Cannab	T	Caa'ii	Fr	Fr	Dim	Wood	54	0.32	0.5	W	DF	FP
K2 0	<i>Clausena anisata</i>	Rutace	Sh	Uwilauhim	Lf	Fr	Op	Eye	61	0.37	0.55	W	OC	CU
K2 1	<i>Clematis longicauda</i>	Ranunc	Cl	Hidaadi	In	Fr	Or	GI	50	0.38	0.48	W	HL	FP
K2 2	<i>Clematis simensis</i>	Ranunc	Cl	Hidafetii	Lf, Sp	Fr	Or	Infection	56	0.34	0.51	W	OH	SH
K2 3	<i>Clerodendrum myricoides</i>	Lamiac	Sh	Mulmuuzu	Rt, Bk	Fr	Or	Wood	68	0.42	0.62	W	RH	LS
K2 4	<i>Conium maculatum</i>	Apiace	H	Dinbilla	Rt	Fr	Na	Resp	59	0.36	0.52	F	TM	AW
K2 5	<i>Crepis rueppellii</i>	Aster	H	—	Rt	Fr	Or	Fever	52	0.31	0.48	W	HL	FP
K2 6	<i>Croton macrostachyus</i>	Euphor	T	Bakani	Lf	Fr	Or	Wood	77	0.6	0.8	W	DF	RP
K2 7	<i>Cucurbita pepo</i>	Cucurb	H	Dabaquila	Sd	Dr	Or	Infection	55	0.33	0.53	F	LT	PR

VC	Scientific name	Fam	G F	LocN	PP U	Pre p	Ad m	LA T	F L	U V	RI	H a b	Th	ConsRec
K28	<i>Cynoglossum lanceolatum</i>	Borag	H	Maxannee	Wp	Fr	Or	GI	54	0.32	0.49	W	HL	FP
K29	<i>Cyphostemma dembianense</i>	Vitace	H	Hiddaboffa	Rt	Fr	Or	Resp	66	0.41	0.61	W	RH	CU
K30	<i>Delphinium dasycaulon</i>	Ranunc	H	—	Rt	Fr	Or	Infection	60	0.38	0.57	W	OH	SH
K31	<i>Discopodium penninervium</i>	Solan	T	Cacuunga	Lf	Fr	Or	Wound	58	0.35	0.52	W	HL	FP
K32	<i>Dodonaea angustifolia</i>	Sapind	S	Xadachaa	Lf, Bk	Fr	Or	Fever	64	0.39	0.57	W	BS	LS
K33	<i>Dombeya torrida</i>	Malvac	T	Buoshn	Lf	Fr	Or	GI	55	0.33	0.53	W	DF	RF
K34	<i>Dracaena afromontana</i>	Asparag	T	Lekut	Lf	Fr	Or	Fever	60	0.36	0.55	W	HL	FP
K35	<i>Echinops kebericho</i>	Aster	S	Qabari cho	Rt	Dr	Or	Resp	80	0.57	0.76	W	OH	CU
K36	<i>Ehretia cymosa</i>	Borag	S	Kuumu	Rt	Dr	Or	Fever	62	0.37	0.55	W	RE	CU
K37	<i>Ekebergia capensis</i>	Meliace	T	Xsuwi	Fr	Fr	Or	Infection	66	0.41	0.61	W	HL	FP
K38	<i>Erythrina brucei</i>	Fab	T	Walensu	Bk	Fr	Or	Fever	64	0.39	0.57	W	BH	PH
K39	<i>Euphorbia ampliphylla</i>	Euphor	T	Dangar	Lx	Fr	Or	Wound	60	0.36	0.54	W	LM	AW
K40	<i>Euphorbia schimperiana</i>	Euphor	H	Aloyye e	Lf	Dr	Or	GI	58	0.35	0.52	W	HL	FP
K41	<i>Ficus sycomorus</i>	Morace	T	Boboch	Lx	Fr	Or	Fever	62	0.37	0.55	W	DF	RF

VC	Scientific name	Fam	G F	LocN	PP U	Pre p	Ad m	LA T	F L	U V	RI	H a b	Th	ConsRec
K42	<i>Galiniera saxifraga</i>	Rubiaceae	T	Burnts ubuz	Rt, Bk	Fr	Or	Infection	65	0.4	0.58	W	RH	CU

Keys / Abbreviations

VC = Voucher Code (K01–K42, field collection code; corresponding herbarium voucher specimens are deposited at the Mizan-Tepi University Herbarium (MTU) under voucher codes MTU–EVP–001–042. = Kulbo collection numbers) **Fam** = Family **LocN** = Local name **GF** = Growth form: H=Herb, Sh=Shrub, T=Tree, Cl=Climber **PPU** = Plant part used: Lf=Leaf, Rt=Root, Bk=Bark, Fr=Fruit, Sd=Seed, Bu=Bulb, Lx=Latex, Wp=Whole plant, Sp=Stem part **Prep** = Condition: Fr=Fresh, Dr=Dried **Adm** = Route of administration: Or=Oral, Dm=Dermal, Na=Nasal, Sm=Smoke inhalation, Op=Ophthalmic **LAT** = Livestock ailment treated **FL** = Fidelity Level (%) **UV** = Use Value **RI** = Relative Importance **Hab** = Habitat: W=Wild forest, F=Farmland/forest edge, H=Homegarden **Threat** = AE=Agricultural expansion, DF=Deforestation, RE=Root extraction, RH=Root harvesting, OH=Overharvesting, HL=Habitat loss, BS=Bark stripping, TM=Toxic misuse, LM=Latex misuse, BH=Bark harvesting, OC=Overcollection **ConsRec** = Conservation recommendation: CU=Cultivation, FP=Forest protection, RF=Reforestation, LS=Leaf substitution, PH=Partial harvesting, SH=Sustainable harvesting, PR=Promotion, AW=Awareness creation, RP=Replanting, DO=Domestication, CA=Cultivation awareness

3.4 Plant parts used and preparation methods.

Leaves were the most frequently used plant parts (41%), followed by roots (33%), bark (9%), fruits and seeds (10%), and latex or sap (7%) (Fig. 4). Fresh plant materials were used in most cases

(78%), while dried materials accounted for 22%. Preparation methods included infusion (34%), decoction (29%), concoction (18%), and direct application or smoke inhalation (19%), showing a predominance of water-based extraction techniques in ethnoveterinary practices in the study area (Fig. 5). Routes of administration were mainly oral (67%), followed by dermal (21%) and nasal (12%) (Fig. 6).

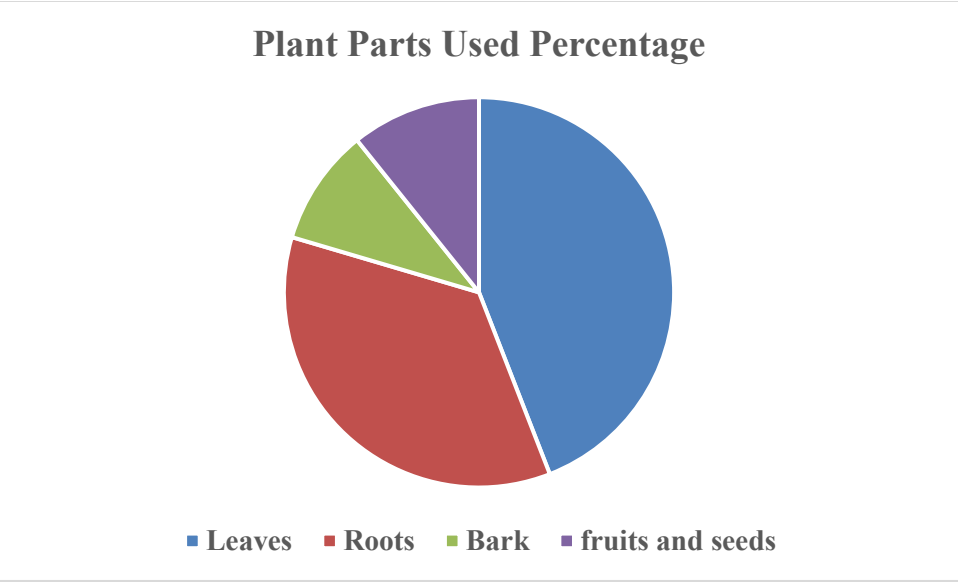


Figure 4. Plant parts used in ethnoveterinary medicinal preparations in Kulbo Forest.

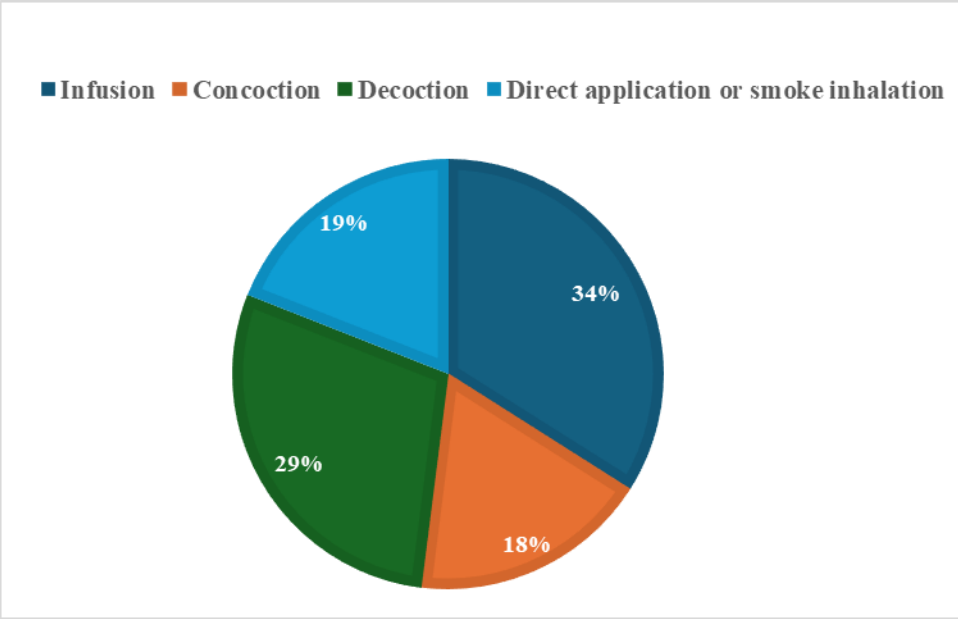


Figure 5. Preparation methods employed in ethnoveterinary remedy preparation in Kulbo Forest.

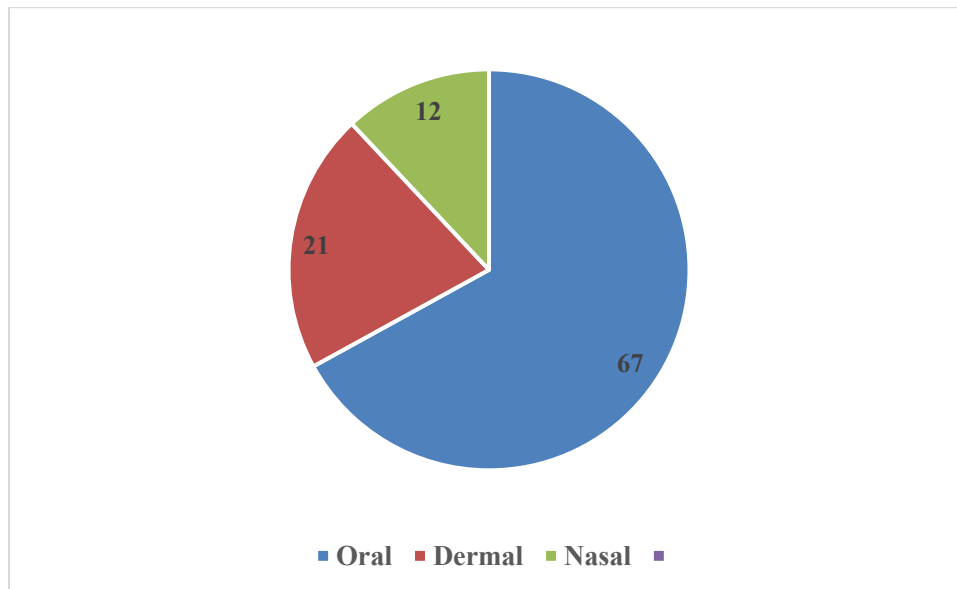


Figure 6. Routes of administration of ethnoveterinary remedies used for livestock healthcare.

3.5 Livestock ailments treated.

A total of 42 ethnoveterinary medicinal plant species were documented for the treatment of 31 livestock disease conditions. The most frequently reported ailments included gastrointestinal disorders, respiratory infections, ectoparasite infestations, wound infections, and reproductive disorders. Informants showed high agreement in identifying remedies for diseases perceived as severe or life-threatening, such as blackleg, rabies, severe diarrhea, and pneumonia. This pattern indicates that culturally salient treatments are concentrated around high-risk and economically important livestock conditions. Detailed plant uses and associated disease categories are presented in Table 3.

3.6 Informant consensus factor (ICF)

Informant Consensus Factor (ICF) values for major livestock disease categories are summarized in Table 4. High ICF values were observed for gastrointestinal disorders (0.87), respiratory

ailments (0.84), and ectoparasitic infections (0.81), indicating strong agreement among informants in the selection of plant-based remedies for these conditions. Lower consensus was observed for general weakness (0.61), suggesting more heterogeneous or individualized treatment practices. Overall, higher ICF values were associated with frequently occurring and economically significant diseases, reflecting shared knowledge and repeated validation of effective remedies within the community.

Table 4. Informant Consensus Factor (ICF) values for major livestock disease categories in Kulbo Forest.

Disease Category	N _{ur}	N _t	ICF
Gastrointestinal disorders	91	12	0.87
Respiratory ailments	84	14	0.84
Ectoparasitic infections	76	15	0.81
Reproductive disorders	69	17	0.77
General weakness	42	16	0.61

High ICF values (>0.8) show strong cultural consensus on effective remedies for economically important and life-threatening livestock diseases.

3.7 Use Value (UV) and Relative Importance (RI)

Use Value (UV) and Relative Importance (RI) indices showed a skewed distribution, with a limited number of species accounting for a high proportion of total use reports. To avoid redundancy and overinterpretation, these indices are presented only for the most frequently cited species and are integrated within Table 2.

These values serve as complementary indicators of cultural salience rather than standalone measures of importance, highlighting species that are consistently recognized and widely used across informants.

3.8 Cross-regional comparison with earlier Ethiopian studies

Quantitative similarity analysis using the Jaccard index revealed moderate to high overlap between the Kulbo Forest ethnoveterinary system and ecologically comparable moist Afromontane regions: Sheka ($J = 0.48$), Kaffa ($J = 0.45$), and Bench-Sheko ($J = 0.42$). When compared to the geographically closer but ecologically distinct Aseko District in the southeastern highlands, the similarity was notably lower ($J = 0.24$), further confirming that ecological filtering overrides geographic proximity in shaping these knowledge systems (Jara et al., 2026a). In contrast, similarity with ecologically distinct dryland areas was significantly lower (Borana $J = 0.18$; Bale $J = 0.21$). This aligns with patterns reported in West and Central African ethnoveterinary systems, where plant selection is shaped by ecological availability rather than geographic proximity (Solazzo et al., 2024). Similar trends have been documented across African ethnoveterinary systems, where ecological condition's structure therapeutic repertoires and knowledge systems (Solazzo et al., 2024). The widespread use of species such as *Calpurnia aurea* and *Croton macrostachyus* across multiple regions further supports the existence of a shared core ethnoveterinary flora. In contrast, species reported exclusively in Kulbo, including *Asparagus africanus*, *Agave sisalana*, and *Bartsia trixago*, reflect localized adaptations and context-specific innovation within the indigenous knowledge system.

3.9 Cultural interpretation of knowledge patterns

The observed overlap in core medicinal species between Dizi communities and neighboring groups such as Sheka and Bench suggests shared ethnobotanical knowledge systems and historical interaction. Knowledge exchange is likely facilitated through intermarriage, trade networks, and cultural proximity.

At the same time, the presence of locally unique remedies indicates adaptive knowledge development shaped by specific ecological conditions and livestock health challenges. This dual pattern of shared and localized knowledge reflects the dynamic nature of ethnoveterinary systems.

3.10 Conservation status and threats

The majority of ethnoveterinary plant species (68%) were harvested from wild forest habitats, indicating strong dependence on natural ecosystems for livestock healthcare. Informants reported a decline in the availability of several key species, particularly *Asparagus africanus* and *Echinops kebericho*, which are frequently harvested for medicinal purposes.

Major threats identified include agricultural expansion, destructive harvesting practices (especially root extraction), fuelwood collection, and general forest degradation. These pressures are likely to affect both species availability and long-term knowledge continuity.

To avoid redundancy, conservation assessment integrates ethnobotanical indices (FL, UV, and RI) with informant perceptions of species availability (Table 5). Species such as *Justicia schimperiana*, *Phytolacca dodecandra*, and *Croton macrostachyus* were identified as highly threatened, while *Calpurnia aurea*, *Myrsine africana*, and *Albizia schimperiana* were categorized as high-priority for conservation.

Community-based conservation strategies proposed by informants include domestication of medicinal plants in home gardens and the establishment of local nurseries. These approaches may reduce pressure on wild populations while maintaining access to essential ethnoveterinary resources.

A conceptual summary of ethnoveterinary knowledge patterns, conservation threats, and proposed mitigation strategies is presented in Figure 7.

Table 5. Culturally important ethnoveterinary plants under conservation threat

<i>Scientific name</i>	<i>FL (%)</i>	<i>UV</i>	<i>RI</i>	<i>Habitat</i>	<i>Perceived threat</i>	<i>Conservation priority</i>
<i>Justicia schimperiana</i>	84.2	0.72	0.85	Wild	High	Urgent
<i>Phytolacca dodecandra</i>	73.7	0.65	0.78	Wild	High	Urgent
<i>Croton macrostachyus</i>	68.5	0.60	0.80	Wild	High	Urgent
<i>Calpurnia aurea</i>	75.0	0.59	0.77	Wild	Medium	High
<i>Myrsine africana</i>	70.0	0.61	0.72	Wild	Medium	High
<i>Albizia schimperiana</i>	68.0	0.41	0.62	Wild	Medium	High

Notes: Habitat shows plant source; FL = Fidelity Level; UV = Use Value; RI = Relative Importance.

Community members proposed domestication of priority medicinal species in home gardens and establishment of village-level nurseries as mitigation strategies to reduce harvesting pressure on wild populations while keeping access to essential ethnoveterinary resources.

Overall, the findings demonstrate that ethnoveterinary knowledge in the Kulbo Forest area is shaped by ecological availability, cultural transmission, and conservation pressures.

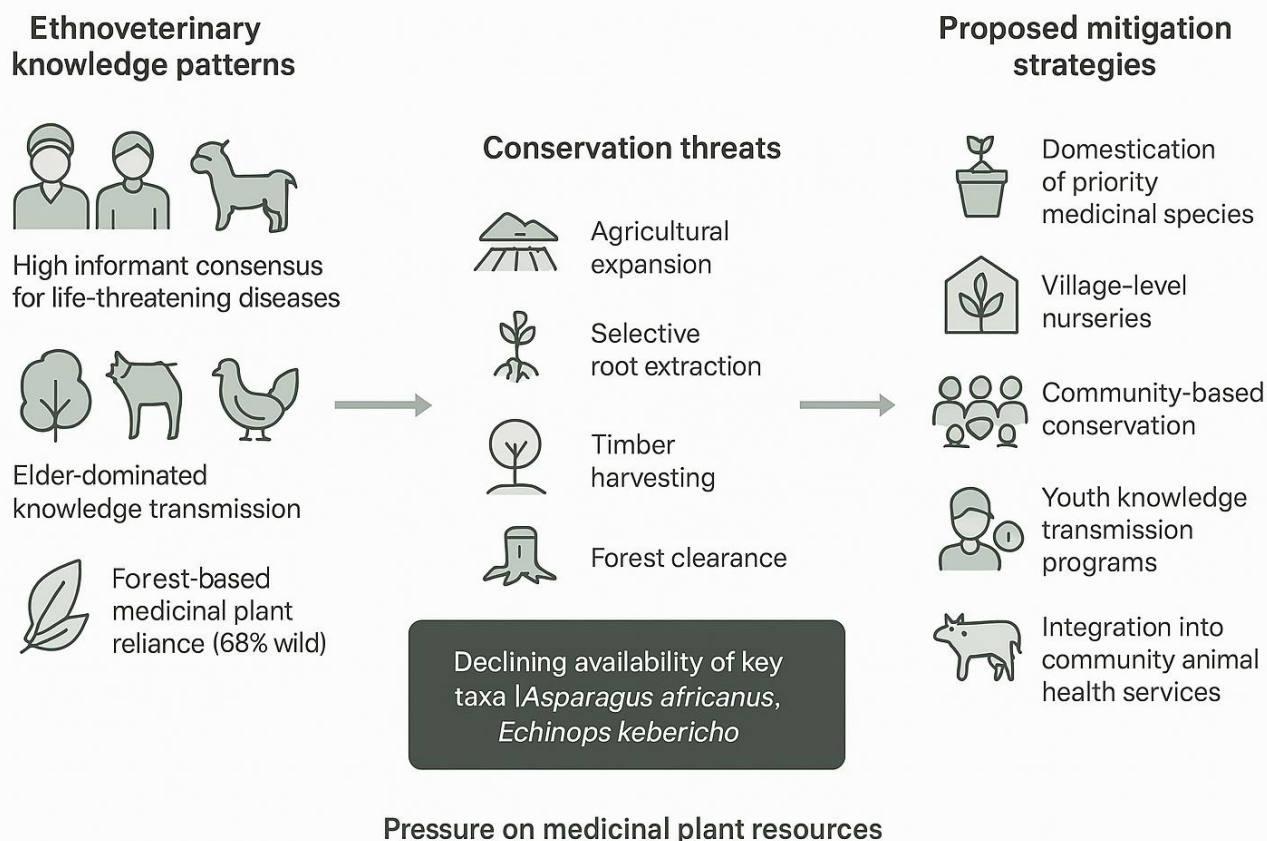


Figure 7. Summary diagram of key ethnoveterinary knowledge patterns, conservation threats, and proposed mitigation strategies in Kulbo Forest.

4. Discussion

The present study provides a comprehensive account of ethnoveterinary medicinal plant knowledge in the Kulbo Forest landscape, revealing a complex interaction between ecological availability, cultural practices, and knowledge transmission systems. The dominance of a limited number of plant families and species reflects patterns widely reported in ethnoveterinary studies across Ethiopia and other parts of Africa, where plant selection is strongly influenced by local abundance, perceived efficacy, and long-term experiential validation.

The predominance of shrubs and trees as sources of ethnoveterinary remedies is consistent with findings from other dryland and semi-forested regions, where woody species are more resilient to seasonal variability and thus more reliably available. This ecological reliability likely contributes

to their cultural prominence in traditional veterinary practices. Furthermore, the frequent use of leaves as the primary plant part aligns with sustainability considerations, as leaf harvesting is generally less destructive than root or whole-plant extraction, indicating an implicit conservation ethic embedded within indigenous knowledge systems.

Preparation methods observed in this study, particularly crushing and mixing with water, reflect practical and accessible techniques that require minimal processing. Similar preparation patterns have been documented across African ethnoveterinary systems, suggesting a shared empirical foundation shaped by generations of trial-and-error experimentation. These methods are not arbitrary but are instead optimized for efficacy, ease of application, and adaptability within resource-limited rural contexts.

A key finding of this study is the uneven distribution of ethnoveterinary knowledge across age groups. Statistical analysis confirmed that older informants reported significantly more medicinal plant species than younger participants, supporting the notion of age-structured knowledge retention. This pattern has been widely observed in traditional knowledge systems, where expertise accumulates over time through lived experience and apprenticeship. However, the relatively low representation of younger individuals in knowledge transmission pathways raises concerns about the long-term continuity of ethnoveterinary practices. Socio-economic changes, formal education systems, and shifting livelihood strategies may be contributing to a gradual erosion of this knowledge base.

Knowledge transmission in the study area is predominantly vertical, occurring within families and from elders to younger generations. While this mode of transmission ensures cultural integrity and knowledge control, it may also limit broader dissemination and adaptation. In contrast, horizontally transmitted knowledge systems—such as those involving peer learning or community-based knowledge exchange—have been shown to enhance resilience and innovation. The strong reliance on vertical transmission observed here suggests that ethnoveterinary knowledge in Kulbo Forest remains culturally protected but potentially vulnerable to disruption.

The use of quantitative ethnobotanical indices in this study provides a structured approach to identifying culturally salient species. However, recent critiques have questioned the interpretive value of such indices, arguing that they may oversimplify complex cultural relationships and

introduce analytical bias (Leonti, 2022; Zenderland et al., 2019). In this context, the indices presented here should be interpreted cautiously and viewed as complementary tools rather than definitive measures of importance. Their primary contribution lies in highlighting frequently cited species, which may serve as candidates for further pharmacological investigation.

Comparative analysis indicates that many of the plant species documented in this study are also reported in ethnoveterinary practices across other regions of Ethiopia, such as the Aseko District (Jara et al., 2026a), and the African continent. Furthermore, the overlap in human ethnobotanical uses between the Kulbo Forest and neighboring regions (Jara and Alemu, 2026) highlights a shared biocultural heritage. This convergence suggests the existence of shared ethnopharmacological knowledge systems, potentially driven by similar ecological conditions and livestock health challenges. At the same time, the identification of locally specific uses underscores the importance of site-based studies in capturing unique cultural adaptations and innovations. Recent continental-scale analyses further emphasize the diversity and commonality of ethnoveterinary knowledge across Africa, reinforcing the value of localized documentation within broader comparative frameworks (Solazzo et al., 2024).

Despite its contributions, this study has certain limitations. The reliance on self-reported information may introduce recall bias and subjective interpretation, particularly in the absence of experimental validation. However, the focus of ethnoveterinary research is inherently centered on emic perspectives, and the documentation of indigenous knowledge remains a critical first step in understanding traditional healthcare systems. Future research could build on these findings by integrating phytochemical and pharmacological analyses to evaluate the efficacy of the most frequently cited species.

Overall, the findings highlight the continued relevance of ethnoveterinary knowledge in rural livestock management while also pointing to emerging challenges related to knowledge transmission and conservation. The integration of traditional knowledge with modern veterinary practices, alongside community-based conservation strategies, may offer a sustainable pathway for preserving both biological and cultural diversity in the region.

Declarations

Ethics approval and consent to participate

477 This study involving human participants was conducted in accordance with relevant ethical
478 guidelines and regulations, including the Declaration of Helsinki. Ethical approval was obtained
479 from the Research Ethics Committee of Mizan Tepi University, College of Agriculture and Natural
480 Resources (Ref. No.: MTU/CANR/RERC/004).

481 Prior to data collection, the purpose and procedures of the study were clearly explained to all
482 participants, and informed consent was obtained from each respondent. Participation was entirely
483 voluntary, and participants were informed of their right to withdraw at any time without any
484 consequences. Confidentiality and anonymity of the information provided were strictly maintained
485 throughout the study.

486 In addition, the study respected local cultural norms and ensured the ethical documentation and
487 use of indigenous knowledge related to ethnoveterinary medicinal practices.

488 **Compliance with botanical guidelines:** The authors confirm that all field studies, plant
489 collections, and harvesting practices comply with the IUCN Policy Statement on Research
490 Involving Species at Risk of Extinction and the Convention on the Trade in Endangered Species
491 of Wild Fauna and Flora (CITES), as well as relevant national and institutional guidelines of
492 Ethiopia.

493 **Consent for publication**

494 Not applicable.

495 **Availability of data and materials**

496 All ethnobotanical voucher specimens (MTU–EVP–001 to MTU–EVP–042) are deposited at the
497 Mizan-Tepi University Herbarium (MTU), Ethiopia. Raw interview data sheets, disease-category
498 matrices, and calculated quantitative ethnobotanical indices are available from the corresponding
499 author upon reasonable request.

Use of artificial intelligence tools

The authors used artificial intelligence–assisted tools for language editing and formatting of the manuscript. All scientific content, data analysis, interpretations, and conclusions were developed, verified, and approved by the authors, who take full responsibility for the content of this work.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

JSJ conceptualized the study, conducted field data collection, performed data analysis, and drafted the manuscript. BA verified plant taxonomic identification, supervised herbarium deposition, and critically reviewed the manuscript. Both authors read and approved the final manuscript.

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