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Traditionally used phytomedicines and their associated threats in Bita district, southwestern Ethiopia

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Abstract

Background Throughout history, plant resources have played a crucial role in human society. After addressing fundamental needs such as food and shelter, humans have sought out plants for medicinal purposes to alleviate various health issues. The utilization of plant resources for diverse applications, including traditional herbal medicine, is integral to the rich cultural heritage and lifestyle of the communities in southwest Ethiopia. However, despite the existence of numerous indigenous traditional medicinal plants, the ethnobotanical knowledge surrounding these resources in the Bita district remains largely unexplored. Consequently, this study aimed to document and analyze the traditional medicinal plants, along with the associated customs and knowledge utilized by the local population.

Methods Between June 2024 and *Pagume* (the 13th month unique to Ethiopia) of the same year, a combination of semistructured interviews, in-person meetings, group discussions, and guided field trips was employed to collect quantitative ethnobotanical data. A total of 136 informants, comprising 104 men and 32 women, participated in the interviews to provide insights into ethnobotanical practices. The research utilized several quantitative methodologies, including the informant consensus factor (ICF), fidelity level (FL), plant part value, preference ranking, and direct matrix ranking. Additionally, various statistical analyses were conducted, including independent t tests, one-way ANOVA, correlation, and regression, utilizing R to assess and compare the ethnobotanical knowledge across different groups of informants.

Result A total of 122 species of traditional medicinal plants, belonging to 104 genera and 53 different plant families, were documented in this study. The Asteraceae family was the most frequently cited, comprising 12 species, making it the largest family identified. This was followed by Lamiaceae with eight species, Solanaceae with eight species, Rubiaceae with seven species, Euphorbiaceae with six species, Cucurbitaceae with five species, and Fabiaceae with four species. The plant parts most commonly utilized in traditional remedies were leaves and roots, with the predominant method of preparation being crushing. Notably, the average number of medicinal plants reported by participants varied significantly across different demographics, including gender, age groups, educational levels, and experience ($P < 0.05$).

Conclusion The study area boasts a diverse range of potential medicinal plants and the associated indigenous knowledge. To mitigate the increasing anthropogenic threats and ensure the preservation of these plants and their related knowledge, it is crucial to implement effective conservation strategies and responsible usage. Furthermore,

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the medicinal properties of these plants should be validated through scientific experimentation to effectively combine local knowledge with modern medicine.

Keywords Ethnobotany, Phytomedicines, Threats, Bita district, Southwestern Ethiopia

Background

Throughout history, plant resources have played a crucial role in human society. After addressing basic needs like food and shelter, humans have sought out medicinal plants to treat various ailments [1]. Plants provide a multitude of ecological, social, and economic benefits. However, their use can also have significant negative impacts on both the environment and society, reflecting the complex interplay of human-forest interactions [2–5]. The relationship between people and forests is shaped by the dynamic interaction of biophysical and human factors over time and across different spaces. Due to poverty and limited access to modern medical care, around 80% of people worldwide in developing nations rely on plants for their primary medical needs [6]. As a result, humans rely on plants for both food and medicine preparation [5]. Ethiopia has a vast variety of climates and ecological conditions, and its fauna and flora is incredibly diverse [7]. According to scholars, 95% of Ethiopia's traditional medicinal preparations come from plants [8]. An estimated 6500–7000 species of higher plants make up Ethiopia's flora, with roughly 12% of those species being endemic [9]. The nation is renowned for having a great deal of geographical diversity, which encouraged the development of various vegetation and habitat zones. Ethiopia is also home to a wide variety of languages, cultures, and beliefs, all of which have influenced the people's traditional knowledge and practices, including the use of medicinal plants [10]. Ethiopian flora has demonstrated significant efficacy in addressing a range of ailments affecting both humans and domestic animals. The prominence of these plants is attributed to the communities' strong belief in the healing properties of traditional medicine, coupled with the relatively low cost associated with their use. Consequently, there is a substantial demand for medicinal plants within Ethiopia. Much of the knowledge regarding traditional medicine is transmitted orally, with practitioners serving a crucial role in this knowledge-sharing process [10]. Traditional medicine has significantly contributed to societal well-being; however, it has garnered minimal attention in modern research and development, with limited efforts directed toward enhancing its practice. Recently, Ethiopian higher education institutions and health authorities have begun to show interest in promoting and advancing this field. The Southwest region of Ethiopia, characterized by its rich biological and cultural diversity, is particularly abundant in medicinal plants. Nonetheless, threats, such as deforestation, environmental degradation, and population growth, jeopardize this invaluable repository of medicinal plant knowledge. These critical issues have led to a decline in indigenous knowledge, which is closely tied to the preservation of the nation's forests that harbor medicinal plants. The forests of Southwest Ethiopia provide a range of ecosystem services, including forest coffee, honey, spices, building materials, and cultural rituals. This region is recognized as the origin and primary center of diversity for *Coffee arabica* L., which continues to grow in its natural habitat and possesses a highly diverse genetic pool. Unfortunately, many of these pristine forests have been fragmented and transformed into agricultural landscapes, while the remaining forests are often managed for semi-forest coffee production or more intensive garden and plantation coffee systems. The influx of new investment opportunities in southwestern Ethiopia is exacerbating the rate at which remnant forests are converted to alternative land uses, such as rice and coffee plantations.

The people of Bita district have a traditional way of life in the countryside and a strong bond with plants [11]. Prior to this study, there has been no comprehensive research focused on the ethnobotany of medicinal plants in the Bita district, aside from the work on land use and land cover dynamics and perceptions by [12]. Thus, it is essential to conduct a survey to document the indigenous knowledge and medicinal flora of the Bita District. While the region boasts significant forest cover and a rich tapestry of largely intact traditional cultures, it is comparatively underserved in terms of infrastructure, particularly in educational and healthcare facilities. Traditional healers in the Bita district have indicated that the area is notably remote from hospitals and health centers, resulting in a heightened risk of mortality from various ailments, compelling residents to rely on traditional medicine. Furthermore, the dense forest environment and the close relationship between the local populace and their natural surroundings have led to numerous incidents of snake bites, jaundice, and worm infestations. These conditions are predominantly addressed through traditional remedies administered by healers with indigenous expertise, rather than through modern medical interventions. This study aims to: (i) documenting the traditional medicinal plants used to treat various human and livestock ailments with the associated indigenous knowledge of the local community in Bita district, including their botanical names, local names, and healthcare applications; (ii) examine the effects of traditional phytomedicine on food security and public health, particularly how these plants contribute to local diets and health practices; (iii) analyze the correlation between informants' knowledge of medicinal plants and their demographic backgrounds; (iv) identify key threats to medicinal plants in the area; and (v) assess the conservation status of these species, focusing on those endangered by overharvesting, habitat loss, or other human activities. The findings of this research are anticipated to guide both ex situ and in situ conservation strategies, encourage the sustainable use of these plants, and facilitate future pharmaceutical innovations.

Methods and materials

Description of the study area

Bita district is located in the Kaffa zone of southwestern Ethiopia, approximately 523 km southwest of Addis Ababa, the capital city. The geographical coordinates of the area range from 7° 12′33″ to 7°35′00″ North latitude and from 30°29′15″ to 35°51′00″ East longitude, covering an area of about 109,247 hectares, which represents 9.45% of the entire Kaffa zone (Fig. 1). Bita is bordered by the Sheka zone to the west, Gesha to the north, Gewata to the northeast, and Chena to the east. The main town in Bita is Bita Genet, which was established from portions of the Chena and Gesha districts. The elevation within the district ranges from 950 to 2,570 m above sea level. According to the 2017 Census conducted by the Central Statistical Agency (CSA), Bita district has a population of 89,506 residents, with a gender distribution of 49.4% male and 50.6% female [13]. The predominant religions in the district are Protestantism, followed closely by Ethiopian Orthodox Christianity, with 44.24% and 44.12% of the population identifying as such, respectively. Additionally, 6.77% of residents are Muslim, while 3.92% adhere to traditional beliefs. The district features a rich diversity of natural vegetation, primarily classified as moist evergreen montane forest. Key plant species in the region include *V. auriculifer*, *V. amygdalina*, *M. ferruginea*, *E. schimperi*, *E. ventricosum*, and *C. esculenta*. Agriculture is the main

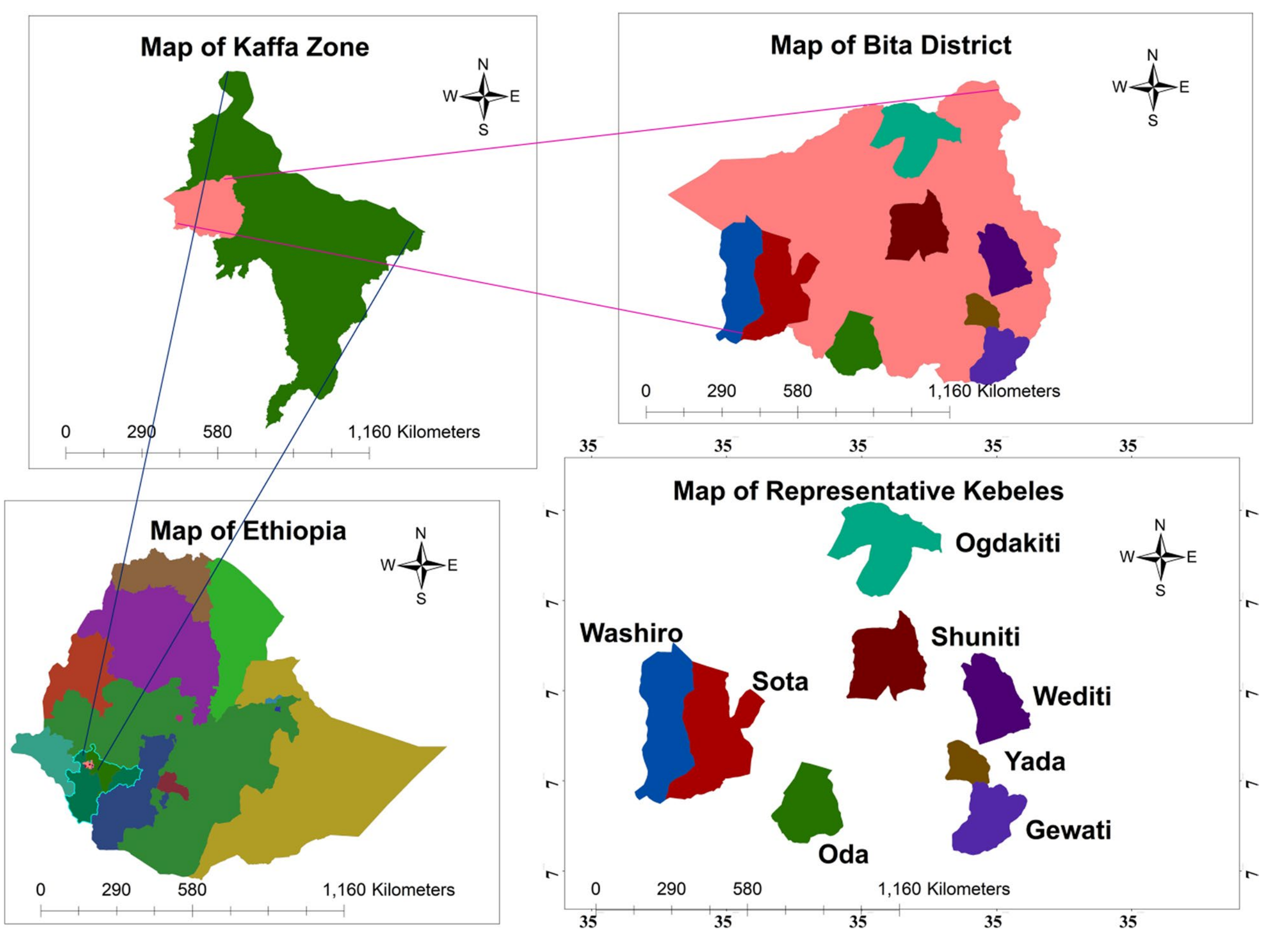

Fig. 1 Map of the study area (Created by Arc GIS 10.4.1)

livelihood for local residents, complemented by various income-generating activities such as honey production, small-scale trade, and charcoal manufacturing. The principal crops grown in the district include permanent crops, cereals, pulses, vegetables, and root crops [12].

Climate

The primary rainy season occurs from April to September, while the dry season, referred to as '*Qaawo*' (winter), spans from December to February. A climate diagram (Fig. 2) was constructed using 20 years of rainfall and temperature data (2003–2023) sourced from Tepi meteorological stations, indicating an average annual rainfall of 1934 mm, with peak precipitation occurring between August and September. The average monthly temperature recorded was 20.1 °C, with maximum and minimum monthly temperatures of 30.1 °C and 12.6 °C, respectively (Fig. 2). This region exhibits a unimodal rainfall distribution, characterized by a predominance of precipitation throughout the year. As noted by [12], the substantial rainfall contributes to the development of the moist evergreen vegetation typical of the Afromontane Forest, which supports a diverse array of unique plant species.

Preliminary survey and study sites selection

The initial survey was carried out from April to May 2024, aiming to establish a foundational understanding of the agroecological characteristics of the region, assess the current condition of the vegetation, gather insights into the indigenous knowledge of local communities regarding the diverse uses of plants, evaluate accessibility, and consider other pertinent environmental factors. Purposive sampling was employed to select the kebeles for study, focusing on those with significant vegetation cover and a documented history of medicinal plant usage. These kebeles were also identified as potential sites for home gardening initiatives. The selection process was further informed by prior data collected from local healthcare practitioners, esteemed elders, community leaders, participants in focus group discussions, and traditional healers. As a result, eight kebeles were chosen for the study, representing 35% of the total 23 kebeles in the District. The selected kebeles include Washiro, Oda, Yada, Shuniti, Wediti, Gewati, Ogdakiti, and Sota (Table 1).

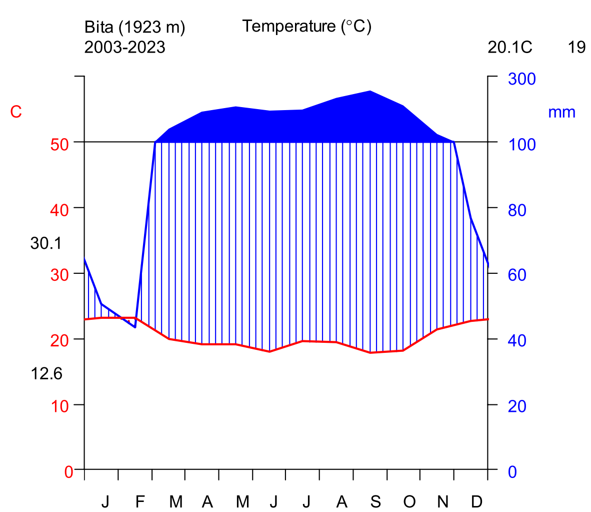

Fig. 2 Climatogram of Bita genet town

Informant selection

The research involved conducting interviews with a total of 136 participants, whose ages spanned from 18 to 85 years. Seventeen individuals were selected from each of the eight kebeles. As noted in previous literature [3], a total of 100 general informants were identified through snowball sampling from the local community within the study area, while 36 key informants were selected using purposive sampling based on established guidelines. The participants were categorized into three distinct age groups: young adults (18–30), middle-aged individuals (31–55), and seniors (56–85). The primary focus of the study was to investigate the intergenerational transmission of knowledge regarding medicinal plants, particularly emphasizing individuals under the age of 30[14].

Ethical considerations

Supportive correspondence was dispatched from the Department of Biology to relevant entities, including the District Agriculture Office, district administrators, and kebele administrators, prior to the field excursions. We took care to uphold ethical standards; all herbalists were made aware that the study was conducted for academic purposes, and ethical approval was secured to guarantee confidentiality prior to the initiation of interviews. Throughout our research, we preserved the confidentiality of the local communities' secrets, knowledge, and taboos while documenting our observations.

Ethnobotanical data collection

Ethnomedical data were collected with the assistance of informants from June 2024 until *Pagume*, the unique13th month in the Ethiopian calendar. Through collaboration with respondents, a comprehensive list of medicinal plants was compiled, which included local names and corresponding images. The data collection methods employed included field observations, guided walks, semistructured interviews, market surveys, and focus group discussions, all conducted in accordance with established methodologies found in relevant literature [3, 15]. The interview was carried out in the appropriate languages

Table 1 Sampled study sites, altitude, latitude, and longitude, agro-ecology, number of households, and sociodemographic characteristics of informants

Name of kebeles	Altitude	GPS Coordinates		Gender		Ethnicity (Kaf, Am, Orm, Ben, Shk, Maj, Sh)	Age categories			Language (Kafn, Amc, Ao, Bng, Skn, Shg, Mg)	Occupation	Religion(Ort, Mus, Pro)	NH	AE
		Latitude (N, S)	Longitude (E, W)	M	F		18–30	31–55	56–85					
Washiro	2381 m	7°22′27″N	35°30′37″E	12	4	Kaf, Am, Orm, Shk	3	5	8	Kafn, Amc, Ao, Skn	Far, Mer, HW, Stu, Tch	Ort, Mus, Pro	1268	Highland
Oda	1519 m	7°14′37″N	35°37′58″E	15	5	Kaf, Am, Orm, Ben, Shk, Maj, Sh	4	9	10	Kafn, Amc, Ao, Bng, Skn, Shg, Mg	Far, Mer, HW, Stu, Tch	Ort, Mus, Pro	1517	Mid-highland
Yada	1884 m	7°17′38″N	35°46′42″E	12	5	Kaf, Am, Orm, Ben, Shk	3	7	9	Kafn, Amc, Ao, Bng, Skn	Far, Mer, HW, Stu, Tch	Ort, Mus, Pro	1189	Highland
Shuniti	2396 m	7°24′30″N	35°42′46″E	15	4	Kaf, Am, Orm, Shk, Maj	3	6	8	Kafn, Amc, Ao, Skn, Mg	Far, Mer, HW, Stu, Tch	Ort, Mus, Pro	1687	Highland
Wediti	2164 m	7°22′35″N	35°46′23″E	11	5	Kaf, Am, Orm, Ben, Sh	2	4	9	Kafn, Amc, Ao, Bng, Shg	Far, Mer, HW, Stu, Tch	Ort, Mus, Pro	1276	Highland
Gewati	1956 m	7°14′59″N	35°47′43″E	12	4	Kaf, Am, Orm, Shk, Maj	3	3	10	Kafn, Amc, Ao, Skn, Mg	Far, Mer, HW, Stu, Tch	Ort, Mus, Pro	1289	Highland
Ogdakiti	2173 m	7°29′50″N	35°42′28″E	12	5	Kaf, Am, Orm, Ben, Shk, Sh	2	6	7	Kafn, Amc, Ao, Bng, Skn, Shg	Far, Mer, HW, Stu, Tch	Ort, Mus, Pro	1312	Highland
Sota	1688 m	7°19′07″N	35°32′32″E	11	4	Kaf, Am, Orm, Ben, Shk	2	4	9	Kafn, Amc, Ao, Bng, Skn	Far, Mer, HW, Stu, Tch	Ort, Mus, Pro	1056	Mid-highland
Total				100	36		22	44	70		Far, Mer, HW, Stu, Tch		10,594	

Kaf, Kaffa; Am, Amhara; Orm, Oromo; Ben, Bench; Shk, Sheka; Maj, Majang; Sh, Sheko; Kafn, Kaffinnono; Amc, Amharic; Ao, Affanoromo; Bng, Benchegna; Skn, Shekinnono; Shg, Shekogna; Mg, Majang; Ort, Orthodox; Mus, Muslim; Pro, Protestant; M, Male; F, Female; AE, Agro-ecology; NH, Number of households; Far, Farmer; Mer, Merchant; HW, House wife; Stu, Student; Tch, Teacher

(Kaffinnono, Afan Oromo, Amharic, Shekinnono, Bench, Majang, and Sheka) of the informants, with the help of translators when required. Individual interviews were conducted to extract detailed information regarding the medicinal plant species, including the parts utilized, preparation methods, ailments commonly treated, routes of administration, and dosage guidelines. Additionally, insights were gathered from the community regarding the threats faced by medicinal plant species. To ensure the accuracy of the data, voucher specimens of all identified medicinal plants were collected from various ecological settings through interviews with traditional healers, who acted as key informants, as well as general informants. During the fieldwork, ethnobotanical information was documented, encompassing local plant names, utilized plant parts, habitats, preparation techniques, application methods, routes of administration, and diseases treated. Critical georeferenced data were also recorded using a geographical positioning system (GPS).

Plant voucher specimens collection, identification, and herbarium preparation

During field excursions, medicinal plant specimens were gathered with the assistance of herbalists and experts in development. To ensure the authenticity of the collection, two specimens from each species were obtained. Labels indicating the collection number and the names of the collectors were affixed to each specimen. The specimens were carefully arranged between two or three sheets of locally produced blotting paper, with some oriented upwards and others downwards to document both sides. Subsequently, they were secured using a specimen presser and holder. The vouchers were dried in sunlight, with the holder side facing the sun, and were aerated to inspect for insect infestations. The collected specimens underwent identification and verification at the mini herbarium of Mizan Tepi University, utilizing taxonomic keys and descriptions from relevant volumes of the Flora of Ethiopia and Eritrea. A visual comparison with authenticated specimens was performed to confirm the identification. During the field trip, a guidebook detailing useful trees and shrubs of Ethiopia was employed. The scientific names, families, and authors of the recorded plants were cross-referenced using resources such as Plant Net Identification, Flora Finder, Plant Snap, the USDA Plants Database, Google Images, the African Plant Database, and the World Checklist of Selected Plant Families. To ensure accurate identification, the JSTOR Global Plants website was consulted for the complete Latin binomial nomenclature of the plants. Ultimately, the voucher specimens were carefully preserved within the mini herbarium of the Biology department to ensure their availability for future research endeavors.

Data analysis

Microsoft Word 2019 was employed to collect, organize, categorize, and document field data, which encompassed both scientific and local plant names, their respective families, life forms, utilized parts, and habitats. Analytical tools such as tables, bar graphs, and pie charts were utilized for frequency analysis. Descriptive statistics, including mean and standard deviation, were calculated using R software version 4.3.3. Prior to conducting the t test, the Shapiro–Wilk test was performed to assess normality. Gender differences in TMPK were analyzed through an independent t test based on the reported plants. Additionally, variations in knowledge across different educational levels and healing experiences were assessed using a separate t test. Knowledge differences among age groups were analyzed using ANOVA. The relationship between age and reported plants was investigated through Pearson correlation and linear regression. Furthermore, quantitative ethnobotanical methods, such as the informant consensus factor (ICF), plant part value (PPV), fidelity level (FL), direct matrix ranking (DMR), and preference ranking, were also employed for data analysis.

Quantitative analysis of ethnobotanical data

Plant part value (PPV)

The methodology outlined by [3] indicates that the calculation of the value of plant parts reflects the relative contributions of various components, including stems, leaves, roots, fruits, bark, and flowers, utilized for medicinal applications. The calculation is performed as follows:

$$\mathrm{PPV}(\%) = \frac{\sum \mathrm{RU\ (plant\ part)}}{\sum \mathrm{RU}} \times 100$$

where $\sum$ RU $_{\text{(plant part)}}$ represents the sum of the cited plant parts and $\sum$ RU represents the total number of cited uses for a given plant.

Informant consensus

The accuracy of the recorded information was verified by reaching out to informants a minimum of two times regarding the same concepts, thereby evaluating the dependability of the data collected during the interviews. Any original information was dismissed as unreliable if it contradicted the opinions of the informants. To assess the level of agreement among informants concerning the reported treatments for the specific group of illnesses, the informant consensus factor (ICF) for each category was calculated. This calculation was conducted in the following manner:

$$ICF = \frac{Nur - Nt}{Nur - 1}$$

where Nur is the number of informant use reports for a specific plant-use category and Nt is the total number of taxa or species used for that plant-use category across all informants. The index has a range of 0 to 1, where values close to 1 indicate that informants strongly agree that the same species is used [16].

Fidelity level (FL)

A fidelity level (FL), as proposed by [17], was employed to assess the relative therapeutic potential of medicinal plants in addressing human health issues. The calculation of the fidelity level (FL) was conducted using the following formula:

$$FL(\%) = \frac{IP}{IU} \times 100$$

where FL = fidelity level or relative healing potential, IP = the number of informants who independently cited the importance of a species for treating a particular ailment (frequency of citation of a species for a particular aliment), and IU = the total number of informants who reported the medicinal plant for a given disease (total number of citations of that species).

Jaccard's similarity index (JSI)

Jaccard's similarity index was utilized to evaluate the similarity in the composition of medicinal plant species across various studies conducted in different regions of the country. The index is calculated using the following formula:

$$JCS = \frac{c}{a + b + c} \quad (2)$$

In this formula, Jaccard's similarity index quantifies the level of similarity between two distinct study areas: study area a (the current study area) and study area b (other study areas). The variables represent the species present in each area, with 'a' denoting the number of species in study area a, 'b' for study area b, and 'c' for the number of common species shared between the two areas. The values of the JSI range from 0 to 1, where a value of 1 indicates complete similarity and a value of 0 indicates no similarity at all. To express the JSI as a percentage, it can be multiplied by 100, yielding a percentage representation of the similarity index [18].

Preference ranking

In alignment with [3, 15], a selection of ten key informants was made to assess the effectiveness of five medicinal plants in combating intestinal parasites in humans. The plants that received the highest rating of 5 were considered the most potent in addressing the condition, whereas those rated the lowest, with a score of 1, were deemed the least effective. The individual scores for each species were aggregated, and this cumulative score facilitated the ranking of each plant. This approach enabled a clearer identification of the medicinal plants that the community found to be most successful in treating these ailments.

Direct matrix ranking

Direct matrix ranking was employed to evaluate multipurpose medicinal plants that were frequently reported by informants, as outlined in reference [3]. From the total pool of medicinal plants, five multipurpose species were selected based on their relative benefits, and the applications of these five plants were documented. To determine the use values for each characteristic, five key informants were consulted, utilizing a scale where 5 represents the highest value, followed by 4 for very good, 3 for good, 2 for less used, and 1 for the least utilized. The seven use values assessed included medicinal applications, construction, charcoal production, furniture, food, firewood, and agricultural tool utility.

Results and discussion

Sociodemographic characteristics of informants

A total of 136 individuals took part in this research study. Among the participants, males constituted 76.4% ($n = 104$), while females represented 23.5% ($n = 32$). In terms of informant classification, the majority, comprising 73.5% ($n = 100$), were identified as general informants, whereas key informants accounted for 26.4% ($n = 36$). The age range of participants spanned from 18 to 85 years, with 51.5% ($n = 70$) belonging to the 56–85 age category, followed by 32.3% ($n = 44$) in the 31–55 age group. The educational levels of participants varied widely, from illiteracy to literacy. Notably, 69.9% of the participants were found to be illiterate ($n = 95$), while the literate individuals comprised 30.1% ($n = 41$) (Table 1).

Naming of medicinal plants related to culture

Medicinal plants are often designated with names that reflect their uses or provide insights into their characteristics. Some local names highlight physical attributes such as growth habit, bark color, leaf morphology, toxicity, flavor, and aroma, while others explicitly denote their therapeutic properties. Importantly, every studied medicinal plant species possesses a local name in one or more languages spoken within the examined regions. It is not uncommon for different communities to use these names interchangeably or with minor variations in pronunciation. Additionally, several species that share similar medicinal properties may be collectively identified by a single local name. The inhabitants of the study area possess extensive knowledge and cultural beliefs regarding their traditional healthcare practices and various social matters. Generally, local populations can recognize the plants in their environment by their indigenous names. In the study area, local populations designate medicinal plants by referencing the ailments they address, typically appending the suffix '*Ato*'. For instance, the plant *D. metel* is utilized for treating snake bites and is referred to as '*Dingerato*', where '*Dinger*' signifies snake and '*Ato*' denotes medicine. Additionally, names, such as *Shatshato, Michichiniato, Michiato, Kakeato, Gergoato*, and *Ambatto,* derive from the specific diseases they are associated with. Some plant names are linked to animals; for example, *A. aspera* is called '*Bege Gicho*', meaning 'Sheep's Spine'. Furthermore, the community employs color-based nomenclature, as seen in the distinctions made between *A. cepa* and *A. sativum*, referred to as '*Chele Dukusho*' and '*Neche Dukisho,*' respectively. Similarly, other researchers have documented in the Sheka zone, particularly in the *Shakicho* language, that any health condition denoted with the suffix '*Bewo*' in conjunction with a specific body part pertains to diseases affecting that organ. For example, *Wame Bewo* indicates ear ailments; *Yehete Bewo* refers to kidney infections; *Afe Bewo* pertains to eye disorders; and '*Qewe Bewo*' denotes Black leg disease in livestock. This finding is in line with the report of [18, 19].

Diversity and distribution of medicinal plants in the study area

In the investigated area, a total of 122 distinct species of medicinal plants, belonging to 104 genera and 53 families, were identified as being utilized for the treatment of 13 diseases affecting livestock and 39 diseases affecting humans. Among these 122 species, 92 (75.4%) were employed as remedies for human ailments, 12 (9.8%) for livestock ailments, and 18 (14.8%) for both human and livestock conditions (Table 2). This indicates a greater reliance on medicinal plants for human health issues compared to those for livestock. This trend may be attributed to the predominance of coffee cultivation in the area, which could limit livestock farming. The findings of this study surpass previous reports from Ethiopia, which documented 81, 63, 72, and 40 plant species, as noted in references [14, 20–22]. Similarly, studies conducted in other regions of the world have reported 42 and 55 plant species, as indicated by [23, 24]. Conversely, reports by [10, 19, 25] have identified 266, 145, and 189 species of medicinal plants, respectively, which exceeds the number found in the current study area. The diversity of medicinal plants identified in different research locations can fluctuate based on several factors, including the type of vegetation present, the number of informants involved, the timing of data collection, and the cultural practices of the region, as noted by [14, 21, 22]. The reliance of the local community on traditional medicine is evidenced by the widespread use of herbal treatments for ailments affecting both humans and animals within the study area. This reliance may stem from various factors, such as the high costs associated with modern pharmaceuticals, challenges in accessing contemporary healthcare services, and the cultural endorsement of herbal remedies, a phenomenon also observed in other regions of Ethiopia, as reported by [19, 26–28]. The Asteraceae family, comprising 12 species, emerged as the most extensive family in the study, followed by the Lamiaceae with eight species, Solanaceae with eight species, Rubiaceae with seven species, Euphorbiaceae with six species, Cucurbitaceae with five species, and Fabiaceae with four species. Notably, the Asteraceae family is the predominant source of plant species utilized for medicinal purposes when compared to other families within the study area. This observation aligns with previous findings from Ethiopia [28–30] and various countries worldwide [31, 32]. Conversely, the Poaceae, Amaranthaceae, and Apocynaceae families were frequently reported in Pakistan [33]. The prevalence of these families can be attributed to their higher abundance and distribution within the regional flora [14, 20]. The research indicates a preference among individuals for plant species that are easily accessible and deemed safe. Consequently, the study underscores the cultural and medicinal importance of various plant families in traditional healing practices, emphasizing the necessity for further investigation into their therapeutic properties and the implementation of conservation strategies to protect these invaluable botanical resources.

Habitat of medicinal plants

Among the 122 identified medicinal plants, 92 (75.4%) were sourced from wild environments, 20 (16.4%) were obtained from both home gardens and wild areas, 6 (4.9%) were exclusively from home gardens, and 4 (3.3%) were procured from markets. The findings indicate that local populations predominantly rely on wild vegetation for medicinal plants rather than cultivating them in home gardens. Informants reported that wild habitats are adversely affected by human activities, leading to a reduction in their size due to increasing population pressures. Although attempts were made to cultivate these plants, informants noted that the plants struggled to thrive due

Table 2 List of medicinal plants utilized for the treatment of different diseases in the study area

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
Acanthaceae	*Justicia schimperiana* (Hochst.ex A. Nees) T.Anders	Shersharo (Kf)	SH	LF	Fresh	Fresh leaves are subjected to heat from a flame, after which salt is applied and the leaves are secured around the swollen area.	Dermal	Wound	HG & Wild	YA25
				RT	Fresh	The crushed root, when combined with water and milk, is consumed orally.	Oral	Rabies		
				LF	Fresh	The leaves and shoots are subjected to crushing and boiling in a mixture of water, salt, and butter, with a single glass being ingested over a period of three consecutive days. The recommended antidote is milk.	Oral	Malaria		
Alliaceae	*Allium cepa* L.	Chele Dukusho (Kf)	H	Bu	Fresh	Ingest the basal leaf (bulb) of this specific plant species.	Oral	Headache	Market	YA18
Aloaceae	*Aloe vera var. aethiopica* Schweinf.	Eret (Am)	H	Rt	Fresh	In the sixth month of gestation, livestock receive a blend of powdered fresh roots that have been ground and subsequently diluted with water following a filtration process.	Oral	Livestock Rh disease	HG	YA98
Amaranthaceae	*Achyranthes aspera* L.	Begegecho (Kf)	H	LF	Dry/fresh	Crushed and pounded dry or fresh leaves are subsequently filtered, and the resulting infusion is consumed during the night.	Oral	Diabetes	Wild	YA01

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
Amaryllidaceae	*Allium sativum* L.	Nech-duqisho (Kf)	H	Bu	Fresh/Dry	Grind leaves of *Allium sativum* and *Ruta chalepensis* seeds together, take a small quantity of the mixture and wrap it in a new cotton cloth that has not been washed with water. Next, wrap the cloth around the head of the sick person three times, starting from the left side, and then tie it on the left elbow for three days. Finally, tie the cloth around the neck using a silk thread.	Oral	Evil eye	Market	YA17
Apiaceae	*Foeninculum vulgare* Miller	Shukeajjo (Shk)	SH	ST	Fresh	A latex component of the BStem has been applied to the infected area of the nail.	Dermal	Nail problem	Wild	YA50
	Coriandrum sativum L	Dimbilal (Am)	H	SD	Dry	The procedure entails the milling of the roasted seeds, followed by their amalgamation with water, and the subsequent oral ingestion of the resultant mixture.	Oral	Common cold	Market	YA100
				SD	Dry	Seeds are ground into a fine powder, mixed with water, and delivered orally to cattle, sheep, goats, and donkeys as a diluted solution.	Oral	Cough		
	Centella asiatica (L.) Urb.	Tepheleshe (Kf)	H	LF	Fresh	Crushed fresh leaves applied as a poultice around the affected eye.	Optical	Eye disease	Wild	YA03
Asparagaceae	*Asparagus racemosus* Willd.	Ufikaro (Kf)	H	ST	Fresh	The stem was damaged and subsequently applied to the infected area until healing occurred.	Dermal	Spider poison	Wild	YA41

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
Asphodelaceae	*Aloe kefaensis* M.G.Gilbert & Sebsebe	Ginwaro (Kf)	H	LT/sap	Fresh	The latex component was applied to the infected area, and this process was repeated by painting the latex onto the affected region consistently over a duration of three to four days.	Dermal	Ringworm	Wild	YA24
				LT/sap	Fresh	The latex component was applied to the wound, and the same latex material was consistently applied to the infected area over a duration of three to four days.	Dermal	Wound		
Asteraceae	*Vernonia auriculifera* Hiern	Dingerato (Kf)	H	LF	Fresh	The leaf was crushed, releasing its fluids onto the bitten area of the body.	Snake bite	Dermal	Wild	YA04
	Guizotia scabra (Vis.) Chiov.	Tuffo (Kf)	H	LF	Fresh	Crushed fresh leaves are combined with water and consumed as a beverage.	Oral	Intestinal worms	Wild	YA05
	Laggera crispata (Vahl) Happer & Wood.	Shetti Uphicho (Kf)	H	LF	Fresh	Heated leaves are applied to the facial areas.	Dermal	Headache	Wild	YA69
	Acmella caulirhiza Del.	Shishimo (Kf)	H	FW	Fresh	Chewing small portions of fresh fruit and swallowing them orally, as well as chewing and applying the fruit around the infected areas, can be beneficial. The fruit serves to cleanse any debris from the eye.	Oral	Tonsilitis	Wild	YA08
	Artemisia abyssinica Sch. Bip. ex A. Rich.	Shukindo (Kf)	H	LF	Fresh	Fresh leaves were crushed and inhaled through the nostrils.	Nasal	headache	Market	YA32
	Echinops kebericho Mesfin	Kaphero (Kf)	SH	RT	Fresh/Dry	The root was damaged, causing debris to scatter around the body or residence.	Dermal	Snake repellant	Market	YA47

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
	Artemisia afra Jacq. ex Willd.	Ae'macho (Kf)	H	LF	Fesh	The leaf fell and consumed for a duration of three days.	Oral	Intestinal parasite	Wild	YA65
	Bidens prestinaria (Sch. Bip.) Cufod.	Kello (Kf)	H	LF	Fresh	The leaf was subjected to a process of crushing, pressing, and the introduction of liquids through the ear over a duration of three days, albeit in minimal quantities.	Auricular	Ear disease	Wild	YA75
	Bidens macroptera (Sch.Bip. ex Chiov.] Mesfin.	Adey abeba (Am)	H	FW	Dry	The flower is ground into a fine powder and administered nasally as a treatment for cancer.	Dermal	Cancer	Wild	YA85
	Solanecio mannii (Hook.f.) C.Jeffrey	Amitibalo (Kf)	SH			Cows occasionally consume fallen leaves, which contributes to their milk production.		Intestinal parasite		YA91
	Ageratum conyzoides L.	Shetti Mitto (Kf)	H	Lf	Fresh	The foliage of *Allium sativum* and *Ruta chalepensis* is amalgamated with seeds and subsequently ground into a fine powder. This powder is then immersed in water for inhalation purposes. Moreover, the powder may be incinerated to produce a fumigatory effect. Additionally, the crushed blend can be enclosed within a cotton cloth and worn around the neck.	Nasal/ Dermal	Wound	Wild	YA94

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
	Vernonia amygdalina Del.	Gesi (Mj)	SH	LF	Fresh	Fresh leaves are crushed with water, then strained and consumed in the morning.	Oral	Intestinal parasites	HG & Wild	YA114
				LF	Fresh	Fresh leaves are combined with the leaf of *Croton macrostachyus*, subsequently pounded and filtered, and then administered orally.	Oral	Stomach problems		
				LF	Fresh	Fresh leaves are subjected to crushing, pounding, and boiling, followed by the consumption of the infusion and decoction in the morning.	Oral	Jaundice		
				LF	Fresh	Fresh leaves are crushed with water, followed by filtration and extraction.	Oral	Malaria		
				LF	Fresh	Fresh leaves are crushed with water, then filtered and consumed.	Oral	Intestinal parasites		
Balsaminaceae	*Impatiens ethiopica* Grey-Wilson	Ekeko (Kf)	H	Lf	Fresh	The leaf was crushed, combined with water, and consumed over a period of three days.	Dermal	Intestinal parasite	HG/Wild	YA53
	Impatiens rothii Hook.f.	Oc'ino (Shk)	Cl	RT	Fresh	The root component was prepared and consumed over a span of three days.	Oral	Blood pressure	Wild	YA68

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
Boraginaceae	*Cordia africana* Lam.	Deo (Kf)	T	LF	Fresh	The fresh shoot of this plant should be applied to the affected area through gentle rubbing until recovery is achieved.	Dermal	Ringworm	HG & Wild	YA11
				LF	Fresh	The fresh shoot of this plant should be applied to the affected area through gentle rubbing until recovery is achieved.	Dermal	Wound		
	Cynoglossum lanceolatum Forssk.	Shimgege (Am)	H	Rt	Fresh	Crush the root; combine it with water, and drunk in a single coffee cup.	Oral	Abdominal pain	Wild	YA111
	Cynoglossum coeruleum (Hochst.ex.A. rich.)	aye-charo (Sh)	H	LF	Fresh	Fresh roots are masticated and applied to the inflamed area.	Dermal	Body swelling	Wild	YA13
				LF	Fresh	The crushed leaves and roots of *Cynoglossum coeruleum* are subjected to boiling and subsequently used for fumigation through the nasal passages, or alternatively, the fresh roots and leaves of the plant can be applied as a cream to the affected area.	Nassal	Spider venom		
	Ehretia cymosa Thonn.	Wogamo (Kf)	T	Lf	Fresh	The leaf was crushed and soaked in a glass of water to create a solution intended for cattle.	Oral	Febrile illness/Mich	HG/Wild	YA106
Brassicaceae	*Brassica nigra* (L.) Koch	Shanafo (Kf)	H	SD	Fresh	Before consumption, immerse both the fruit and leaf of this plant in either milk or water, and then consume them on an empty stomach.	Oral	Intestinal ailment	Wild	YA96
	Lepidium sativum L.	Feto (Am)	H	Sd	Dry	The process involves grinding dry seeds, mixing the resulting powder with water, and consuming the solution orally.	Oral	Dysentery	Market	YA109

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
Campanulaceae	*Lobelia giberroa* Hemsl.	Shamburo (Kf)	SH	LF	Fresh	The leaf was crushed and steeped in half a cup of coffee.	Oral	Intestinal parasite	Wild	YA55
Caricaceae	*Carica papaya* L.	Papaya (Am)	T	LF	Dry	The leaves of *Carica papaya* are processed in conjunction with the bulbs of *Allium sativum*, being ground into a fine powder. This blend is subsequently boiled and mixed with honey. It is recommended to consume one coffee cup of this preparation each morning for a period of three days. The antidote for this mixture is Bulla, which is derived from Enset ventricosum.	Oral	Malaria	HG	YA117
				LF	Dry	Administer a half cup of freshly ground *Carica papaya* seeds to the affected animal, or alternatively, combine the crushed seeds with water to create a drench suitable for chickens.	Oral	Watery diarrhea		
Caryophyllaceae	*Stellaria mannii* Hook.f.	Dingermiko (Kf)	H	LF	Fresh	The foliage and stem were crushed, resulting in pigment being transferred onto the bitten surface of the body.	Dermal	Spider bite	Wild	YA77
	Stellaria sennii Chiov.	Shekiato (Kf)	H	RT	Fresh	LRoot experienced a crash, having consumed excessive amounts of alcohol over a three-day period while relying on fresh milk to mitigate the effects of the substance.	Oral	Jaundice	Wild	YA78

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
	Uebelinia kiwuensis T.C.E.Fr.	Mocho (Kf)	H	Lf	Fresh	The leaf was crushed and fell onto the impacted body.	Dermal	Wound	Wild	YA118
Celastraceae	*Catha edulis* (Vahl.) Forssk. ex Endl.	Chato (Kf)	SH	RT	Dry/fresh	Crushed dry or fresh roots are subjected to boiling, followed by filtration and cooling, after which the resulting liquid is consumed until recovery is achieved.	Oral	Amoeba	HG & Wild	YA09
	Maytenus arbutifolia (A. Rich.) Wilczek	Anamiagixo (Kf)	SH	LF	Fresh	The newly developed sections of the leaf were crushed and applied as a spray to the affected eye.	Optical	Eye disease	Wild	YA56
Commelinaceae	*Cyanotis barbata* D. Don	Nalato (Kf)	Cl	LF	Fresh	The TLeaf experienced a malfunction and became lodged in the nasal cavity.	Dermal	Headache	Wild	YA66
	Commelina benghalensis L.	Wuhaankur (Am)	H	Lf	Fresh	The leaf was meticulously crushed and securely bound with fabric until it returned to its initial condition.	Dermal	Hata	Wild	YA79
				St	Fresh	Administer the stem sap to the impacted area until full recovery is achieved.	Dermal	Ringworm		
Crassulaceae	*Kalanchoe petitiana* A. Rich	Kachamiitobo (Kf)	H	LF	Fresh	Fresh leaves are subjected to heat, followed by the application of salt, and subsequently secured onto the inflamed area.	Dermal	Wound	HG & Wild	YA26
Cucurbitaceae	*Cucurbita pepo* L.	Buqo (Kf)	H	SD	Dry	Dry seeds are prepared and consumed in the morning.	Oral	Tape worm	HG & Wild	YA12
				SD	Dry	Dry seeds are prepared and consumed in the morning.	Oral	Ascaries		

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
	Momordica foetida Schumach.	Umbrao (Kf)	H	WH	Fresh	The entire component is crushed and ground, subsequently filtered, and consumed.	Oral	Glandular swelling	Wild	YA28
				LF	Fresh	A series of tests were conducted over a three-day period, during which urine was applied to the apex of the leaf shoot to assess for the presence of jaundice.	Dermal	Jaundice		
				RT	Fresh	The root section has failed, resulting in damage to the surrounding facial area.	Dermal	Facial problem		
				LF	Fresh	To promote healing of the wound, it is advisable to extract the juice from the leaf of this plant and apply it directly to the affected region.	Dermal	Wound		
	Coccinia abyssinica (Lam.) Cogn.	Anchote (Am)	H	TB	Fresh/dry	The tuber of this plant is administered to individuals with injuries to aid in the recovery from fractured bones	Oral	Broken bone	Wild	YA43
				TB		Root tuber sections consumed consistently over several days.	Oral	Gastric		
	Lagenaria abyssinica (Hook.f.) C. Jeffrey	Tojo (Kf)	H	FR	Fresh/dry	The fruits were crushed with water and consumed using a small coffee cup over the course of three days.	Oral	Intestinal parasite	Wild	YA44
	Mukia maderaspatana (L.) M.J.Roem.	Gaato (Kf)	Cl	RT	Fresh	The root can be boiled and used to prepare a decoction or infusion for the purpose of cleansing the teeth.	Oral	Toothache	Wild	YA58

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
Cuppressaceae	*Juniperus procera* Hochst. ex Endl.	T'ido (Shk)	T	SD	Dry	Dry seeds are ground into a fine powder, which is subsequently blended with tea. This mixture is then consumed and inhaled through the nasal passages.	Oral	Asthma Pneumonia	Wild	YA104
				LF	Fresh	Fresh leaves are ground and pulverized before being combined with butter for oral administration.	Oral	Cough		
Dracaenaceae	*Dracaena steudneri* Engler	Astu (Sh)	Sh	ST	Fresh	The internal portion of the stem was crushed, and the resulting liquid was combined with Eragrostis teff bread, locally referred to as Gasho. This mixture was consumed over a period of three days using a small cup.	Oral	Jaundice	Wild	YA46
Euphorbiaceae	*Euphorbia ampliphylla* Pax	Gineato (Kf)	SH	LT/sap	Fresh	The combination of sap and butter administered orally.	Oral	Rabies	Wild	YA21
				RT	Fresh	Root tied on swollen part	Dermal	Body swollen		
	Euphorbia dumalis S.Carter	Abdombo (Shk)	SH	ST	Fresh	Application of stem cut and latex paint on the enlarged areas of the body.	Dermal	Wound	Wild	YA67
	Manihot esculenta Cranz.	Kech (Am)	Sh	TB	Fresh	The tuber of this plant is utilized in culinary practices and consumed for its potential to lower elevated blood pressure levels.	Oral	Hypertension	Wild	YA80

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
	Croton macrostachyus Del.	Waago (Kf)	T	LF	Dry/fresh	Leaves, whether dry or fresh, are crushed and ground into a powder before being applied. Additionally, latex extracted from the petiole or leaf is utilized.	Dermal	Wound	HG & Wild	YA101
				BR	Fresh	Fresh stem bark is crushed and pounded with water, subsequently filtered, and consumed in the morning after breakfast until recovery is achieved.	Oral	Amoeba		
				LF	Fresh	Fresh leaves are crushed, pounded, and filtered, followed by the process of drenching.	Oral	Stomach problem		
	Ricinus communis L.	Gulo (Or)	SH	RT	Fresh	Fresh roots are crushed and pounded, after which a decoction is prepared and consumed either in the morning or at night.	Oral	Pneumonia	HG & Wild	YA112
				RT	Fresh/dry	Fresh or dried roots can be chewed and applied to the affected area as a spray.	Dermal	Body swelling		
	Euphorbia tirucalli L.	Kinchib (Am)	T	Rt	Fresh	The root is chopped into small fragments, pulverized, and mixed with water to form a solution that is given orally to dogs and cats over a duration of three days, utilizing a single coffee cup for measurement.	Oral	Rabies	Wild	YA119

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
Fabaceae	*Erythrina abyssinica* Lam.	Bero (Kf0	T	BR	Dry	The bark of this plant is utilized in smoking practices as a means to repel snakes and counteract poison.	Dermal	Snake poison	Wild	YA20
				LF	Fresh	Freshly cut plant segments were crushed, resulting in a drop of liquid being introduced into the eye.	Optical	Eye disease		
	Millettia ferruginea (Hochst.) Hochst. ex Baker	Bibero (Kf)	T	BR	Fresh	Fresh stem bark is ground and mixed with water, then administered orally and applied topically on the skin.	Dermal	Ectoparasites	Wild	YA40
				BR	Dry	Utilize the bark to ignite a fire and employ it to grasp the teeth.	Oral	Toothache		
	Melilotus suaveolens Ledeb.	Cholo (Kf)	SH	SD	Fresh/dry	The fruit component was crushed, boiled in water, and consumed half a cup daily for a duration of three to four days.	Oral	Cough	Wild	YA57
	Senna didymobotrya (Fresen.) H.S. Irwin & Barneby	NA	Sh	LF	Fresh/dry	A preparation derived from the infusion of leaves may be ingested to alleviate gastrointestinal disorders.	Oral	Abdominal pain	Wild	YA81
Francoaceae	*Bersama abyssinica* Fresen.	Azamira (Am)	T	LF	Dry	Dry leaves were incinerated and combined with butter, subsequently applied under direct sunlight.	Dermal	Wound	Wild	YA07
Labiatae	*Pycnostachys eminii* Gürke	Boqale kako (Kf)	SH	ST	Dry	Stems were incinerated and animals were subjected to smoking.	Dermal	Skin disease	Wild	YA90
Lamiaceae	*Achyrospermum parviflorum* S. Moore	Atbatto (Shk)	H	LF	Fresh	The crushed portion of fresh leaves is applied to the wound.	Dermal	Wound	Wild	YA06
	Ajuga integrifolia Buch.-Ham.ex D.Don	kursi-charo (Sh)	H	LF	Fresh	Crushed fresh leaves consumed in small quantities each morning.	Oral	Stomach bleeding problem	Wild	YA16

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
	Clerodendrum myricoides (Hochst.) R.Br. ex Vatke	Agiwo (Kf)	Sh	RT	Dry/fresh	Crushed and pounded dry or fresh roots are boiled in water, then allowed to cool before the resulting decoction is consumed in the morning until recovery is achieved. The fresh stem bark emits a nasal aroma.	Oral	Pneumonia	Wild	YA116
				RT	Fresh	Fresh root is masticated and applied to swelling body.	Dermal	Swelling		
				LF	Fresh	Leaves are crushed and ground into a fine powder, which is then applied as a spray to the eye.	Optical	Eye problems		
	Leucas tomentosa Gürke	Shonku-charo (Sh)	H	LF	Fresh	Fresh leaves combined with *Ocimum urticifolium* are to be chewed and ingested in the morning.	Oral	Intestinal Parasites	Wild	YA27
	Ocimum urticifolium Roth.	Damo Gabo (Kf)	H	LF	Fresh	Fresh leaves are manually rubbed, and the resulting droplets are consumed; additionally, the leaves are applied to the skin and inhaled.	Oral	Fever	HG & Wild	YA30
				LF	Fresh	Fresh leaves are manually rubbed, and the resulting droplets are consumed, while the leaves are also applied to the skin and inhaled.	Oral	Headache		
	Ocimum lamiifolium Hochst. ex Benth.	Damo (Kf)	SH	LF	Fresh	The steam is generated by immersing the fresh leaves and stems in boiling water, after which it is inhaled.	Nasal	Fibril lines	HG & Wild	YA59

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
	Pycnostachys abyssinica Fresen.	Yearo (Kf)	SH	LF	Fresh	Fresh leaves were crushed, pressed, and combined with liquids and cheese before consumption.	Oral	Stomach bleeding	Wild	YA64
				LF	Fresh	After giving birth, the females engaged in a cleansing ritual that lasted for five days, during which they immersed themselves in water, while the leaves fell around them.	Dermal	Fibril illness		
	Satureja simensis (Benth.) Briq.	Neddo (Kf)	H	LF	Fresh	Leaves fell and languished for five days following their emergence.	Oral	Abdominal pain	Wild	YA70
Lauraceae	*Persea americana* Mill.	Avocado (Am)	H	Lf	Fresh	To prevent the ailment, it is advisable to prepare and consume one glass of tea derived from the leaves of this plant on a daily basis.	Oral	Diabetes	HG	YA122
Malvaceae	*Sida acuta* Burm.f.	Keravat (Am)	H	LF	Fresh	The area of the wound is addressed through the application of a solution obtained from the leaf.	Oral	Wound	Wild	YA82
Meliaceae	*Melia azedarach* L.	Nim (Am)	T	LF	Fresh	To prepare the mixture, crush the leaves of the plant and combine them with water. Consume this mixture following your breakfast.	Oral	Malaria	Wild & HG	YA84
	Ekebergia capensis Sparrm.	Ororo (Kf)	T	Seed	Dry	The dry seeds are ground into a powder and administered to the animal.	Oral	Cough	Wild	YA93
				LF	Fresh	To eliminate any plastics present in the stomachs of animals, fresh leaves are crushed and subsequently soaked.	Oral	Intestinal disease		

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
Menispermaceae	*Stephania abyssinica* (Dillon & A. Rich.) Walp.	Kuda (Sh)	Cl	RT	Fresh	Fresh roots are masticated, and the extracted juice is ingested.	Oral	Sudden sickness	Wild	YA38
				LF	Fresh	Freshly picked leaves are manually rubbed, and droplets are applied to the skin.	Dermal	Skin cancer		
				WH	Fresh	Fresh and whole components are crushed and pounded, followed by infusion and decoction, which are consumed in the evening.	Oral	Jaundice		
				ST	Fresh	Chewing fresh stems and ingesting the resulting extracts.	Oral	Cough		
	Cissampelos mucronata A.Rich.	Nech hareg (Am)	Cl	Rt	Fresh	The root is masticated, and the resulting liquid is ingested, followed by applying it to the abdominal area.	Oral	Stomachache	Wild	YA120

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
Moraceae	*Ficus ovata* Vahl	Chaphero (Kf)	T	BR	Dry	The bark of this plant is ground into a powder and combined with water and milk for oral consumption.	Oral	Rabies	Wild	YA22
	Ficus sur Forssk.	Shola (Am)	T	FR	Dry	Dried fruits are ground into a fine powder and subsequently combined with honey, which is then consumed orally on two occasions.	Oral	Malaria	Wild	YA23
				FR	Dry	Dried fruits are crushed into a powder and subsequently formed into a paste for application on wounds.	Dermal	Wound		
				FR	Dry	Dried fruits are crushed into a powder and subsequently formed into a paste for application on wounds.	Dermal	Acute bleeding		
				BR	Fresh	Fresh stem barks are crushed, pounded, boiled, and subsequently cooled before being consumed as tea on two occasions.	Oral	Vomiting		
Moringaceae	*Moringa stenopetala* L.	Shiferaw (Am)	T	LF	Fresh	Freshly chopped leaves are prepared and consumed as a part of the daily diet.	Oral	Diabetes	HG & Wild	YA29
Musaceae	*Ensete ventricosum* (Welw.) Cheesman	Odu (Sh)	H	St	Dry	Bulla, a starchy powder prevalent in the region, is usually ingested alongside milk.	Oral	Broken bone set	Wild	YA49
	Musa accuminata Colla.	Muz (Am)	H	Fr	Fresh	Peel the fruit outer part and paint the affected skin.	Dermal	Eczema	HG	AA56
				Lax	Fresh	The latex of this plant added to cut skin to stop bleeding.	Dermal	Skin Bleeding		

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
Myrsinaceae	*Embelia schimperi* Vatke	Dupho (Kf)	SH	FR	Fresh/Dry	Fruits were blended with water, and the resulting liquid was consumed over a period of three days.	Oral	Intestinal parasite	Wild	YA48
	Measa lanceolata Forssk	Chego (Kf)	SH	LF	Fresh	The newly emerged shoot section was damaged and subsequently sprayed onto the impacted area of the body.	Dermal	Wound	Wild	YA76
Myrtaceae	*Eucalyptus globulus* Labill.	Nech bahrzaf (Am)	T	LF	Fresh	Fresh leaves were manually rubbed and then inhaled for their scent.	Nasal	Headache	HG & Wild	YA19
				LF	Fresh	Fresh leaves are manually crushed and inhaled for their aromatic qualities.	Nasal	Common cold		
	Psidium guajava L.	Zeytuna (Am)	T	Lf	Dry	The affected body is treated by applying a mixture of finely powdered plant part and fresh butter until complete recovery.	Dermal	Skin rash	HG	YA102
Oleaceae	*Olea europeasubsp. Cuspidata* (Wall.ex G. Don) Cif.	Woyira (Am)	T	LF	Dry/fresh	The utilization of dry or fresh branches as a means of oral hygiene serves to eliminate bacteria within the oral cavity.	Oral	Teeth problem	HG & Wild	YA31
				LF	Fresh	Boil fresh leaves and consume the infusion in the morning.	Oral	Stomach ache		
Phytolaccaceae	*Phytolacca dodecandra* L'Herit.	Shorshu (Sh)	Cl	RT	Dry/fresh	The root, whether dry or fresh, is masticated and subsequently ingested.	Oral	Bilharzia	HG & Wild	YA108
				BR	Dry	The stem bark is exposed to sunlight for drying, after which it is chewed and the resulting fluid is ingested over a period of three days.	Oral	Amoeba		

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
				RT	Dry	The dried root is crushed into a fine powder and subsequently combined with water, which is then consumed following breakfast.	Oral	Pneumonia		
				RT	Dry	The dried root is crushed into a fine powder and subsequently combined with water, which is then consumed following breakfast.	Oral	Stop pregnancy		
				BR	Fresh/dry	Fresh or dried stem bark or leaves are crushed and pounded, subsequently filtered, and administered orally while also being applied topically on the body.	Dermal	Black leg		
				BR	Fresh/dry	The fresh or dried stem bark or leaves are subjected to crushing and pounding, followed by filtration, and subsequently administered orally.	Oral	Leeches		
				RT	Fresh/dry	The dry or fresh root is ground and mixed with water, after which the mixture is filtered and consumed for a duration of four days for livestock and two days for human use.	Oral	Anthrax		
				RT	Dry/fresh	The dry or fresh root is ground and mixed with water, after which the mixture is filtered and consumed over a period of four days for livestock and two days for human use.		Sickness and Mastitis		

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
				RT	Dry/fresh	The dry or fresh root is ground and mixed with water, after which the mixture is filtered and consumed over a period of four days for livestock and two days for human use.		Rabies		
				RT	Dry/fresh	The dry or fresh root is ground and mixed with water, after which the mixture is filtered and consumed over a period of four days for livestock and two days for human use.		Stomach problems		
Piperaceae	*Peperomia retusa* (L.f.) A.Dietr.	Gargio (Kf)	Cl	ST	Fresh	The stem was masticated and its fluid ingested through the oral cavity.	Oral	Stomachache	Wild	YA61
				ST	Fresh	The stem was masticated and ingested along with its fluid through the oral cavity.		Intestinal problem		
	Piper capense L.f.	Turfo (Kf)	SH	FR	Dry	Fruits were crushed and combined with *Clerodendrum* myricoides, resulting in intoxication among animals.	Oral	Intestinal pain	Wild	YA89
Poaceae	*Arundinaria alpina* K. Schum.	Shinatto (Kf)	SH	LF	Fresh	Crushed fresh root is applied to the infected area.	Dermal	Wound	Wild	YA34
	Setaria megaphylla (Steud.) Th. Dur. & Schinz	Fotto (Shk)	H	RT	Fresh/dry	The root was either damaged or consumed, resulting in a spray being applied to the body.	Dermal	Snake problems	Wild	YA71

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
Polygonaceae	*Rumex nervosus* Vahl,	Ambuacho (Am)	SH	LF	Fresh	Fresh stems or leaves are crushed in a mixture of butter and water, subsequently creamed, and after a few hours, rinsed with water.	Dermal	Scabies/Itching	Wild	YA35
				LF	Fresh/dry	Fresh or dried leaves are crushed and subsequently either applied as a spray or secured onto the wound.	Dermal	Wound		
	Rumex nepalensis Spreng.	Goricho (Kf)	H	LF	Fresh	Fresh leaves are subjected to heat, after which the extracted fluids are administered into the ear canal.	Auricular	Ear problem	Wild	YA36
				RT	Dry/fresh	The dried or fresh root can be masticated and applied directly to the affected area.	Dermal	Body swelling		
	Persicaria setosula (A.Rich.) K.L.Wilson	Cercko (Shk)	H	ST	Fresh	The stem broke, and the children consumed its fluid.	Oral	Intestinal problem	Wild	YA62
	Rumex abyssinicus Jacq.	Ambatto (Kf)	H	Rt	Fresh	The pulverized root of *Rumex abyssinicus* is mixed with water and applied to the affected area through gentle rubbing.	Oral	Wound	Wild	YA97
Ranunculaceae	*Ranunculus multifidus* Forssk.	Fogio (Kf)	H	LF	Fresh	Fresh leaves are crushed, followed by infusion, and the resulting decoction is consumed in the morning until recovery is achieved.	Oral	Pneumonia	Wild	YA110
				LF	Fresh	Fresh leaves are manually crushed and inserted into the nostrils.	Nasal	Headache		

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
Resedaceae	*Caylusea abyssinica* (Fresen.) Fisch. & C.A.Mey.	Yamo (Kf)	H	LF	Fresh	Crushed fresh leaves are applied to the affected areas of the body, facilitating the expulsion of fungus from the skin.	Dermal	Ringworm	Wild	YA02
Rhamnaceae	*Rhamnus prinoides* L'Herit.	Gesho (Am)	SH	LF	Fresh	Fresh leaves were applied to the affected area of the skin.	Dermal	Wound	HG & Wild	YA33
Rosaceae	*Prunus Africana* (Hook.f.) Kalkm.	Omo (Kf)	T	ST	Dry	The dry stem bark is subjected to crushing, pounding, and grinding processes, after which it is transformed into a fine powder and subsequently applied to...	Dermal	Wound	Wild	YA107
Rubiaceae	*Coffea arabica* L.	Moye (Mj)	SH	WH	Dry	Entire sections are ablaze and emitting smoke.	Nasal	Malaria	HG & Wild	YA39
				SD	Dry	Seeds are crushed, masticated, and ingested.	Oral	Gastric illness		
				SD	Dry	Dried, ground seeds are administered nasally.	Nasal	Headache		
	Galium simense Fresen. .	Shatto (Kf)	H	RT	Fresh	The internal root section was scraped and applied to the wound for a duration of two to three days.	Dermal	Wound	Wild	YA51
				LT	Fresh	Latex extracted from the stem is placed in a specific container and consumed orally over a period of three days using a small cup.	Oral	Pneumonia		
	Hallea rubrostipulata (K. Schum.) J.-F. Leroy	Oppo (Shk)	T	BR	Fresh/Dry	Bark experienced a series of intense episodes, characterized by loud impacts, and consumed half a cup of liquid over the course of three days.	Oral	Jaundice	Wild	YA52
	Pavetta gardeniifolia Hochst. ex A.Rich.	Aemato (Kf)	T	LF	Fresh	Leaves were severed four times and placed in front of the patient beside the affected eye.	Optical	Eye disease	Wild	YA60

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
	Vangueria madagascariensis J. F. Gmel.	Gujjii machoo (Kf)	T	BR	Dry	Bark was crushed and combined with wheat flour, then boiled and consumed in one glass over the course of two days.	Oral	Ascaries	Wild	YA73
	Galinierea saxifraga (Hochst.) Bridson	Dido (Shk)	SH	LF	Fresh	Extract portions of the leaf that have been masticated and apply the resulting substance to the eyes of animals.	Optical	Eye disease	Wild	YA87
	Pentas schimperiana (A. Rich.) Vatke	Machibutto (Kf)	SH	LF	Fresh	The newly sprouted sections of the leaf, when harvested and consumed by cattle, contribute to the production of milk and possess properties that are effective in eliminating intestinal parasites.	Oral	Intestinal parasite	Wild	YA88
Rutaceae	*Citrus sinensis* (L.) osb.	Burtukanoo (Kf)	SH	FT	Fresh	Consuming fresh fruit juice on an empty stomach is a common practice.	Oral	Gastric illness	HG & Wild	YA10
	Clausena anisata Willd. Benth.	Embricho (Kf)	SH	ST	Fresh/dry	Utilizing a stem can effectively eliminate bacteria from the teeth through brushing three times a week.	Oral	Toothache	Wild	YA42
	Teclea nobilis Del.	Shengaro (Kf)	H	LF	Fresh	Leaves fell and were collected into a single teacup's worth for the animal.	Oral	Intestinal parasite	Wild	YA92

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
	Ruta chalepensis L.	Chedramo (Kf)	H	LF	Fresh	In the morning, individuals chew and ingest fresh leaves and stems.	Oral	Amoeba	HG	YA113
				LF	Dry	Dry leaves are brewed like tea and consumed.	Oral	Vomiting		
				LF	Fresh	Fresh leaves are ground into a fine powder and combined with oil, after which the mixture is consumed in the morning for a duration of three days.	Oral	Pneumonia		
				LF	Fresh	Fresh leaves are consumed directly by humans, while for livestock, they are pounded with water and administered orally, often combined with salt.	Oral	Stomach problem		
Sapindaceae	*Allophylus abyssinicus* (Hochst.) Radlk.	She'o (Kf)	T	RT	Fresh	The root, leaf, and bark components were combined, crushed, and subjected to friction over a period of three days.	Dermal	Skin problem	Wild	YA95
Simaroubaceae	*Brucea antidysenetrica* J.F.Mill.	Nukisho (Kf)	SH	LF	Fresh	Fresh leaves are crushed with water and administered orally.	Oral	Stomach problem	Wild	YA86
Solanaceae	*Datura stramonium* L.	Nafnifo (Kf)	H	LF	Fresh	Fresh leaves are crushed and applied as a paste to the scalp.	Dermal	Ringworm	Wild	YA14
	Datura metel L.	Dingerato (Kf)	H	WH	Fresh	Applying the entire plant portion to the area impacted by a snake bite.	Dermal	Snake poison	Wild	YA15
	Solanum incanum L.	Embuay (Am)	SH	RT	Fresh	The raw root is masticated and ingested.	Oral	Intestinal parasites	Wild	YA37
				LF	Fresh	Fresh leafs are rubbed and inserted in to nose.	Nasal	Nasal bleeding		

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
				FR	Fresh	Fresh fruits or foliage are applied to the area affected by snake bites through a rubbing motion.	Dermal	Snake bite		
	Solanum americanum Mill.	Acho (Kf)	H	LF	Fresh	Leaves were prepared and consumed as a regular part of the diet.	Oral	Gastric problems	Wild	YA72
	Withania somniera (L.) Dunal	Kumo (Or)	Sh	LF	Dry	In periods of illness, a therapeutic preparation can be created by finely grinding the leaves of *Withania somnifera* in conjunction with the leaves of *Artemisia abyssinica*, *Ruta chalepensis*, and the bulb of Allium sativum. This composite can subsequently be inhaled and secured around the neck with the aid of cotton fabric and silk thread.	Nasal	Evil eye	HG	YA83
	Solanum dasyphyllum Schumach. & Thonn.	Kumbaffo (Kf)	SH	LF	Fresh	The leaf was crushed and consumed by the animal.	Oral	Intestinal disease	Wild	YA99
	Lycopersicon esculentum Mill	Timatim (Am)	H	Lf	Fresh	Place the masticated leaf on the impacted area and maintain its position until full recovery is achieved.	Dermal	Spider poison	Wild	YA103
	Nicotiana tabacum L.	Timbaho (Am)	H	Lf	Fresh	The leaf of this specific plant is ground and mixed with water. Subsequently, a coffee cup filled halfway with the resulting liquid is administered through the nasal passage to eradicate the leech.	Oral	Leech	HG & Wild	YA105

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
Sterculiaceae	*Dombeya torrida* (J.F. Gmel.) P. Bamps	Shawuko (Kf)	T	LF	Fresh	The newly harvested leaves collide and blend with the foliage of *Setaria megaphylla*, creating a vibrant application on the surface.	Dermal	Snake bite	Wild	YA45
				LF	Fresh	The fresh leaves and bark of 'DIKINO' are initially ground using a mortar and pestle, after which they are combined with honey and administered orally to the patient.	Oral	Tuberculosis		
Verbenaceae	*Lippia adoensis* Hochst. ex Walp. var. koseret Sebsebe	Kosert (Am)	SH	LF	Fresh	A fresh leaf shoot was crushed and combined with milk, then consumed using half a coffee cup daily for a duration of seven days.	Oral	Blood pressure	Wild	YA54
				LF	Fresh	A fresh leaf shoot was crushed and combined with milk, then consumed using half a coffee cup over the course of three days.	Oral	Intestinal parasite		
	Verbena officinalis L.	Ambelacho (Kf)	H	Lf	Fresh	The leaf component was damaged and ingested orally.	Oral	Gastric	Wild	YA74
Vitaceae	*Cissus petiolata* Hook.f	Asqusa (Sh)	Cl	Rt	Fresh	Following the meticulous chopping of the root into fine pieces and the subsequent extraction of its juice, a total of one cup of the resulting mixture was ingested over a span of three days. The antidote recommended for this preparation consists of a combination of milk and honey.	Oral	Bloody diarrhea	Wild	YA63

Table 2 (continued)

Family	Scientific name	Local Name	HA	PU	CPU	Preparation and application	RoA	Diseases Treated	Source	Voucher Number
Zingiberaceae	*Zingiber officinale* Rosc.	Yanjibelo (Kf)	H	RZ	Dry/fresh	The dry or fresh rhizome is combined with salt and subsequently ground into a paste, which is then administered orally.	Oral	Intestinal problem	HG	YA115
				RZ	Dry/fresh	Rhizome is either chewed or ground into a powder, subsequently prepared as a tea and consumed.	Oral	Common cold		

Habit (HA) (T, Tree; SH, Shrub; H, Herb; Cl, Climber), PU, Parts used ((LF, Leaf; RT, Root; BU, Bulb; BR, Bark; FR, Fruit; SD, Seed; ST, Stem; LT, Latex; BU, Bulb; Fw, Flower; WH, Whole part; RZ, Rhizome; TB, Tuber). RoA, Route of administration. Source: W, Wild and HG, Home garden. CPU, Condition of plants used; Local Name: Or, Afan Oromo; Am, Amharic; Shk, Sheka; Kf, Kaffinnono; Sh, Sheko; Mj, Majang; NA, not available to their natural growth in mountainous and shaded areas, which are not conducive to the local soil types and climate. This observation aligns with previous research conducted in Ethiopia [20, 21, 34, 35], as well as studies from other regions [36, 37]. Consequently, there is an urgent need for action to conserve these natural resources and ensure their availability for future generations.

Growth forms of medicinal plants

The results revealed that the medicinal plants employed for the treatment of various ailments consist of herbs (47, 38.5%), shrubs (40, 32.8%), trees (23, 18.9%), and climbers (12, 9.8%). The prevalence of herbal medicinal plant species in the Bita district may be attributed to the region's favorable climatic conditions, characterized by consistent high rainfall, which supports the growth of diverse plant varieties. This pattern suggests a higher availability and abundance of herbs in the ecosystem compared to shrubs and trees. Numerous researchers have observed that herbs are the predominant growth form employed in the treatment of various health issues, both in local [35, 38–41] and global contexts [33, 42]. This observation is encouraging for plant conservation efforts, as herbs typically have shorter growth cycles and require less space for cultivation than shrubs and trees. Consequently, the sustained high rainfall throughout the year fosters an environment conducive to the proliferation of herbaceous medicinal plants in the Bita District, which constitute over half of the total species utilized and promote a rich diversity of plant life. In contrast, greater number of studies has indicated the utilization of shrubs and trees both at local [25, 43–45] and global scales [37, 46–48]. This trend may be attributed to their consistent annual availability and resilience against drought conditions and invasive alien species, which renders them suitable for extensive application. Additionally, this observation points to a variation in the use of medicinal plants, influenced by cultural differences, agroecological contexts, topographical characteristics, and accessibility to these species [14, 25, 43, 45]. Consequently, the wide array of medicinal plants, encompassing herbaceous species in certain regions and shrubs or trees in others, underscores the rich botanical diversity available for medicinal applications and highlights the significance of safeguarding traditional knowledge for future generations.

Plant parts used for remedies

The results of the study revealed that different parts of medicinal plants (MPs) were recognized as the main components employed to tackle various health issues. The analysis of plant components, determined by the overall frequency of references made by informants, revealed that leaves (53.6%) were the most frequently utilized part of the plant, followed by roots (17.2%), bark (8.2%), seeds (6.6%), and fruits (4.4%). Leaves emerged as the most frequently mentioned plant parts for remedy preparation. This preference for leaves may be attributed to their widespread use, ease of preparation, and the effectiveness of their phytochemical properties. While the use of leaves for medicinal purposes is generally sustainable, it is important to consider that overharvesting can compromise the health of the plant and hinder its reproductive capabilities. This information is corroborated by findings from various researchers, including [21, 22, 43], as well as studies conducted in other countries [41, 49–52]. Research indicates that roots are more prevalent in traditional medicine compared to other plant components, such as stems and whole plants. This assertion is corroborated by the findings of various scholars, including those referenced in studies [20, 53] and additional global research [36, 54, 55]. The prevalence of roots in medicinal applications may be attributed to their ability to remain viable underground during extended dry periods, ensuring a consistent supply throughout the year. Nonetheless, the sustainability of medicinal plants is threatened by the overexploitation of roots for medicinal use, coupled with environmental degradation resulting from agricultural expansion. For instance, in the local markets of the Bita district, the root of *E. kebericho* is highly sought after. Furthermore, studies conducted in other regions of Ethiopia and globally have demonstrated that the excessive harvesting of root parts poses a significant risk to the survival of medicinal plant species [14, 36].

Form of remedy preparation

The inhabitants of the Bita district employ four primary techniques for the preparation of traditional medicines, crushing (49.1%), concoction (24.9%), powdering (19.3%), and decoction (6.7%). Herbal practitioners in this region utilize straightforward methods and locally crafted tools, such as mortars and pestles, to crush plant materials along with common additives like honey, coffee, salt, and butter. These supplementary ingredients not only enhance the flavor of the remedies but also increase their nutritional benefits for the patients. A parallel can be drawn with the Gamo people of Ethiopia, who similarly incorporate items such as meat, honey, and butter into their traditional medicinal preparations to augment both taste and nutritional value [11]. Crushing is primarily viewed by local healers as the most common method for preparing herbal medicines, as it efficiently and quickly extracts the active compounds from plant materials. Following this, powdering is the second most frequently used technique, which aids in preserving the active constituents found in dried plants. For instance, when creating remedies for the evil eye, the leaves of *A. sativum* and the leaves of *R. chalepensis* are ground together. A small amount of this mixture is then wrapped in a new cotton cloth that has not been washed with water. The cloth is placed around the head of the afflicted person three times, starting from the left side, and then tied to the left elbow for three days. Finally, the cloth is secured around the neck using a silk thread. Additionally, to treat malaria, the leaves of *C. papaya* are combined with the bulbs of *A. sativum* and ground into a fine powder. This mixture is then boiled and sweetened with honey. It is advised to consume one coffee cup of this preparation each morning for three days. The antidote for this mixture is *BULLA*, which is obtained from E. ventricosum. These findings align with similar studies conducted both locally and internationally [27, 56–58]. To ensure the preservation of these invaluable resources for future generations, it is crucial to promote conservation efforts and sustainable harvesting practices. A variety of remedies incorporate numerous additives such as bread, milk, water, coffee, food, tea, salt, butter, honey, and sugar. These additives play a crucial role in diminishing the potency of the medications, enhancing their flavor, and mitigating adverse effects. Certain informants assert that the administration of medicinal plants in conjunction with food yields superior results compared to their isolated consumption. For instance, the dried fruits of Ficus sur are pulverized, combined with honey, and ingested to address malaria. Comparable observations have been documented in previous studies [56, 59, 60].

Informants have provided insights into various skills associated with herbal preparation during the data collection phase focused on medicinal treatments for human health issues. Notably, the formulation of remedies often involves the use of individual plants or their combinations. Herbal practitioners frequently blend different species to enhance the therapeutic efficacy of their concoctions. The analysis revealed that a significant majority of remedies (91.2%) were derived from a single plant species, while only 8.8% utilized a mixture of different plants. These results are consistent with findings from previous studies [57, 60, 61]. Herbalists employ different parts of plants to create remedies under diverse conditions. The data indicate that out of 122 species examined, 92 (75.4%) were utilized in their fresh state, 13 (10.6%) in both fresh and dried forms, and 7 (5.7%) in dried form only. Patients tend to favor remedies prepared from fresh materials, and most herbaceous species are predominantly used in their fresh state. This preference may be attributed to the region's unimodal rainfall pattern, which allows for the plants to remain evergreen year-round. The local communities' reliance on fresh plant parts can be understood in light of their belief in the superior therapeutic properties of these fresh materials, despite the risk of diminishing these valuable medicinal plants due to such dependence on fresh resources [19, 62, 63].

Routes of administration of herbal remedies

A diverse array of techniques is employed to enhance the therapeutic efficacy of medicinal plants, with routes of administration serving as a significant component of traditional medicine. The research indicates that these plants are utilized in multiple ways within regional healthcare practices, encompassing external applications and oral consumption. This variety in administration methods contributes to the flexibility of traditional medicine. In the study area, oral administration was the most prevalent, followed by dermal and nasal routes (Fig. 3). Oral administration involves administering treatments either by drenching livestock or utilizing powders and decoctions. Similar observations have been reported globally [33, 37, 64] and within Ethiopia [18, 19, 29, 63], confirming that the oral route is the predominant method for administering medicinal plant preparations. This preference may be attributed to the high incidence of internal illnesses in the study area, as well as the effectiveness of oral and dermal methods in rapidly interacting with pathogens' physiology and enhancing therapeutic efficacy. Dermal administration is favored due to its ease of application for patients and its lower risk of toxicity and absorption issues.

Dosage measurement for medicinal plants

Traditional healers in the research area determined and established the dosages of medicinal preparations

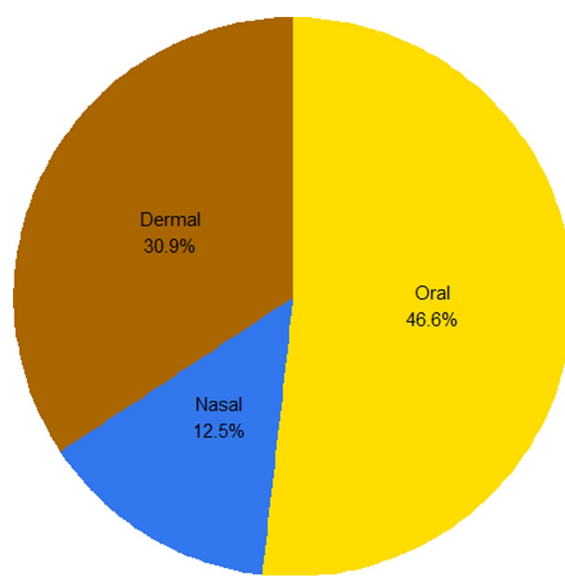

Fig. 3 Most cited routes of administration

utilizing various units of measurement. These included finger length for root and stem bark, a pinch for powdered plant materials, numerical counts for leaves, seeds, fruits, and flowers, and a cup for decoctions and infusions of plant components. While these healers maintain that traditional medicines are effective, the methods employed to ascertain dosages lack standardization. The dosages are influenced by several factors, including the patient's age, physical condition, stage of illness, pregnancy status, and the presence or absence of other concurrent diseases. This observation is consistent with the findings reported in [10, 18, 19, 56, 62]. To mitigate the adverse impacts of various ailments, traditional healers employ a diverse array of substances, such as milk, coffee, honey, meat, *Bulla* an indigenous product derived from *E. ventricosum* and *'Dooco',* a locally brewed beer. These practitioners frequently emphasize the absence of side effects associated with their traditional remedies. They assert that antidotes are utilized to neutralize any potential negative reactions from medicinal preparations, including *C. papaya* and *C. macrostachyus*, which are administered for conditions like rabies and malaria. Such practices underscore the necessity for standardization while simultaneously showcasing the richness and cultural diversity inherent in traditional medicine. To guarantee the safety and efficacy of the treatments provided by traditional healers, it is essential to establish a regulatory framework that respects and incorporates their unique cultural practices and knowledge.

Application of plant remedies

The herbalist employs visual assessments of the patient's skin and eye pigmentation, as well as the examination of the tongue and throat regions, alongside body temperature measurements, to arrive at a diagnosis. Additionally, the herbalist engages the patient in discussions regarding their symptoms. This approach is consistent with findings from various ethnobotanical studies conducted across different regions of the country. Such observations corroborate previous research [14, 19, 56, 65]. Traditional healers utilized a variety of methods to prepare and administer medicinal plants to patients. Common practices included drinking, painting, and chewing, swallowing, topical application, inhalation, smoking, and binding the herbs to the affected area. The findings indicate that drinking, chewing, and swallowing were prevalent methods for addressing internal ailments. For skin infections, including snake bites, the affected regions were often rubbed and painted. Techniques, such as crushing, pounding, decoction, and infusion, were employed for oral administration in the treatment of conditions like pneumonia and jaundice.

A variety of methods were utilized to address different ailments, including the treatment of the evil eye and headaches through the use of aromatic substances. For the elimination of intestinal parasites, the powdered or chewed forms of the stems and roots of *V. madagascariensis* and *B. abyssinica* are employed. Local practitioners maintain that the application of either the same or different parts of a medicinal plant can effectively address multiple health issues. For instance, *C. macrostachyus* and *P. dodecandra* are administered in various forms such as ingestion, topical application, or mastication of leaves, roots, and stem bark to treat intestinal parasites, diarrhea, and blood clots. To enhance the efficacy of these treatments, herbalists in the region recommend that patients adhere to specific guidelines, including fasting and avoiding food and drink, particularly in the morning. An example of this practice is the preparation of a remedy using *P. dodecandra* and *A. sativum* which is prescribed for intestinal parasites. Patients are instructed to consume this remedy prior to breakfast and to fast for an extended period, typically four hours, to facilitate the expulsion of worms from the gastrointestinal tract.

Marketability of medicinal plants

Among the medicinal plant species evaluated for their commercial viability in treating various health conditions, only four were identified as being actively traded for their therapeutic properties. These species are *Echinops kebericho* Mesfin, *Olea europaea*, *Clausena anisata* (Willd.) Hook.f. ex Benth., *Artemisia abyssinica* Sch. Bip. ex A. Rich, and *Withania somnifera*. In local markets, the average cost for a single root of *E. kebericho* was approximately 20 Ethiopian Birr. Conversely, a bundle of leaves from *A. abyssinica* and *W. somnifera*, along with a segment of stem from *O. europaea* and *C. anisata*, was available for 15 Birr. The other medicinal plants documented were predominantly sold in bulk for non-medicinal purposes, including culinary uses, spices, and beverages. Nonetheless, they were also employed as traditional medicine when necessary. Notable examples of these species include *Solanum americanum* Mill., *Allium sativum* L., *Ruta chalepensis* L., and *Coccinia abyssinica* (Lam.) Cogn. This finding is in line with the report of [14, 18, 19, 22, 66, 67].

Efficacy of herbal medicines

The analysis of the informant consensus factor (ICF) involved categorizing diseases into ten distinct groups (Table 3). This classification was informed by various criteria, including the nature of the disease, its causative factors, the specific anatomical location affected, and the symptoms and signs exhibited by the individuals suffering from these conditions. The ICF value reached a

Table 3 Informant consensus factor values of medicinal plants

Diseases category	Nt	Nur	Nur-Nt	Nur-1	ICF	%	Rank
Integumentary system	10	94	84	93	0.90	90	1st
Sense organs	13	118	105	117	0.89	89	2nd
Digestive system	3	16	13	15	0.86	86	3rd
Respiratory systems	6	35	29	34	0.85	85	4th
Febrile illness	5	26	21	25	0.84	84	5th
Folk related	12	68	56	67	0.83	83	6th
Circulatory systems	6	23	17	22	0.77	77	7th
Ectoparasite and vector cause	8	19	11	18	0.61	61	5th
Excretory system	12	25	13	24	0.54	54	8th
Musculoskeletal system	3	4	1	3	0.33	33	9th

ICF, Informant consensus factor; Nur, Number of use reports by informants, Nt = Number of plant taxa or species used. One informant cited more than one ailment

maximum of 0.90 for the integumentary system category, with the sense organ and digestive system categories following closely at 0.89 and 0.86, respectively. Notably, a low ICF value among traditional healers indicates a limited degree of collaboration among indigenous practitioners in the dissemination of their TMPK. This lack of interaction may be attributed to geographical separation and the inclination of healers to safeguard their knowledge from potential exploitation. Additionally, traditional healers may utilize different species of medicinal plants in various contexts to address the same health issues. The study revealed that community members exchanged vital MPK for the treatment of prevalent ailments. While some plant species were deemed less effective than others, this does not imply a lack of efficacy, as only a limited number of valuable species were shared among selected healers, suggesting the presence of discreet practices. These findings align with the results reported in references [17, 20, 62, 68, 69].

Healing potential of medicinal plants

The fidelity level (FL) of medicinal plants (MPs) serves as an important metric for evaluating their effectiveness in addressing specific health conditions. This study identified several MPs with elevated FL values that are particularly effective in treating various health issues. Notably, *N. tabacum* and *C. papaya* demonstrated significant efficacy in managing leech infestations and malaria, respectively, as illustrated in Table 4. These findings indicate that plants exhibiting high FL values should be prioritized for conservation efforts, management strategies, and sustainable utilization, contingent upon thorough evaluation and validation of their bioactivities. Additionally, a lower FL indicates that a greater number of informants have reported the use of a particular MP compared to those with higher FL values. For example, *S. abyssinica* exhibited a diminished healing capacity for tonsillitis treatment. These observations corroborate the findings presented in references [66, 70].

Table 4 Fidelity levels of most cited medicinal plants (Key informants)

Scientific name	Human diseases	IP	IU	FL	%	R
Nicotiana tabacum L	Leech	12	12	1	100	1st
Carica papaya L	Malaria	15	17	0.80	88	2nd
Phytolacca dodecandra L'Herit	Rabies	18	24	0.75	75	3rd
Ocimum urticifolium Roth	Headache	11	15	0.73	73	4th
Vernonia amygdalina Del	Intestinal parasite	19	29	0.65	65	5th
Croton macrostachyus Del	Stomach problem	19	32	0.59	59	6th
Momordica foetida Schumach	Wound	12	24	0.50	50	7th
Commelina benghalensis L	Ringworm	16	35	0.45	45	8th
Acmella caulirhiza Del	Tonsilitis	12	33	0.36	36	9th
Stephania abyssinica Dillon and A.Rich	Jaundice	9	29	0.31	31	10th

R, Rank; FL, fidelity level; Ip, Number of informants who independently cited the importance of a species for treating a particular disease; Iu, Total number of informants who reported the plant for any given disease

Preference ranking

The findings indicated that the local community's selection of medicinal plants was shaped by their understanding of which species were most effective in addressing their health issues. For instance, *P. dodecandra* is utilized for the treatment of intestinal parasites (Table 5). Conversely, contrary to previous research (13), *B. pilosa* arose as the most preferred plant species for the management of wounds.

Direct matrix ranking

The inhabitants of the study region rely on forests for a variety of essential functions, including construction, medicinal applications, and charcoal production, and fencing, provision of shade, firewood, food, and agricultural implements. By employing direct matrix ranking (DMR) to assess five multipurpose plants (MPs) utilized for treating different health issues, it became feasible to discern which species are under greater stress compared to others in the area, as well as the specific threats facing these plants. The results indicated that the most favored multipurpose plant species in the Bita district were *P. africana* and *P. gardeniifolia*, while *C. africana* emerged as the most endangered. Beyond their medicinal applications, these species also serve various nonmedical functions. Consequently, species like *C. africana*, which are highly ranked, are anticipated to face significant threats in the near future, necessitating collaborative conservation efforts to protect these vital multipurpose plants. Previous studies [14, 71–73] corroborate the classification of *C. africana* as a multipurpose medicinal plant, aligning with the current findings. Conversely, *C. macrostachyus* was identified as the most versatile species in the analyses conducted by [20, 74]. Marketable medicinal plants, particularly those valued for their therapeutic properties, may be at greater risk. Informants noted that *E. kebericho* has become notably scarce in the Bita district due to high market demand for its roots, a finding supported by research from [14, 18, 19, 69, 75]. These outcomes suggest that the local community in the Bita district possesses a comprehensive understanding of the medicinal properties of plants and their importance for health and well-being. The study also underscores the urgent need for conservation initiatives to mitigate the overexploitation of these valuable plant resources.

Comparative analysis of medicinal plant species in bita and other regions of Ethiopia

Ethiopia is renowned for its diverse ecosystems and a rich tradition of herbal medicine. Various studies have highlighted the ethnobotanical knowledge possessed by local communities regarding the medicinal use of plants. For example, research in the Sheka zone of southwestern Ethiopia identified 266 medicinal plant species [19], while another study recorded 274 species in the Dawuro zone of the same region [30]. In the Sekela district of the West Gojam zone, northwestern Ethiopia, 121 medicinal plant species were documented as being utilized by locals to treat conditions such as rabies, snake bites, malaria, intestinal parasites, evil spirits, and wounds, emphasizing the importance of traditional knowledge [57]. Furthermore, comparative studies have been conducted to illustrate how local knowledge contributes to biodiversity conservation [14, 19]. Additionally, advanced pharmacological investigations have been carried out on the antibacterial properties, antioxidant potential, and phytochemical profiles of selected medicinal plants in the Dibatie district of the Metekel zone and in Habru District, North Wollo zone, Amhara Region, Ethiopia [35, 76]. Our research identified 122 medicinal plant species used by the community in Bita, which is consistent with previous studies that reported 23 and 188 species, respectively [11, 20].

The traditional uses of various medicinal plants in Bita reflect trends seen in other regions. For instance, *A. caulirhiza* is utilized for treating tonsillitis, consistent with findings from [14], while *D. stramonium* is used for ringworm, similar to its application in the Artuma fursi district of the Amhara Regional State in Ethiopia, as reported by [72]. A recent study in the Yeki district of southwestern Ethiopia highlighted the unique use of *P. abyssinica* Fresen, known locally as *Yearo*, which is used for typhoid by placing the leaves on the body alongside oral consumption [18]. Another study in the Guraferda

Table 5 Preference ranking of TMPs reported for treating intestinal parasites

Medicinal plants	Respondents (R_1–R_{10})											
	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}	Total	Rank
Embelia schimperi Vatke	5	4	5	5	5	4	5	4	5	4	46	1st
Leucas tomentosa Gurke	4	3	4	4	3	5	4	3	4	5	39	2nd
Teclea nobilis Del	3	5	3	1	4	3	3	5	3	2	32	3rd
Guizotia scabra (Vis.) Chiov	1	1	2	2	2	1	2	2	2	3	18	4th
Brassica nigra (L.) Koch	2	2	1	3	1	2	1	1	1	1	14	5th

district documented the use of *Cissampelos mucronata* for stomachaches, where the root is chewed, the juice is consumed, and the abdomen is gently smeared [14]. This ethnobotanical research has uncovered previously unreported phytomedicines used in Bita and nearby areas. In a separate study conducted in the Sheka zone of southwestern Ethiopia, [19] identified additional novel species used by local communities, adding to the growing literature on Ethiopian ethnomedicine. These studies not only record the plants used but also delve into their preparation and administration methods, providing valuable insights into traditional healthcare practices. Moreover, research into the pharmacological properties of these traditionally used plants is increasing. For example, a study on the antibacterial activity, antioxidant potential, and phytochemical screening of selected medicinal plants in the Dibatie district, Metekel zone, western Ethiopia, conducted by [35], showed that certain plants thought to treat human ailments contain bioactive compounds with confirmed efficacy. These findings support traditional claims and foster further investigation into their therapeutic potential.

The Jaccard's similarity index (JSI) was used to evaluate cultural similarities among various ethnic communities based on shared plant species and their medicinal applications. This comparative analysis reveals both similarities and differences between current findings and previous studies. The traditional medicinal uses of plants detailed in Table 2 were compared with 36 published ethnomedicinal sources at regional and national levels. The highest JSI recorded was 14.7% from a study in the Yeki district, southwestern Ethiopia [18], followed by 14.1% from research in the Ameya district, Oromia Regional State, Ethiopia [66], 14% from the Dalle district in south-central Ethiopia [53], and 12.7% from the Gera district [20]. Notably, Goro had a JSI of 11.9% [77], and the Sheka zone of Southwest Ethiopia recorded a JSI of 11% [19] (Table 6). Overall, the JSI showed a gradual decline from the southwestern, south-central, and southeastern regions to the western, northern, northwestern, and northeastern parts of the country. This trend aligns with findings from [45] in the Quara district, northwestern Ethiopia. The high Jaccard's similarity index (JSI) between the current study and the Ameya district [66] can be attributed to the close geographical proximity of these neighboring areas. The resemblances observed among various regions in southwestern, south-central, and southeastern Ethiopia can be elucidated through several factors, including geographical features, cultural traditions, and vegetation types. The parallels in ethnobotanical practices between the study area and certain other regions can be ascribed to a blend of influences, such as shared plant ecology, common linguistic affiliations, and intersecting customs. From an ecological standpoint, specific plant species may flourish under analogous environmental conditions, resulting in similar uses and cultural importance across diverse communities. For example, areas characterized by comparable climates and soil compositions typically support similar flora, which can affect local dietary habits and medicinal practices. Furthermore, language significantly contributes to the dissemination of ethnobotanical knowledge; communities with shared linguistic backgrounds may have inherited analogous customs and practices related to plant utilization. This linguistic bond can enhance the exchange of ideas and practices, thereby reinforcing the similarities in the perception and use of plants. Ultimately, it is the interaction of these ecological and cultural factors that shapes the ethnobotanical landscape, illustrating that both environmental conditions and cultural heritage play vital roles in the observed similarities across various regions [45, 72, 78]. The gradual decline in JSI from southern to northern regions likely reflects the effects of distance and geographical barriers that limit the exchange of information about ethnomedicinal plant usage [45]. These findings suggest that traditional medicinal plant use is generally more consistent in areas that are geographically close and culturally similar, while diversity tends to increase with greater distances and obstacles. This highlights the importance of considering regional and cultural factors when studying traditional plant-based healthcare practices. The shared use of certain species indicates a common cultural heritage related to traditional medicine in Ethiopia, while the unique practices identified in Bita point to localized knowledge that deserves further investigation. This chapter demonstrates that, although there is a strong foundation of shared knowledge about medicinal plants across Ethiopia, regional variations reflect adaptations to local environmental conditions and cultural traditions. Despite the rich legacy of traditional medicine, several threats jeopardize the sustainability of phytomedicinal resources in Ethiopia, including the study area. Deforestation, land degradation, and climate change pose significant challenges to biodiversity and the availability of medicinal plants. Research by [14, 19, 53] has shown that habitat loss due to agricultural expansion and urbanization has led to the decline of many plant species traditionally used for medicinal purposes. The insights from this comparative analysis highlight several potential avenues for future research, including biodiversity conservation, understanding how local practices contribute to the preservation of medicinal plant species, conducting phytochemical studies to investigate the bioactive compounds in

Table 6 Jaccard's similarity index comparing the current study with earlier research conducted in Ethiopia

Study area	Species number (a or b)	Common species (c)	Jaccard index	Similarity (%)	References
Bita	122	–	–	–	Present study
Abaya	188	32	0.093	9.3	[11]
Adwa	127	18	0.067	6.7	[61]
Ale	72	22	0.102	10.2	[21]
Ameya	78	33	0.141	14.1	[66]
Armachiho	78	18	0.082	8.2	[43]
Artuma fursi	92	21	0.089	8.9	[72]
Asagirt	103	27	0.107	10.7	[27]
Borecha	81	25	0.109	10.9	[26]
Dalle	71	32	0.14	14	[53]
Damo woyda	57	21	0.105	10.5	[74]
Dawuro	274	43	0.098	9.8	[30]
Dibatie	170	29	0.09	9	[78]
Ensaro	101	24	0.097	9.7	[63]
Fadis	40	16	0.089	8.9	[22]
Gamo	188	41	0.116	11.6	[11]
Ganta	173	28	0.086	8.6	[80]
Gechi	70	23	0.107	10.7	[28]
Gera	63	27	0.127	12.7	[20]
Goro	84	28	0.119	11.9	[77]
Guraferda	81	29	0.125	12.5	[14]
Gurage	244	45	0.109	10.9	[8]
Habru	134	23	0.082	8.2	[68]
Hamar	145	27	0.092	9.2	[25]
Kelala	82	21	0.093	9.3	[70]
Mojana	56	17	0.087	8.7	[60]
Nensebo	127	26	0.094	9.4	[69]
Quara	128	18	0.067	6.7	[45]
Quarit	112	20	0.078	7.8	[75]
Raya Kobo	91	19	0.082	8.2	[4]
Sedie Muja	69	23	0.107	10.7	[62]
Sekela	121	24	0.089	8.9	[57]
Sheka	266	48	0.11	11	[19]
Tulo	104	33	0.127	12.7	[65]
West Gojam	97	29	0.117	11.7	[56]
Yeki	98	38	0.147	14.7	[18]
Zuway	73	21	0.097	9.7	[34]

uniquely utilized species from Bita, and documenting cultural heritage to protect local knowledge systems related to ethnomedicine.

Implications of utilizing medicinal plants in the bita district of southwestern Ethiopia

The findings of this study on traditionally used phytomedicines in the Bita district of southwestern Ethiopia highlight important implications for environmental sustainability, food security, and public health. The region's rich biodiversity in medicinal plants emphasizes the significance of traditional knowledge systems in maintaining ecological balance and promoting sustainable practices. However, threats, such as habitat loss, overharvesting, and climate change, pose serious risks to local flora and the livelihoods that depend on them. In terms of food security, the study underscores the crucial role of traditional knowledge in utilizing plants for health and nutrition. A decline or loss of this knowledge could lead to decreased food security, as many medicinal plants also serve as food supplements. Furthermore, many of the phytomedicines utilized by the community are harvested or cultivated locally. A reduction in their availability could adversely affect local economies reliant on the harvesting and sale of these plants, exacerbating poverty and further threatening food security, as households may struggle to afford sufficient food and healthcare. Traditional knowledge about the preparation and consumption of these plants can significantly contribute to addressing malnutrition and promoting dietary diversity. Examples of medicinal plants that are also used as food include *C. abyssinica*, *S. americanum*, and *M. esculenta*. Economically, the sale of medicinal plants, like *C. sinensis*, *C. edulis*, *A. abyssinica*, and *E. kebericho*, provides income opportunities for local communities, assisting families facing food insecurity in obtaining essential goods. Encouraging sustainable harvesting and cultivation of these plants can foster resilient livelihoods, reducing reliance on external food sources.

The decline of these plants could reduce dietary diversity and worsen malnutrition, especially among vulnerable populations. The variety of medicinal plants found in Bita highlights the region's ecological richness. The local community's dependence on these native plants is essential for conserving biodiversity. Traditional knowledge encourages sustainable harvesting practices, helping to prevent overexploitation. Additionally, many medicinal plants are important for habitat restoration, contributing to soil stabilization and providing shelter for various wildlifes, which enhances overall ecosystem health. Medicinal plants also provide vital ecosystem services for the community, such as attracting pollinators critical for the productivity of both wild and cultivated plants, and improving soil health through processes like nitrogen fixation and the enhancement of organic matter. In terms of public health, this study stresses the importance of incorporating traditional medicine into formal healthcare systems. Many communities depend on these phytomedicines to treat various ailments, with their effectiveness often grounded in centuries of empirical knowledge. However, threats to these resources could lead to a greater reliance on synthetic pharmaceuticals, which may be less accessible or culturally accepted in these communities. Protecting and promoting the sustainable use of traditional medicines can improve public health outcomes by offering affordable and culturally relevant healthcare options. Thus, this study highlights the interconnectedness of environmental integrity, food security, and public health in the Bita district. Addressing the threats to traditionally used phytomedicines is essential for cultivating a sustainable future that respects local traditions while safeguarding both ecological and human health. This finding is consistent with the report by [18].

Relationship of informant sociodemographic variables and medicinal plant knowledge

Comparison of medicinal plant knowledge based on key and general informants

R software was utilized to conduct a t test aimed at examining the differences in MPK between key informants and general informants. The results of the t test indicated a statistically significant difference in MPK between the two groups ($t = 9.5$, $P < 0.05$). Key informants exhibited a notably higher average MPK score ($M = 5.4$, SD = 1.4) compared to general informants ($M = 2.6$, SD = 1.5) as presented in Table 7. These results align with the findings reported in studies [14, 27, 71, 79]. This suggests that key informants are perceived to utilize traditional knowledge more frequently than general informants, likely due to cultural factors and their extensive, immersive experience with plant resources. There are several significant implications arising from the pronounced knowledge gap between key informants and general informants. In the realm of medicinal plant knowledge, this disparity underscores the importance of recognizing and leveraging the expertise of key informants. These individuals play a vital role in preserving traditional knowledge and practices related to medicinal plants, as well as in promoting sustainable harvesting and cultivation methods. Furthermore, the substantial knowledge divide necessitates the implementation of targeted educational and capacity-building initiatives designed to enhance the understanding of medicinal plants among general informants. By equipping the broader community with relevant knowledge and skills, we can foster the sustainable utilization of medicinal plants and cultivate a deeper appreciation for traditional healing practices.

Table 7 Medicinal plants knowledge among informant groups (t test)

Characters	Informant groups	*N*	Mean± SD	*t* value	*p* value
Gender	Male	104	3.9 ± 1.9	4.0	*P < 0.05*
	Female	32	2.6 ± 1.5		
Experience of informant	Key informant	36	5.4 ± 1.4	9.5	*P < 0.05*
	General informant	100	2.6 ± 1.5		

Comparison of medicinal plant knowledge based on informants gender

A t test was conducted using R software to analyze the differences in MPK between male and female informants. The results indicated a statistically significant disparity in MPK scores across genders ($t = 4.0$, $P < 0.05$) as presented in Table 7. Specifically, male informants exhibited a higher mean MPK score ($M = 3.9$, $SD = 1.9$) compared to their female counterparts ($M = 2.6$, $SD = 1.5$). This finding aligns with previous studies [18, 40, 71]. Conversely, research by [67] suggested that women possess greater knowledge of MPs than men. Additionally, other studies have indicated that both genders have comparable levels of knowledge regarding MPs [61, 80]. A study conducted on ethnic tribes in Mizoram, India, found no statistically significant difference in knowledge between male and female informants ($p > 0.05$) [81]. These variations may stem from historical, social, or cultural factors influencing MPK knowledge between genders. Another possible explanation is that men may have more opportunities to engage with natural environments, such as fields or forests, which are habitats for wild MPs. Furthermore, some researchers [43, 77] have noted that medical knowledge tends to be passed down to sons rather than daughters, although this notion is not universally applicable. Women have historically been equally capable of exploring remote areas and gathering plant species. In fact, in many cultures, women have played significant roles in hunting and gathering activities. Therefore, it is essential to challenge the stereotype that only men can contribute to the collection of plant species and to acknowledge the contributions of both genders. To address the underlying factors contributing to this inequality, further investigation is necessary to inform the development of programs and policies that empower female informants and promote gender-inclusive strategies in resource management and traditional medicine.

Comparison of medicinal plant knowledge across various educational levels of informants

A one-way analysis of variance (ANOVA) was conducted utilizing R software to assess the influence of varying educational levels (illiterate, elementary, and high school and above) on the medicinal knowledge scores of informants. The ANOVA results indicated a statistically significant difference in ethnobotanical knowledge among the three educational categories ($F = 26.0$, $p < 0.05$). The sum of squares between the groups (education level) was notably greater ($SS = 156.4$, $MS = 78.2$) than the sum of squares within the groups ($SS = 399.6$, $MS = 3.0$), suggesting that the differences in knowledge regarding medicinal plants were significantly affected by the participants' educational backgrounds (Table 8). This finding suggests that variations in the understanding and knowledge of medicinal plants across different educational levels may stem from the role of formal education in shaping the acquisition and sharing of traditional medicinal knowledge. It is evident that individuals with formal education often perceive the traditional use of medicinal plants as outdated and detrimental, opting instead for modern medical facilities. This observation aligns with previous studies conducted nationwide [61, 67, 72, 82]. Furthermore, individuals with higher academic qualifications may possess limited knowledge of medicinal plants due to insufficient exposure to traditional practices within formal educational frameworks, particularly at the tertiary level. Cultural influences, such as the transmission of traditional knowledge within specific communities, also play a role in shaping awareness of medicinal plants across different educational strata. Consequently, individuals with higher education may become disconnected from traditional medical practices, largely due to the curriculum's focus on western medicine. The findings of this study carry significant implications for public health and educational policies, highlighting the urgent need for targeted interventions aimed at bridging the knowledge disparity regarding medicinal plants among individuals with varying educational levels. To foster a more cohesive healthcare framework, it is essential to integrate traditional medical knowledge into both formal educational curricula and healthcare practices. Further analysis through post hoc tests using Tukey's HSD revealed that the illiterate group had notably higher mean scores ($M = 4.1$, $SD = 1.9$, $p < 0.05$) in comparison with the elementary group ($M = 2.2$, $SD = 1.1$, $p < 0.05$) and the high school and above group ($M = 1.3$, $SD = 1.0$, $p < 0.05$) (Fig. 4). Importantly, significant differences in ethnobotanical knowledge were observed across all three educational

Table 8 Comparison of medicinal plant knowledge among different educational levels (one-way ANOVA)

Source of variation	Df	SS	MS = SS/Df	F ratio	*P* value
Between groups	*k* − 1 3 − 1 = 2	156.4	78.2	26.03	*P < 0.05*
Residual (within)	*n* − *k* 136–3 = 133	399.6	3.0		
Total	*n* − 1 136 − 1 = 135	556	81.2		

K, number of leve; n, Number of observation; Df, Degree of freedom; SS, Sum of squares; MS, Mean of square; Significant codes: 0.05

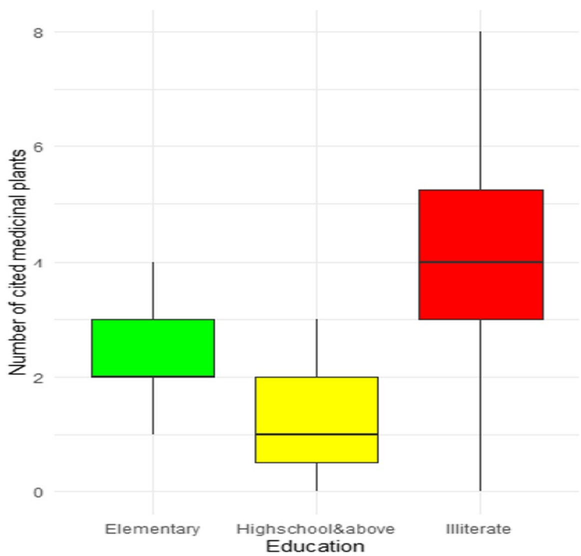

Fig. 4 Boxplot for education level

categories. Specifically, individuals in the high school and above category demonstrated significantly lower levels of ethnobotanical knowledge than those in the elementary category ($p < 0.05$) and the illiterate group ($p < 0.05$). Additionally, the illiterate individuals showed significantly greater ethnobotanical knowledge compared to both the high school and above group ($p < 0.05$) and the elementary group ($p < 0.05$). The association between educational attainment and knowledge of medicinal plants among informants was analyzed through correlation analysis utilizing R software. The findings revealed a substantial negative correlation, with a correlation coefficient of -0.48, indicating that higher levels of education are associated with a decrease in knowledge of medicinal plants among the study participants. Additionally, the statistical significance of this correlation is reinforced by a p value of less than 0.05, suggesting that the observed relationship is unlikely to be a result of random variation. These results provide compelling evidence to affirm the hypothesis that there is a significant relationship between education level and the knowledge of medicinal plants among the participants.

Comparison of medicinal plant knowledge among different age groups of informants

The analysis of variance (ANOVA) conducted in R revealed that age groups—young, middle-aged, and elderly—had a significant impact on TMPK scores ($F = 32.4$, $p < 0.05$). The results indicated that age-related differences in MPK were substantial, as demonstrated by the greater variance observed between age groups (SS = 200.2, MS = 100.1) compared to the variance within groups (SS = 411.1, MS = 3.09) (Table 9). Further analysis using Tukey's HSD post hoc tests showed that the elderly group exhibited significantly higher mean scores (M = 6.2, SD = 3.2, $p < 0.05$) than both the middle-aged group ($M = 3.4$, SD = 1.6, $p < 0.05$) and the young group ($M = 1.5$, SD = 0.9, $p < 0.05$) (Fig. 5). These findings suggest a potential decline in the perceived value of traditional knowledge across generations. Supporting evidence from international studies [32] and various authors [14, 18, 81, 82] indicates that older individuals are more inclined to utilize medicinal plants compared to their younger counterparts. This research corroborates those observations. The disparity may stem from the elders' extensive experience with local medicinal plants for treating various ailments through traditional methods, while younger generations appear to be increasingly disengaged from

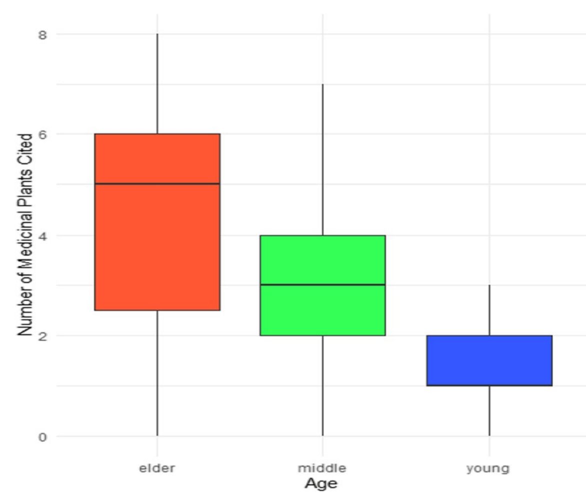

Fig. 5 Boxplot for age categories

Table 9 Age categories with informant knowledge (one-way ANOVA)

Source of variation	Df	SS	MS = SS/Df	F ratio	*P* value
Between groups	$k-1$ 3 − 1 = 2	200.2	100.1	32.4	*P < 0.05*
Residual (within)	$n-k$ 136 − 3 = 133	411.1	3.09		
Total	$n-1$ 136 − 1 = 135	611.3	103.2		

K, Number of level, n, Number of observation, Df, Degree of freedom, SS, Sum of squares, MS, Mean of square, Significant codes: 0.05

these practices, influenced by the forces of modernization and globalization. Younger individuals in local communities are increasingly drawn to contemporary educational opportunities, resulting in a diminished interest in traditional ethnomedicinal knowledge. This shift has led to their migration in search of diverse employment prospects. Consequently, the erosion of local ethnobotanical and indigenous knowledge is becoming a significant concern. The relationship between age groups and MPk exhibits a positive correlation, evidenced by a correlation coefficient of 0.8 (Fig. 6). This indicates that as individuals age, their understanding of MP knowledge tends to increase. Such findings align with the research conducted by [14, 25, 71]. Furthermore, the regression analysis results revealed that at a significance level of $p < 0.05$, the estimates for $\beta 0$ and $\beta 1$ were -1.56 and 0.12, respectively. The positive correlation between age categories and MPk, as indicated by the $\beta 1$ estimate, suggests that with each advancement in age category, the expected value of MPK rises by 0.12 (Fig. 7). Consequently, these results carry important implications for the transmission and preservation of TMPK, highlighting the need to prioritize and support older generations as vital sources of information.

Transmission of traditional medicinal knowledge in the study area

The transmission of ancestral knowledge concerning the use of medicinal plants in the research area primarily occurs through oral communication, as there are no written records available for consultation. The majority of participants convey this knowledge within their families,

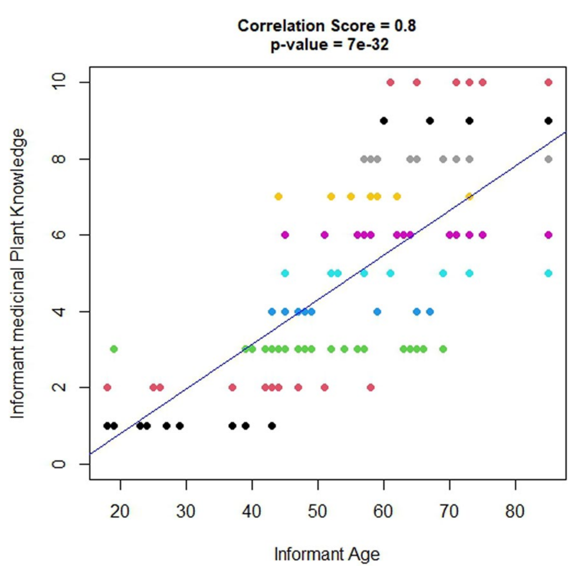

Fig. 6 Correlation model of informant age groups

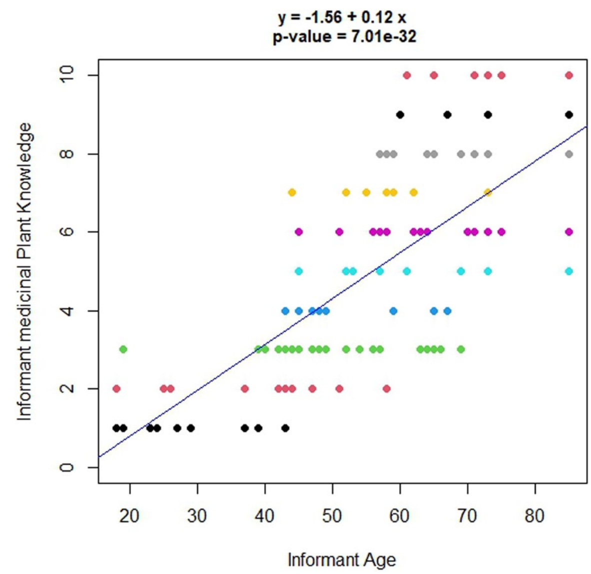

Fig. 7 Regression model of informant age groups

with the eldest sons often taking on the role of custodians of this information. A limited number of individuals also share traditional insights with trusted neighbors and relatives. These findings are consistent with the research conducted by [14, 19, 35]. Currently, the older generations in the Bita district hold significant indigenous knowledge regarding medicinal plants; however, this knowledge faces the threat of extinction with the passing of these knowledgeable elders. Most sources indicate that factors, such as the rise of modern medicine, advancements in education, religious influences, and societal modernization, have led to a decline in indigenous knowledge about medicinal plants in the region. A notable concern identified in the study area is that elderly traditional healers often choose to keep their knowledge confidential, fearing that its disclosure may weaken the healing properties of the plants and diminish their potential for economic benefit. Furthermore, the indigenous healers, referred to locally as *Dengo, Eqqecho,* or *Tenquay* (Magician), recognize the necessity of protecting their wisdom and rituals through secrecy. [89-90]. This observation is corroborated by the results of several other studies [10, 18, 22, 72].

Additionally, research suggests that younger individuals exhibit a reluctance to engage with and adopt traditional medicinal practices. This trend poses a risk of losing critical knowledge as older practitioners of these traditions may pass away without imparting their expertise. To effectively mitigate the erosion of traditional knowledge (TK) among younger generations, it is imperative to implement a holistic approach that integrates education, community engagement, and intergenerational collaboration. Initially, the inclusion of TK in formal educational curricula can provide young individuals with a structured understanding of their cultural heritage, ensuring they learn about local flora, traditional practices, and ancestral wisdom from an early age. Additionally, organizing community workshops and mentorship programs where elders share their knowledge with the youth can facilitate the direct transmission of skills and stories, thereby highlighting the relevance of TK in contemporary society. The incorporation of modern technology, such as digital storytelling and social media platforms, can further captivate younger audiences by making TK both accessible and relevant to their lives. Furthermore, promoting youth involvement in the documentation and preservation of TK through initiatives like community herbariums or local history projects can instill a sense of ownership and responsibility toward their cultural heritage. By executing these practical strategies, communities can foster an environment where traditional knowledge is not only preserved but also adapted and celebrated by future generations. Additionally, it is crucial to develop a comprehensive database that catalogs information on medicinal plants and their various uses. This resource should be easily accessible online or in libraries to promote public engagement [86-88]. Moreover, the transfer of this knowledge to younger generations can be enhanced through organized educational programs or mentorship with experienced traditional healers. Raising public awareness about the significance of traditional knowledge is also essential, which can be effectively achieved through educational outreach and media campaigns.

Threats and conservation practices of medicinal plants

Agricultural expansion has emerged as the most significant threat to plants utilized in traditional medicine, as indicated by respondents in the Bita district. This concern is closely followed by issues related to timber production and the harvesting of plants for firewood. Focus group discussions further corroborated that agricultural deforestation represents the primary conservation challenge facing medicinal plants in the region. Similar findings have been documented in Ethiopia [14, 26, 70], where agricultural expansion and timber collection are recognized as the principal conservation challenges for medicinal plant resources. The predominant driver of the decline in traditional medicinal plants in Ethiopia is agricultural expansion, largely due to the reliance of many communities on agriculture as their primary economic activity, compounded by limited land availability and a growing population [22, 50]. Participants in the study expressed that medicinal plants are under severe threat from the rapid proliferation of invasive alien species (IAS) in the Bita district, including *L. trifolia*, *S. didymobotrya*, *S. hirsuta*, *S. acuta*, *P. hysterophorus*, and *L. camara*. These IAS pose significant risks as they can rapidly spread and dominate thereby alter the ecosystem upon their introduction. Their capacity to outcompete native species disrupts the natural balance, placing native plants at risk of extinction [18, 58, 83, 84]. This observation aligns with previous reports and has been identified as a major factor contributing to the decline of herbaceous medicinal plants. Additionally, *P. juliflora* has been recognized by other scholars as another IAS that poses a threat to medicinal plants [74]. The research indicates that multipurpose medicinal plants are particularly vulnerable due to various threats, a conclusion that aligns with previous studies. Additionally, the use of herbicides and the removal of medicinal plants, which are often viewed as weeds, has been noted in agricultural areas, echoing findings from the Dibatie district in the Metekel zone of the Benishangul-Gumuz region in western Ethiopia [78]. This situation may arise from the local community's limited understanding of the ecological, economic, and health benefits of medicinal plants. Furthermore, challenges, such as wildfires, damage from animals, and infestations by insects or fungi, have been reported in the region. This scenario highlights the urgent need for conservation efforts to protect the availability of medicinal plants in both the study area and across the country. Interestingly, in the current study, out of the 122 medicinal plant species identified, a significant majority, 92 species (75.4%), were discovered to be uncultivated in the area. The findings suggest that the local community within the study area has not engaged significantly in community-based conservation efforts. This observation is consistent with the conclusions drawn in references [14, 57, 85]. Informants indicated that the Youngs have shown a reluctance to acknowledge or utilize traditional medicine, which raises concerns about the potential loss of critical knowledge when traditional healers pass away without imparting their expertise. A majority of informants from Bita district advocated for the adoption of Dr. Abiy Ahmed's green legacy initiative, which aims to conserve medicinal plants through cultivation in home gardens, along riverbanks, along roadsides, and within places of worship. They emphasized that raising awareness about these practices represents the most effective strategies for preserving plants utilized in traditional medicine. The cultivation of plant species with medicinal properties was pursued not only for their health benefits but also for their roles in culinary practices, aromatics, spices, economic activities, and a variety of other uses. Common cultivation techniques for these medicinal plants included home gardens (*R. halepensis*), coffee shade systems (*E. abyssinica*), live fencing (*J.

schimperiana, roadside planting (*E. globulus*), and intercropping within agricultural fields. The results indicate a deficiency in community-driven conservation initiatives by the local populace in the studied region, aligning with the observations noted in references [14, 57]. Therefore, it is imperative to enhance awareness about the importance of medicinal plants and the obstacles they face. This can be accomplished through educational programs, outreach efforts, and the utilization of media channels.

Limitation of the study

The research encountered several challenges, including communication issues and difficulties in data interpretation due to language barriers, a small sample size that may not fully represent the population, obstacles in accessing remote communities, the risk of losing indigenous knowledge as a result of rapid social and environmental changes, and ethical concerns surrounding intellectual property rights and informed consent. Despite these challenges affecting the research process, the study achieved its objectives by implementing alternative strategies, such as encouraging informants to participate, using translators, and navigating transportation difficulties by walking or renting horses and motorcycles. As a result, future researchers could investigate phytochemical analysis and antimicrobial testing of this important phytomedicine in the study area.

Conclusion and recommendations

The inhabitants of the Bita district possess a considerable wealth of traditional knowledge regarding medicinal plants, which continues to be preserved within the community. A total of 122 species of medicinal plants have been documented for their use in treating ailments affecting both humans and livestock. Traditional healers in the region often prefer specific remedies for certain conditions, including febrile illnesses, wounds, rabies, and spider bites, over those offered by modern medical facilities. The notable preference for species, such as *R. nervosus, C. asiatica*, *W. somnifera*, *P. dodecandra*, and *C. macrostachyus*, for various treatments suggests a need for further phytochemical studies, pharmacological research, and conservation efforts. An analysis of the sociodemographic characteristics of informants revealed statistically significant differences in medicinal plant knowledge based on gender, educational attainment, type of informant, and age groups. Additionally, the overexploitation of medicinal plant resources, driven by agricultural expansion, poses a threat to the diversity of these species. Concurrently, the erosion of knowledge regarding medicinal plants is exacerbated by factors such as secrecy, reliance on oral transmission of knowledge, and the younger generation's reluctance to engage with traditional practices. Herbaceous medicinal plants in the Bita district face significant threats due to the rapid proliferation of invasive alien species (IAS) such as *L. trifolia*, *S. hirsuta*, *P. hysterophorus*, and *L. camara*. Consequently, it is imperative to promote awareness initiatives aimed at conserving and safeguarding medicinal plants and the indigenous knowledge associated with them. This is particularly crucial for species that are frequently harvested for their roots, including *C. mucronata*, *R. abyssinicus*, and *E. kebericho*. Local communities in Bita should be actively involved in the preservation, management, and conservation of medicinal plant resources and the traditional knowledge linked to them. Additionally, the cultivation of multipurpose plants, such as *C. africana*, should be encouraged. Establishing community-based forest priority areas within the district to protect forests, especially those containing medicinal plant resources, is essential. By prioritizing conservation efforts and promoting techniques such as in situ and ex situ conservation that support traditional healers, it may be possible to mitigate the rapid decline of medicinal plants. Furthermore, enhancing public awareness is necessary to motivate the local peoples to manage and sustainably utilize these valuable resources.

Abbreviations

ANOVA	Analysis of variance
CSA	Central statistical agency of Ethiopia
FL	Fidelity level
IAS	Invasive alien species
ICF	Informant consensus factor
IK	Indigenous knowledge
PPV	Plant part value
TMPK	Traditional medicinal plants knowledge
TMPs	Traditional medicinal plants
FGD	Focus group discussion
JSI	Jaccard's similarity index

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Author contributions

All authors made significant contributions to this original research. AA drafted the manuscript and methodology, GG focused on language editing, verifying botanical names of plants, and conducting an overall review, YS managed data collection, KC also managed data collection,WT verified the data analysis, and HG created the climatogram for the study area. AT prepared the map of the study area. Each author has reviewed and approved the final manuscript.

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Declarations

Ethical approval and consent to participate
Before the commencement of data collection, authorization letters were obtained from the Bita district Administration Offices. Informants provided verbal consent prior to participating in interviews and group discussions, and their data were documented with their approval. Additionally, consent was secured from the informants for the publication of the individual data gathered from them.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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