The traditional uses of plant diversity in Gokwe South District, Zimbabwe: Timber & construction, ethnoveterinary medicine, firewood & charcoal, food, tools and handicraft, religious ceremonies & rituals & other uses.

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Research

Abstract

Background: Most people who reside in rural areas have over the years benefited from the utilization of forest products obtained from forests and surrounding woodlands. Both timber and non-timber forest products are important in livelihood maintenance, provision of security, reduction of poverty and malnutrition and help generate income. The aim of the study is to evaluate and document plants that are traditionally used by community in Gokwe South District, Zimbabwe and to assess their contribution to the livelihood and sustenance of the community.

Methods: Ethnobotanical data was collected from February 2022 till March 2022 through semi-structured interviews and data analysed through quantitative indices such as use value (UV) and relative frequency of citation (RFC). Field surveys were made to collect voucher specimens, which were identified, authenticated and deposited at the National Herbarium, Zimbabwe.

Results: A total of 89 plant species belonging to 81 genera and 44 families are traditionally used in Gokwe South District. The Fabaceae family is the highest plant species (15 species) followed by Anacardiaceae and Euphorbiaceae (five species each). Seven use categories were identified with the food category recording the highest number of plant species used (48 species) followed by tools and handicraft (29 species).

Conclusions: The study showed that the traditional use of plant is still a common practice in the district. The great diversity of plants gives the need for their conservation and sustainable use to be established and monitored.

Keywords: Plant diversity, use patterns, traditional uses of plants, Gokwe South District

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Background

Local indigenous people have over the years learned to experiment and use traditional plants from the forest for different benefits other than medicinal plants for their livelihood maintenance, security, poverty reduction and income generation (Houessou *et al.* 2019, Jamshidi-kia *et al.* 2018, Ouédraogo *et al.* 2020, Ullah *et al.* 2020). The use of plant resources can be traced back to ancient times were indigenous locals had free access to forest resources and ultimately developed many innovative uses of plants within their vicinity. Majimbe *et al.* (2018) has stated that these forest products are used for firewood, food and medicines and are important in providing a safety net in times of crisis such as droughts and hardships. Forests are important natural resources that help countries to achieve their Sustainable Development Goals (SDGs) (Simeons 2018). In light of numerous challenges that forest resources face due to their overexploitation, SDGs goals calls for new alternative ways that ensure there is sustainable consumption and production patterns (Aleksandrowicz *et al.* 2016). Furthermore, they advocate for the protection, restoration and promotion of sustainable use of terrestrial ecosystems (Dangi & Chaudhary 2018). In Southern Africa, the Miombo woodlands not only offer medicinal plants for the provision of health and well-being, but the same plants have also been utilized for other important benefits. These benefits include provision of food (Majeed *et al.* 2020), fodder, construction materials, high valued timber as well as small tools and handicrafts (Clarke *et al.* 1996, FAO 2010). An estimated population of over 15 million in Sub- Saharan Africa have earned income through sale of forest products such as firewood, charcoal and handicraft production (Kaimowitz 2003). The demand especially for timber and firewood have placed a lot of pressure on important medicinal plants and the subsequent continual harvesting for timber or firewood could lead to their populations dwindling and ultimately affect global bioprospecting of important medicinal plants (Bondé *et al.* 2020, Chomba *et al.* 2013). Due to the versatility in the use of medicinal plants, they are prone to overharvesting pressure and overuse often leading to adverse effects such as dwindling of their population and in extreme cases, it could lead to important plant species becoming extinct.

Potential threats posed on the plants such as anthropogenic factors and human disturbances such as illegal logging, poor harvesting practices, collection of plants for firewood and charcoal production, overgrazing by livestock have an impact on the sustainable use and conservation of plant species. These anthropogenic factors coupled with natural droughts, disease outbreaks and excessive wind have caused serious plant species decline that could lead to their extinction in the near future. As such, there a need to establish and formulate appropriate plant resources management and conservation strategies for their use to avoid overexploitation, misuse and overuse. A study by Forzieri *et al.* (2020) has shown that natural disturbances put valuable ecosystem services at risk. On the other hand some of the forests especially in tropical dry regions are less protected and are exposed to high degree of disturbances and loss of species richness (Jhariya & Singh 2021a-b, Rivas *et al.* 2020). However, it can also be observed from theories in ethnobotany that preferences of plant species use can be traced to the versatility, availability and ecological apparency hypothesis which help in explaining why most plant species are preferred than others (Alencar *et al.* 2010, de Albuquerque 2006, de Albuquerque & de Oliveira 2007). For the plant species to be selected for use by individuals, they base their preferences on the quality on which it would be used for, customs and belief systems which are noted to be different and vary between communities (Ahlberg 2017, Clarke *et al.* 1996).

Hart *et al.* (2017) noted that the versatility hypothesis helps in explaining why plants have many different uses and makes them to be multipurpose plant species. Multipurpose plants are those that have many non-medicinal uses attached to them which include uses as timber, construction material, food, firewood, religious ceremonies and rituals. The greater number of uses, the more vulnerable would be the plant species to overexploitation and species decline. At the same time some plants are preferred more than others because they are easily identified and located in the forests. The ecological appearance hypothesis proposed by Philips & Gentry (1993) can be applied to determine the behavior of humans on plant use and preference based on the plants that can be easily seen and identified in the forest. Those plants that are readily noticed are prone to be harvested more frequently and people would tend to experiment with them so that they can derive maximum uses from them. However, the readily available or most abundant plant species the greater the diversity of use it would have. This is why the most abundant plant species suffer from misuse and overexploitation because they are easily accessible and can be used for experimentation for new uses (de Albuquerque 2006, Voeks 2004). Various ethnobotanical indices have been put forward to test the versatility and ecological apparency hypothesis. These indices have been proposed to determine the plants usefulness and relative importance such as the use-value (UV), relative frequency of citation (RFC) and informant consensus factor (ICF). The use-value as proposed by Philips & Gentry (1993) is able to use knowledge from people on the number of uses each plant species has and quantify its relative value. Thus, ethnobotanical indices can help to predict the important plant species in a local community. The RFC is an index that can be used to show the local importance that a plant species has whilst the ICF is used to show the degree of agreement on the use of a particular plant species by informants in the study area. It is also used to predict the knowledge transfer between individuals in a community.

It has also been noted that most indigenous local traditional knowledge is being eroded and on the verge of being lost due to numerous factors such as rapid urbanization and the subsequent migration of indigenous people from rural communities to urban communities (Bersamin *et al.* 2020). Other factors include industrialization, rapid loss of natural habitat due to excessive population growth and expansion as well as changes in lifestyle as many people adopt modern lifestyles. The loss of indigenous knowledge is a cause for concern because over the years such valuable information has been passed down from a knowledgeable elder to the young ones by word of mouth without its proper documentation. As a result, important information such as the indigenous utilization of plants in the local community can gradually be lost, therefore, there is a need to urgently carry out a survey and document the available local knowledge. Teklehaymanot and Giday (2007) concurred that it is vital to document indigenous knowledge before it becomes hard to retrieve it. As such one method of harnessing this important knowledge is through ethnobotanical studies that involve documenting the plant-based knowledge on indigenous plant use. They also contribute to the preservation of important indigenous knowledge of plants being used in a local community with the ultimate goal of achieving conservation of this natural heritage. Documentation of folk knowledge is gaining popularity world over due to its usefulness in maintaining cultural heritage. With most countries ratifying to various convention, the Convention on Biodiversity (CBD) aims to preserve, maintain indigenous ecological knowledge of communities including their way of practices and innovations embodying their traditional lifestyle so that they accomplish conservation and sustainable use of their biodiversity. This is because indigenous communities have learnt to manage their own resources and have developed ways to avoid depleting them through use of local traditional practices such as use of traditional beliefs, culture, taboos and sacredness that help in guiding social behavior of people when using their forest resources for their sustainability and conservation (Mawere 2013).

Therefore, this study was carried out in two parts firstly it aimed at evaluating and documenting the different use categories of indigenous plants used in Gokwe South District, Zimbabwe. The wealth of local knowledge in the district was assessed to establish the different purposes that the local indigenous plants have and evaluate their contribution to the livelihood and sustenance of rural people. Secondly, the research was done to identify the factors affecting forests resources due to their harvesting methods and utilization and to evaluate the major conservation practices done in the district. The research findings will aid in increasing knowledge on the different plant uses, forming a basis that would help in formulating sustainable harvesting methods, sound management systems and help formulate policies on their protection for future generations. The documentation of the indigenous local knowledge and their uses in Zimbabwe helps to identify high priority needs for important plant species that will enable their conservation and prevent loss of oral knowledge and its subsequent erosion thereby promoting the rural livelihoods.

Materials and Methods

Study site

Gokwe South District is found in the Midlands Province and lies in the northern- eastern parts of Zimbabwe between 18°S and 19°S latitude and 28°E and 29°E longitude (Fig. 1). Gokwe South District has a total area of 11477 km^2 that has 6 urban wards and 33 rural wards found in five constituencies. It is mostly a rural area with its land composed of mostly communal land, indigenous forest reserves and agriculture reserves. The district lies in agro-ecological region (natural region) III and IV and part of its land lies on the Mapfungautsi plateau, and the other part lies in the Zambezi Valley. Region III mostly relies on semi-extensive livestock farming and growing of small grains that are drought resistance such as *Pennisetum glaucum* (millet) and *Eleusine coracana* (rapoko) (Mungundani *et al.* 2012). The average annual rainfall in Region III ranges from 500 - 750mm whilst dry mid-season spells are experienced. The parts that lie in natural region IV mostly lies in low areas and have an annual rainfall of between 450 - 650mm (Mungundani *et al.* 2012). Frequent seasonal droughts and dry spells are experienced in this region. Cattle production is done extensively with other communities involved in goat rearing as well as wildlife production. The soils are mostly covered in Triassic and Kalahari sands, with the sandy soils being generally acidic (Farrell 1968). The commerce and industry of the district is dominated by small formal entrepreneurship that are made up of retailer shops and wholesalers of international standards and other financial houses are found in the district.

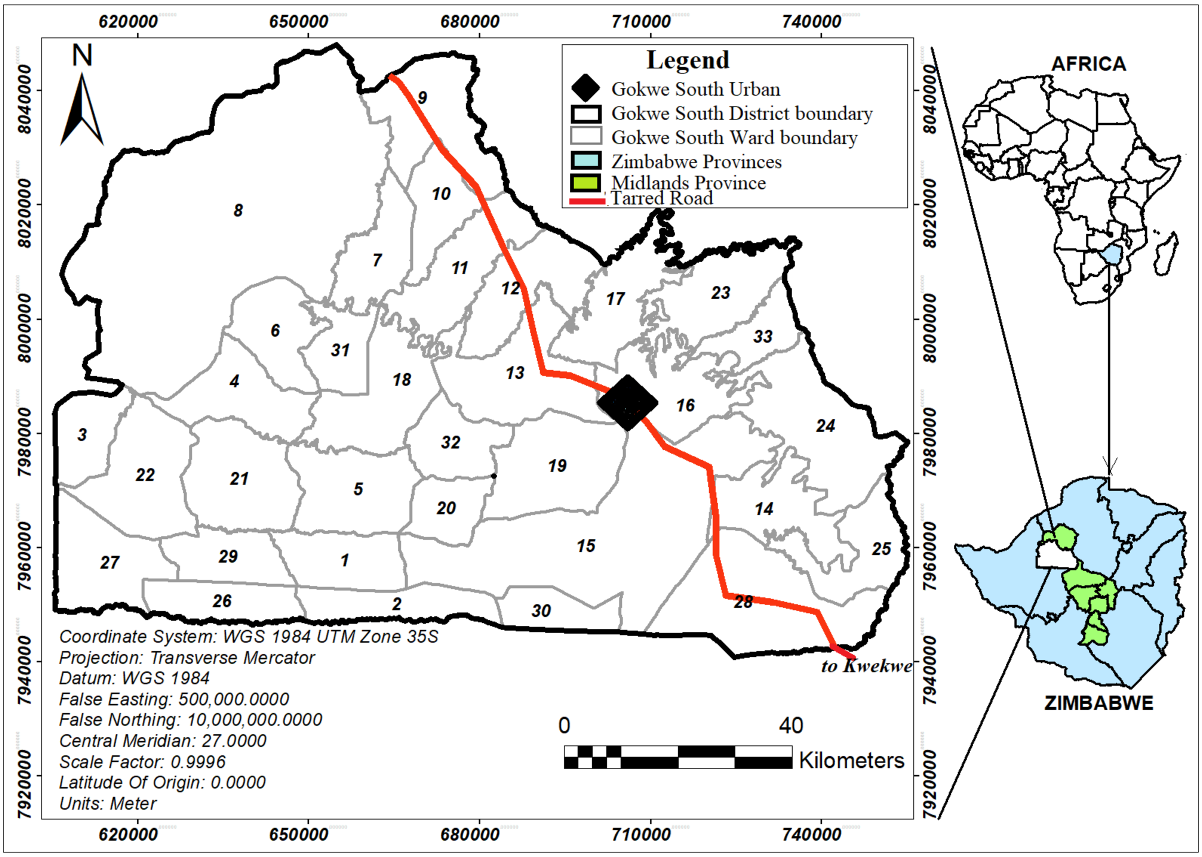

Figure 1. Map of Gokwe South District showing the ward numbers (1-33)

Ethnobotanical data collection

Data was collected from October 2020 to March 2022 and the study time is as follows; October 2020 was a preliminary survey that was meant to request for permission to conduct the study from the local administration, chiefs and headman. The semi structured questionnaires were pilot tested during this period, and this made the survey to be broken down into three distinct timeframes. October 2020 was a survey also done to access the feasibility of the study in the area and findings from the visit made the survey to be done in October 2021 - November 2021 to access and document medicinal plants used in the district and the survey for the period February 2022 - March 2022 investigated the medicinal plants used in the district for other diversity of uses. Thus, this ethnobotanical data was conducted during the months of February 2022 - March 2022 from randomly chosen wards that were sampled through the use of semi structured questionnaires and field surveys. Data was collected during the months of February 2022 to March 2022 and 35 participants including key and general informants were randomly selected comprising of different age groups, gender, ethnicity and marital status. The age groups were categorised into five different classes based on their ages which were 18-25 years, 26-35 years, 36-45 years, 46-55 years, 55-65 years and over 65 years. Key informants and general informants were selected based on their residence time in the district, knowledge of indigenous plants and the plants that were to be listed for other uses were strictly those species known to be used as medicinal plants. This was done so as to evaluate the indigenous plants` cultural importance and determine their possible threats and help to establish ways that are used to conserve them.

Survey methods comprised of individual interviews using semi structured questionnaires that comprised of open-ended questions. The design of the questionnaire was done in order to elicit local knowledge on how indigenous plants are used in the district and to list the plants found in the district. The various methods of using them such as preparation methods and their consumption was noted. The local practices of managing the forest resources so that they achieve their conservation and identification of major threats were also noted. Interviews were carried face to face with the participants using their local language and during data analysis, English language was used to translate the information and input data into Excel sheets. The informants that undertook the survey were randomly selected from marketplaces, the village wards and shopping areas based on their knowledge and willingness to share information on indigenous plant use in the district. Participation to undertake the survey was based on ethical consideration and the Midlands State University ethical clearance was sought (FSTech 007/01/21). Participation was based on being anonymous, confidentiality and was voluntary. Participants in the study were allowed to discontinue the interviews at any given time. The minimum age to participate was 18 years and there was no maximum age limit. Permission to carry out the study in the district was sought from the Rural District Council, local chiefs and village headmen and some were key informants.

Prior informed consent was sought from each informant and a consent form was signed as a way of agreement before undertaking the interview. The informants filled in the questionnaire that was structured in two parts with Part A that noted the socio-demographic data of the participants which included age, sex, ethnicity and marital status. Part B sought to establish information on the number of indigenous plants found in the district and how the local people used them. The mode of preparation and consumption was also investigated. The informants were required to list the known threats of indigenous plants in the district as they harvest them and the conservation methods that have been set in place.

The guided tour technique was employed and consisted of transect walks and field visits in order to observe the uses of indigenous plants, identify the indigenous plants and to collect voucher specimens. The guided walks were done through the assistance of key informants who assisted in in preliminary identification of all the plants using their local language in the field. During voucher specimen collection, information such as habit, location, color was noted. The plants were tagged with a voucher specimen number and pressed between sheets of newspapers and placed on a plant press so that they could dry off using standard procedures. The pressed voucher specimens were processed and deposited at the National Herbarium and Botanic Gardens, Harare (SRGH). The plant taxa were verified, identified and authenticated by specialist taxonomist at the herbarium following keys from Flora of Zimbabwe (https://www.zimbbweflora.co.zw) as well as use of Plants of the World Online (https://powo.science.kew.org).

The plants that were listed for use in the district during the survey were placed into categories prior to analysis. Seven use categories were noted which where food, timber and construction, tools and handicraft, ethnoveterinary medicine, religious ceremonies and rituals, firewood and charcoal and lastly other products. The food category included plants used as wild edible plants, leafy vegetables, used as teas, jam, fruits and nuts. The category other uses comprised of plants used as fodder, used for washing, used as tannins and dye, paper, paints, shade and ornamental plants. The conservation and major threats listed in the district were also categorized and coded based on their similarities of function.

Pilot testing
The pilot test was done in the district in order to test the validity and reliability of the questionnaires to be used in the study if the questions were appropriate. This was done during the visit to the Rural Administrator`s office and Chiefs compound when permission to carry out the study was being sought. The objectives of the study were explained to them, and the instrument tested among three focus group discussion with the elders and leaders of the different wards in the village. The focus group discussions were also used to triangulate the data obtained during the survey.

Data analysis
The data generated from the semi-structured questionnaires for the different plant uses were recorded and coded and placed into seven categories accordingly as described above. Conservation methods and threats of the listed plants were placed into five and seven categories based on their level of similarities respectively. Both qualitative and quantitative data analysis was carried out to analyze the data and test their hypothesis. The null hypothesis was sought to find out if there were no significant differences based on age, sex, ethnicity and marital status to the number of indigenous plants cited for use in the district. The level of significance was tested at $p<0.05$, if the level was less than 0.05 then the null hypotheses would be accepted that there is no significant differences between age, sex, ethnicity and marital status to the number of traditionally used plants found in the district. Otherwise, if $p> 0.05$, the alternative hypothesis would be accepted there is significant differences between age, sex, ethnicity and marital status and the number of traditionally used plants.

Descriptive statistics was used to group the data into graphs, tables and charts whilst inference was made using statistical analysis such as independent t-test and one way analysis of variance (ANOVA) to compare the mean difference of age, age, marital status and ethnicity in relation to the medicinal plant use using Statistical Package for the Social Sciences (SPSS) version 26. The dependent variables in this study were the number of uses cited for each plant whilst the independent variable were age, sex, marital status and ethnicity. Pearson product moment correlation was used to determine the linear relationship among variables such as age, sex, marital status and ethnicity. Linear relationship between Relative Frequency of Citation (RFC) and Use Value (UV) of plants cited for use as food, timber and construction, ethnoveterinary, religious ceremonies and rituals, tools and handicraft, other uses and as firewood and construction material was investigated using correlation analysis based on Pearson product moment correlation. The dependent variable in this study was the number of plants cited by the informants and the independent variables were age, sex, ethnicity and marital status.

The data was analyzed through use of ethnobotanical quantitative indices which included the Relative Frequency of Citation, Use Value and Informant Consensus Factor to determine the relative importance and usefulness of the plant species.

The **RFC** of reported plant species was determined using the following equation (Tardío & Pardo-de-Santayana 2008) to show the local importance of each plant species;

$$RFC = FC/N$$

The ranges is ($0<RFC<1$), where Frequency of citation (FC) is the number of informants mentioning the use of species divided by the total number of informants participating in the study. The range of scale varies between zero and one. The value is zero when no informant referred to any plant species as being useful and when the value is one it shows that there are a maximum number of informants that consider a plant taxon useful (Tardío & Pardo-de-Santayana 2008).

Use Value (UV) was used to determine the uses category of the plant species in the study area.

$$UV = (\Sigma Ui)/N$$

Where, Ui is the number of use reports cited by each informant for a given species and N is the total number of participants (Upadhyay *et al.* 2011).

Informant Consensus Factor (ICF) was used to test the level of homogeneity/ agreement among the information given by the participants on the indigenous plant species used in the district. It was calculated using the formula below according to Trotter & Logan (1986).

$$ICF = (Nur - Nt)/ Nur -1$$

Where, Nur is the number of use reports from informants for a particular plant use category, Nt is the number of species that are used for that plant use category by all the informants. The values of ICF varies from 0 to 1, the values close to zero signifies a low homogeneity or agreement by the informants on the plant species being explored. The closer the value is to one show that there is high homogeneity or agreement between the informants.

Results

Demographic features of the informants

A total of thirty-five informants took part in the survey after they were randomly selected using the criteria based on having knowledge of the plants used in the district, they were supposed to be indigenous people from the district as well as being knowledgeable in the medicinal plants used in the district. The gender of the participants comprised of 16 men and 19 women which was a percentage of 45.7% and 54.3% respectively. There was no significant difference between men and women ($p = 0.290$) and the Pearson's correlation was a negative linear relationship between the number of cited plants and gender ($r^2 = -0.184$). Similarly, the results from Independent t-test showed that there was no significant differences amongst female and male participants ($p = 0.290$, $t = 1.076$). Analysis of variance showed that the least number of plants cited by females were five plants compared to males who at least cited eight plants, however, their mean variation was not very significant ($p = 2.90$, $F = 1.157$).

The age groups that were noted during the study were the 18-25 years (three informants), 26-35 years (11 participants), 36-45 years (eight informants), 46- 55 years (nine informants), 56-65 years (two informants) whilst the over 65 years (two informants). The highest age group with the most participants was the 26-35 years followed by the 46-55 years. The lowest number of respondents came from the 56-65 years and the over 65 years a category that recorded two informants. There was a significant difference between the age groups in the number of plants cited since $p = 0.013$ as well as a positive linear relationship between age groups and cited plants of $r^2 = 0.414$. To test for the equality of means between the 18-25 years and 56-65 years, the Independent t-test was used and there was a significant difference amongst the age groups (p = 0.01, t = -4.045). Analysis of variance noted that the highest mean number of plants cited for use in the district were listed from the 56-65 years (17 plant species) whilst the maximum number of indigenous plants listed in the 46-55 years (33).

About thirty-three of the participants were married whilst only two were not married. The hypothesis tested on the null hypothesis was that there is no significant differences in the number of plants known between the married informants and single (p= 0.780), thus the null hypothesis was accepted since the level of significance (p > 0.05). The mean number of indigenous plants cited in the district was 14.40 whilst there was a negative Pearson's correlation between marital status and cited plants (r^2 = -0.049). The single category listed a minimum of 10 plants and maximum of 16 indigenous plant species compared to the married who listed a minimum of five plant species but a maximum of 33 plants furthermore, results from ANOVA showed no significant differences (p = 0.780).

The ethnic groups that were recorded in the study were the Karanga (two formants), Ndebele (11 participants), Manyika (two informants) and the Zezuru (20 participants). The results suggest that there is no significant differences (p = 0.477) between ethnicity and knowledge of indigenous plants although the Pearson's correlation showed a positive linear relationship between number of indigenous plants cited and ethnicity (r^2 = 0.124). The mean indigenous plants cited for use between the Karanga and Ndebele when analysed for their mean difference using the Independent t-test was not significantly different (p = 0.143, t = -1.578). Similarly, there was no significant differences between the Manyika and Zezuru (p = 0.618, t = -0. 506). The Zezuru ethnic group listed the most maximum number of indigenous plant species followed by Ndebele (27 plant species), Manyika had 16 plants and lastly Karanga group had 8 plants.

Traditionally used plants and their diversity of use

A total of 89 indigenous plant species that have been used traditionally as medicinal plants were recorded to be used for other utilitarian roles in the district by the informants. They represented 44 families that recorded two or more plant species in their families (Figure 2). The highest family was the Fabaceae which had 15 different plant species used for various uses such as timber and construction, firewood and charcoal, tools and handicraft, ethnoveterinary, other products, food and during religious ceremonies and rituals. The families that also recorded high plant species were the Anacardiaceae, Euphorbiaceae and Rubiaceae with five plant species each. However, 28 plant families recorded only one plant species only which was a percentage of 64% (Figure 2).

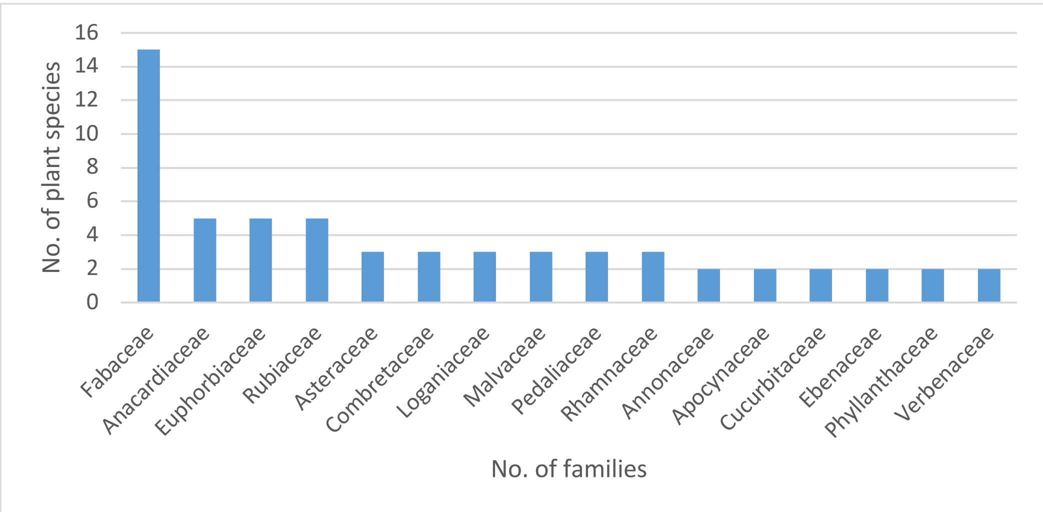

Figure 2. Number of families with two or more plant species cited

Traditional uses of food plants

The food category had the highest number of plant species cited for all the use categories (48 plant species, Table1). The plant species cited the most were *Bidens pilosa* L. (26 informants) claiming its use followed by *Cleome gynandra* L. (19 citations) and *Vitex payos* (Lour.) Merr. (15 citations). The citation for the plant species ranged from 26 informants per plant species to one informant who claimed to have used the plants and some informants are still using the plants extensively. Number of uses for the plants ranged from six to only one. *Parinari curatellifolia* Planch. Ex Benth., had six uses whilst *Piliostigma thonningii* (Schumach.) Milne-Redh. and *Hyphaene spp* had four uses each. In order to verify the importance of the plants used as food plants, the relative frequency of citation was determined, and it ranged from 0.74 to 0.03. The highest plants recording a highest RFC was *Bidens pilosa* (0.74) followed by *Cleome gynandra* and *Sesamum calycinum* Welw. at 0.54 and 0.46 respectively. These three plants were notably used as leafy vegetables that are cooked before consumption. The use value ranged from 0.17 to 0.03. *Parinari curatellifolia* had a use value of 0.17 whilst *Hyphaene spp* and *Piliostigma thonningii* had 0.11. The linear relationship between RFC and UV was in a positive manner (r^2 = 0.185) whilst there was no significant differences between the mean variances (p =0.209) as analysed through the correlation analysis using Pearson product moment of correlation.

Table 1. Traditionally used food plants

Plant species name and voucher specimen number	Family	Local name	Relative Frequency of Citation	Use Value
Adansonia digitata L., BS93	Malvaceae	**Muuyu**	0.34	0.09
Amaranthus thunbergii Moq., BS2	Amaranthaceae	**Bonyongwe/ mowa**	0.29	0.03
Annona stenophylla Engl. & Diels, BS66	Annonaceae	**Muroro**	0.11	0.09
Azanza garckeana (F. Hoffm.) Exell & Hillc., BS86	Malvaceae	**Mutohwe**	0.40	0.09
Berchemia discolor (Klotzsch) Hemsl., BS54	Rhamnaceae	**Munyii**	0.23	0.06
Bidens pilosa L., BS90	Asteraceae	**Mutsine**	0.74	0.06
Carissia spinarum L., BS7	Apocynaceae	**Muruguru**	0.06	0.03
Cleome gynandra L., BS1	Cleomaceae	**Munyevhe/ nyere**	0.54	0.06
Commiphora mossambicensis (Oliv.) Engl.BS & RJM9	Burseraceae	**Mubobo**	0.06	0.06
Corchorus olitorius L. BS & RJM2	Tiliaceae	**Derere**	0.03	0.03
Cucumis anguria L., BS70	Cucurbitaceae	**Muchacha**	0.23	0.03
Curcubita pepo L., BS18	Cucurbitaceae	**Muboora**	0.20	0.03
Dioscorea spp, BS20	Dioscoreaceae	**Munyenya**	0.09	0.03
Diospyros kirkii Hiern, BS78	Ebenaceae	**Musumha**	0.17	0.09
Euclea divinorum Hiern, BS25	Ebenaceae	**Muchekesani**	0.03	0.03
Ficus sycomorus L., BS & RJM43	Moraceae	**Muonde**	0.06	0.06
Flacourtia indica (Burm. f.) Merr., BS46	Salicaceae	**Munhunguru**	0.17	0.03
Grewia flavescens Juss., BS17	Malvaceae	**Mubhubhunu**	0.14	0.06
Hexalobus monopetalus (A.Rich.) Engl. & Diels, BS39	Annonaceae	**Mupodzvongo**	0.11	0.03
Hyphaene spp BS & RJM37	Arecaceae	**Murara**	0.06	0.11
Ipomoea batatas (L.) Lam., BS & RJM38	Convolvulaceae	**Mbambaira**	0.03	0.03
Lannea discolor (Sond.) Engl., BS32	Anacardiaceae	**Mugan'acha**	0.14	0.03
Lannea edulis (Sond.) Engl., BS88	Anacardiaceae	**Tsambatsi**	0.09	0.03
Lippia javanica (Burm.f.) Spreng., BS107	Verbenaceae	**Zumbani**	0.09	0.06
Manihot esculenta Crantz, BS & RJM20	Euphorbiaceae	**Mujumbuya**	0.06	0.03
Moringa oleifera Lam., BS49	Moringaceae	**Moringa**	0.14	0.06
Opuntia ficus-indica (L.) Mill., BS28	Cactaceae	**Mudhorofiya**	0.03	0.03
Parinari curatellifolia Planch. Ex Benth., BS37	Chrysobalanaceae,	**Muchakata**	0.37	0.17
Piliostigma thonningii (Schumach.) Milne-Redh., BS73	Fabaceae	**Musekesa**	0.09	0.11
Pouzolzia mixta Solms, BS112	Urticaceae	**Nhanzva**	0.03	0.03
Schinziophyton rautanenii (Schinz) Radcl.-SM., BS31	Euphorbiaceae	**Mungomangoma**	0.03	0.09
Sclerocarya birrea (A.Rich.) Hochst., BS109	Anacardiaceae	**Mupfura**	0.23	0.06
Searsia lancea (L.f.) F.A.Barkley, BS120	Anacardiaceae	**Musokosiyana**	0.03	0.03
Sesamum calycinum Welw., BS & RJM3	Pedaliaceae	**Derere remusango**	0.46	0.06

Solanum incanum L., BS124	Solanaceae	**Nhundurwa**	0.03	0.06
Steganotaenia araliacea Hochst., BS76	Apiaceae	**Musvodzambudzi**	0.03	0.03
Strychnos cocculoides Baker., BS82	Loganiaceae	**Muzhumwi**	0.34	0.03
Strychnos innocua Delile, BS35	Loganiaceae	**Mugwati/ mugwadi**	0.34	0.03
Strychnos madagascariensis Poir., BS81	Loganiaceae	**Mutamba**	0.03	0.06
Syzygium cordatum Hochst. Ex C. Krauss, BS & RJM42	Myrtaceae	**Muhute**	0.26	0.03
Uapaca kirkiana Müll.-Arg., BS & RJM44	Phyllanthaceae	**Muzhanje**	0.17	0.03
Vangueria infausta Burch., BS127	Rubiaceae	**Nzvirumombe**	0.29	0.03
Vangueriopsis lanciflora (Hiern) Robyns, BS & RJM45	Rubiaceae	**Mutufu**	0.06	0.03
Vigna unguiculata (l.) Walp., BS97	Fabaceae	**Munyemba**	0.11	0.03
Vitex payos (Lour.) Merr., BS64	Lamiaceae	**Mutsvubvu**	0.43	0.03
Ximenia caffra Sond., BS45	Olacaceae	**Mutsvanzva/ Munhengeni**	0.31	0.03
Ziziphus mauritiana Lam., BS71	Rhamnaceae	**Musawu**	0.06	0.03
Ziziphus mucronata Willd., BS53	Rhamnaceae	**Muchecheni**	0.06	0.03

Useful plants for timber and construction material

A total of 18 plants species were cited for use in the district (Table 2). The number of citations for plants used for timber and construction ranged from 16 to one, *Pterocarpus angolensis* DC. recorded the highest informants claiming its use of 16 followed by *Colophospermum mopane* (J.Kirk ex Benth.) J.Léonard and *Terminalia sericea* Burch. Ex DC., which recorded 12 and 10 citations respectively. The relative frequency of citation ranged from 0.46 to 0.03. *Pterocarpus angolensis* had the highest value of 0.46, followed by *Colophospermum mopane* at 0.34 and *Terminalia sericea* was 0.29. The use values ranges were from 0.17 to 0.03. The highest use value was recorded for *Parinari curatellifolia* at 0.17 followed by *Pterocarpus angolensis* and *Baikiaea plurijuga* which had 0.14 each. The correlation analysis showed that a positive linear relationship exists between RFC and UV (r^2 = 0.323) whilst there is no significant differences between the two variables (p = 0.191).

Table 2. Useful plants for timber and construction material

Plant species name and voucher specimen number	**Family**	**Local name**	**Relative Frequency of Citation**	**Use Value**
Afzelia quanzensis Welw., BS38	Fabaceae	**Mukamba**	0.23	0.06
Baikiaea plurijuga Harms, BS8	Fabaceae	**Mukusvi**	0.26	0.14
Bauhinia petersiana Bolle, BS23	Fabaceae	**Mubondo**	0.03	0.09
Bobgunnia madagascariensis (Desv.) J.H. Kirkbr. & Wiersema, BS84	Fabaceae	**Mucherekese/ Mutemandakotoka**	0.03	0.06
Brachystegia boehmii Taub., BS62	Fabaceae	**Mupfuti**	0.06	0.09
Brachystegia spiciformis Benth., BS24	Fabaceae	**Musasa**	0.09	0.11
Colophospermum mopane (J.Kirk ex Benth.) J. Léonard, BS58	Fabaceae	**Mupane/ mopane**	0.34	0.09
Cynanchum viminale (L.) L., BS98	Apocynaceae	**Rusungwe**	0.03	0.03
Dichrostachys cinerea (L.) Wight & Arn., BS41	Fabaceae	**Mupangara/**	0.11	0.11
Eucalyptus camaldulensis BS & RJM36	Myrtaceae	**Mupuranga**	0.06	0.11
Julbernardia globiflora (Benth.) Troupin, BS87	Fabaceae	**Mutondo**	0.09	0.11
Kirkia acuminata Oliv., BS & RJM12	Kirkiaceae	**Mubvumira**	0.03	0.03
Ormocarpum kirkii S. Moore, BS13	Fabaceae	**Kapurupuru**	0.09	0.03

Parinari curatellifolia Planch. Ex Benth., BS37	Chrysobalanaceae	**Muchakata**	0.03	0.17
Pericopsis angolensis (Baker) Meeuwen, BS43	Fabaceae	**Muwanga**	0.03	0.03
Pterocarpus angolensis DC., BS119	Fabaceae	**Mubvamaropa/ Mubhagazi**	0.46	0.14
Terminalia sericea Burch. ex DC., BS79	Combretaceae	**Mangwe/ mususu**	0.29	0.09
Terminalia stuhlmannii BS and RJM17	Combretaceae	**Mugaranjiva**	0.03	0.11

Plants that have other uses

A total of 16 plant species were used in the district for other uses (Table 3). The plant species that were noted to be used for other uses had at least one citation for each use whilst *Pterocarpus angolensis* was the only plant species that recorded two informants citing its use. The relative frequency of citation ranged from 0.06 to 0.03, *Pterocarpus angolensis* had the highest value of 0.06 and all the other plant species had 0.03. The use value ranged from 0.14 to 0.03. The highest values were recorded for *Pterocarpus angolensis* and *Baikiaea plurijuga* Harms (0.14) followed by *Brachystegia spiciformis* Benth, *Hyphaene spp* and *Piliostigma thonningii* at 0.11. Correlation analysis showed a positive linear relation between RFC and UV (r^2 = 0.449) and the null hypothesis that there is no significant differences between RFC and UV was accepted because p = 0.81.

Table 3. Plants that have other uses

Plant species name and voucher specimen number	Family	Local name	Relative Frequency of Citation	Use Value
Adansonia digitata L., BS93	Malvaceae	**Muuyu**	0.03	0.09
Azanza garckeana (F. Hoffm.) Exell & Hillc., BS86	Malvaceae	**Mutohwe**	0.03	0.09
Baikiaea plurijuga Harms, BS8	Fabaceae	**Mukusvi**	0.03	0.14
Berchemia discolor (Klotzsch) Hemsl., BS54	Rhamnaceae	**Munyii**	0.03	0.06
Brachystegia boehmii Taub., BS62	Fabaceae	**Mupfuti**	0.03	0.09
Brachystegia spiciformis Benth., BS24	Fabaceae	**Musasa**	0.03	0.11
Canna indica L. BS & RJM19	Cannaceae	**Muhota**	0.03	0.03
Cleome gynandra L., BS1	Cleomaceae	**Munyevhe/ nyere**	0.03	0.06
Dicerocaryum senecioides (Klotzsch) Abels, BS102	Pedaliaceae	**Soso/ ruredzo**	0.03	0.03
Hyphaene spp BS & RJM37	Arecaceae	**Murara**	0.03	0.11
Moringa oleifera Lam., BS49	Moringaceae	**Moringa**	0.03	0.06
Piliostigma thonningii (Schumach.) Milne-Redh., BS73	Fabaceae	**Musekesa**	0.03	0.11
Pterocarpus angolensis DC., BS119	Fabaceae	**Mubvamaropa/ Mubhagazi**	0.06	0.14
Ricinus communis L., BS61	Euphorbiaceae	**Mupfuta**	0.03	0.06
Schinziophyton rautanenii (Schinz) Radcl.-SM., BS31	Euphorbiaceae	**Mungomangoma**	0.03	0.09
Sesamum calycinum Welw., BS & RJM3	Pedaliaceae	**Derere remusango**	0.03	0.06

Traditional plants used as ethnoveterinary medicines

A total of 11 plant species were used in the district for ethnoveterinary medicinal practices (Table 4). The number of informants that recorded uses of plants as ethnoveterinary medicine ranged from 2 informants to only one informant. *Cissus quadrangularis* and *Pterocarpus angolensis* had two informants recording their uses. The relative frequency of citation ranged from 0.06 to 0.03 whilst the use values ranged from 0.14 to 0.03. A positive linear relationship was observed between RFC and UV using Pearson's product moment (r^2 = 0.137) whilst there was no significant variation between RFC and UV (p = 0.688).

Table 4. Traditional plants used as ethnoveterinary medicines

Plant species name and voucher specimen number	Family	Local name	Relative Frequency of Citation	Use value
Aloe zebrina Baker, BS10	Asphodelaceae	**Gavakava**	0.03	0.03
Baikiaea plurijuga Harms, BS8	Fabaceae	**Mukusvi**	0.03	0.14
Bobgunnia madagascariensis (Desv.) J.H. Kirkbr. & Wiersema, BS84	Fabaceae	**Mucherekese/ Mutemandakotoka**	0.03	0.06
Cissus quadrangularis L., BS95	Vitaceae	**Murunjurunju/ Muvengahonye**	0.06	0.03
Dichrostachys cinerea (L.) Wight & Arn., BS41	Fabaceae	**Mukonashanu**	0.03	0.11
Jatropha curcas L., BS11	Euphorbiaceae	**Jatropha**	0.03	0.03
Julbernardia globiflora (Benth.) Troupin, BS87	Fabaceae	**Mutondo**	0.03	0.11
Monotes engleri Gilg, BS56	Dipterocarpaceae	**Munyunya**	0.03	0.06
Pseudolachnostylis maprouneifolia Pax, BS75	Phyllanthaceae	**Mushozhowa**	0.03	0.06
Psydrax livida (Hiern) Bridson, BS and RJM27	Rubiaceae	**Musemahonye**	0.03	0.03
Pterocarpus angolensis DC., BS119	Fabaceae	**Mubvamaropa/ Mubhagazi**	0.06	0.14

Plants used during religious ceremonies and rituals

A total of 18 plant species were used for religious ceremonies and rituals in the district (Table 5). Informants that used plants for religious ceremonies and rituals ranged from six informants that used the same plant species to one informant. The highest plant species that recorded the highest citation was *Parinari curatellifolia* with six citation followed by *Peltophorum africanum* at five. The relative frequency of citation values ranged from 0.17 to 0.03 and *Parinari curatellifolia* had 0.17 followed by *Peltophorum africanum* at 0.14. The use values varied from 0.17 to 0.03. Correlation analysis showed that there was a positive linear relationship between RFC and UV (r^2 = 0.441). The null hypothesis was tested, and it showed that there was no significant variation between RFC and UV (p = 0.67).

Table 5. Plants used during religious ceremonies and rituals

Plant species name and voucher specimen number	Family	Local name	Relative Frequency of Citation	Use Value
Anselia africana BS & RJM5	Orchidaceae	**Intelezi**	0.06	0.03
Baccharoides adoensis (Sch. Bip. ex Walp.) H. Rob., BS51	Asteraceae	**Munyatela**	0.03	0.03
Ceratotheca triloba (Bernh.) Hook. F.BS & RJM35	Pedaliaceae	**Munhuwenhuwe**	0.06	0.03
Chenopodium ambrosoides BS & RJM6	Chenopodium	**Mbanda**	0.03	0.03
Dicoma anomala Sond., BS80	Asteraceae	**Chifumuro**	0.06	0.03
Eucalyptus camaldulensis BS & RJM36	Myrtaceae	**Mupuranga**	0.03	0.11
Gymnosporia senegalensis (Lam.) Loes., BS104	Celastraceae	**Chizvuzvu/ Mugaranjiva/**	0.09	0.11
Hyphaene sp. BS & RJM37	Arecaceae	**Murara**	0.06	0.11
Lantana camara L. BS & RJM39	Verbenaceae	**Lantana camara**	0.03	0.03
Lippia javanica (Burm. f.) Spreng., BS107	Verbenaceae	**Zumbani**	0.03	0.06
Ochna pulchra Hook., BS89	Ochnaceae	**Musvedzagudo**	0.03	0.03
Parinari curatellifolia Planch. ex Benth., BS37	Chrysobalanaceae,	**Muchakata**	0.17	0.17
Peltophorum africanum Sond. BS & RJM40	Fabaceae	**Muzeze**	0.14	0.03
Pseudolachnostylis maprouneifolia Pax, BS75	Phyllanthaceae	**Mushozhowa**	0.03	0.06

Ricinus communis L., BS61	Euphorbiaceae	**Mupfuta**	0.03	0.06
Solanum incanum L., BS124	Solanaceae	**Nhundurwa**	0.03	0.06
Spirostachys africana Sond., BS & RJM41	Euphorbiaceae	**Mutovhoti**	0.03	0.03
Terminalia stuhlmannii BS and RJM17	Combretaceae	**Mugaranjiva**	0.03	0.11

Plant species important for firewood and charcoal production

A total of 16 plant species were noted to be used in the district for firewood and charcoal production (Table 6). The number of plant citations ranged from 13 to only one and *Julbernardia globiflora* recorded the highest number of informants claiming its use for firewood and charcoal production followed by *Brachystegia spiciformis* and *Colophospermum mopane* at seven citations each. The relative frequency of citation ranged from 0.37 to 0.03 with *Julbernardia globiflora* recording the highest value of 0.37 followed by *Brachystegia spiciformis* and *Colophospermum mopane* at 0.20. The use values ranged from 0.17 to 0.09 and *Parinari curatellifolia* had the highest range. The correlation analysis showed that a negative linear relationship existed (r^2 = -0.204), although the linear relationship was considered not to be significant (p = 0.448).

Table 6. Plant species important for firewood and charcoal production

Plant species name and voucher specimen number	**Family**	**Local name**	**Relative Frequency of Citation**	**Use Value**
Azanza garckeana (F. Hoffm.) Exell & Hillc., BS86	Malvaceae	**Mutohwe**	0.03	0.09
Baikiaea plurijuga Harms, BS8	Fabaceae	**Mukusvi**	0.09	0.14
Bauhinia petersiana Bolle, BS23	Fabaceae	**Mubondo**	0.11	0.09
Brachystegia boehmii Taub., BS62	Fabaceae	**Mupfuti**	0.09	0.09
Brachystegia spiciformis Benth., BS24	Fabaceae	**Musasa**	0.20	0.11
Colophospermum mopane (J. Kirk ex Benth.) J. Léonard, BS58	Fabaceae	**Mupane/ mopane**	0.20	0.09
Dichrostachys cinerea (L.) Wight & Arn., BS41	Fabaceae	**Mupangara/**	0.03	0.11
Diospyros kirkii Hiern, BS78	Ebenaceae	**Musumha**	0.03	0.09
Eucalyptus camaldulensis BS & RJM36	Myrtaceae	**Mupuranga**	0.03	0.11
Gymnosporia senegalensis (Lam.) Loes., BS104	Celastraceae	**Chizvuzvu/ Mugaranjiva/**	0.03	0.11
Julbernardia globiflora (Benth.) Troupin, BS87	Fabaceae	**Mutondo**	0.37	0.11
Parinari curatellifolia Planch. ex Benth., BS37	Chrysobalanaceae,	**Muchakata**	0.03	0.17
Piliostigma thonningii (Schumach.) Milne-Redh., BS73	Fabaceae	**Musekesa**	0.09	0.11
Pterocarpus angolensis DC., BS119	Fabaceae	**Mubvamaropa/ Mubhagazi**	0.03	0.14
Terminalia sericea Burch. ex DC., BS79	Combretaceae	**Mangwe/ mususu**	0.14	0.09
Terminalia stuhlmannii BS and RJM17	Combretaceae	**Mugaranjiva**	0.03	0.11

Traditional plants used to make tools and handicraft

A total of 29 plant species were noted to be used in the district for tools and handicraft manufacture (Table 7). The number of citations ranged from 0.17 to only one citation per plant used for making tools and handicraft. *Terminalia sericea* had 17 informants claiming its use followed by *Pterocarpus angolensis* at 13. The number of uses for the plant species ranged from six to one whilst the relative frequency of citation ranged from 0.49 to 0.03, *Terminalia sericea* had the highest value of 0.49, followed by *Pterocarpus angolensis* at 0.37 and *Julbernardia globiflora* at 0.17. The use values were in the ranges of 0.17 to 0.03 with *Parinari curatellifolia* recording the highest value of 0.17. The correlation analysis revealed that a positive linear relationship existed between RFC and UV (r^2 = 0.159). The null hypothesis was accepted that there was no significant difference between RFC and UV (p = 0.409).

Table 7. Traditional plants used to make tools and handicraft

Plant species name and voucher specimen number	Family	Local name	Relative Frequency of Citation	Use Value
Adansonia digitata L., BS93	Malvaceae	**Muuyu**	0.09	0.09
Afzelia quanzensis Welw., BS38	Fabaceae	**Mukamba**	0.17	0.06
Albizia antunesiana Harms, BS65	Fabaceae	**Muriranyenze**	0.06	0.03
Baikiaea plurijuga Harms, BS8	Fabaceae	**Mukusvi**	0.20	0.14
Bauhinia petersiana Bolle, BS23	Fabaceae	**Mubondo**	0.03	0.09
Brachystegia spiciformis Benth., BS24	Fabaceae	**Musasa**	0.03	0.11
Colophospermum mopane (J. Kirk ex Benth.) J. Léonard, BS58	Fabaceae	**Mupane/ mopane**	0.11	0.09
Combretum hereroense Schinz, BS83	Combretaceae	**Mutechani**	0.06	0.06
Commiphora mossambicensis (Oliv.) BS & RJM9	Burseraceae	**Mubobo**	0.11	0.09
Crossopteryx febrifuga (Afzel. ex G. Don) Benth., BS12	Rubiaceae	**Mukombegwa**	0.11	0.03
Dichrostachys cinerea (L.) Wight & Arn., BS41	Fabaceae	**Mupangara/**	0.11	0.11
Diospyros kirkii Hiern, BS78	Ebenaceae	**Musumha**	0.03	0.09
Eucalyptus camaldulensis BS & RJM36	Myrtaceae	**Mupuranga**	0.09	0.11
Faurea saligna De Wild. BS & RJM14	Proteaceae	**Mudhwadhwa**	0.06	0.03
Gardenia resiniflua Hiern, BS114	Rubiaceae	**Mutarara**	0.03	0.06
Grewia flavescens Juss., BS17	Malvaceae	**Mubhubhunu**	0.14	0.06
Gymnosporia senegalensis (Lam.) Loes., BS104	Celastraceae	**Chizvuzvu/ Mugaranjiva/ Chipfimbavafi**	0.03	0.11
Hyphaene spp BS & RJM37	Arecaceae	**Murara**	0.11	0.11
Julbernardia globiflora (Benth.) Troupin, BS87	Fabaceae	**Mutondo**	0.17	0.11
Lannea schweinfurthii (Engl) Engl., BS33	Anacardiaceae	**Mugaranyenze**	0.11	0.03
Monotes engleri Gilg, BS56	Dipterocarpaceae	**Munyunya**	0.06	0.06
Parinari curatellifolia Planch. ex Benth., BS37	Chrysobalanaceae,	**Muchakata**	0.03	0.17
Piliostigma thonningii (Schumach.) Milne-Redh., BS73	Fabaceae	**Musekesa**	0.03	0.11
Pterocarpus angolensis DC., BS119	Fabaceae	**Mubvamaropa/ Mubhagazi**	0.37	0.14
Schinziophyton rautanenii (Schinz) Radcl.-SM., BS31	Euphorbiaceae	**Mungomangoma**	0.09	0.09
Sclerocarya birrea (A. Rich.) Hochst., BS109	Anacardiaceae	**Mupfura**	0.11	0.06
Strychnos madagascariensis Poir., BS81	Loganiaceae	**Mutamba**	0.03	0.06
Terminalia sericea Burch. ex DC., BS79	Combretaceae	**Mangwe/ mususu**	0.49	0.09
Terminalia stuhlmannii BS and RJM17	Combretaceae	**Mugaranjiva**	0.03	0.11

Informant Consensus Factor

The consensus or level of agreement on the informants on indigenous plant use in the district was determined by using the informant consensus factor. In order to develop this consensus, the uses of plants used in the district were grouped together based on similarity of function and were placed into seven categories (Table 8). The value of ICF varied between 0.75 and 0.40. The use of plants for firewood and charcoal production recorded the highest consensus value of 0.75 followed by use of plants for tools and handicraft and other uses which recorded 0.67. The least value of 0.40 was recorded for plants used as food.

Local plant conservation practices

The local communities practice conservation methods that ensures preservation of their forest resources. There are five major categories that the local people use in the district to preserve their plants (Figure 3). These are use of traditional knowledge which had 15 informants citing the practice followed by prohibition of cutting down of whole and live trees with 11 citations. Interestingly out of the total informants, 10 cited that they didn't know of any conservation methods used to protect forest resources. The fourth category was use of selective harvesting methods which was cited by nine informants and lastly the use of non-destructive means of harvesting was cited by 5 informants.

Table 8. Informant consensus factor (ICF)

Category of use	No. use (Nur)	No. of taxa (Nt)	ICF
Food	79	48	0.40
Timber & construction material	56	18	0.69
Other products	46	16	0.67
Tools & handicraft	87	29	0.67
Firewood & charcoal	62	16	0.75
Ethnoveterinary	28	11	0.61
Religious ceremonies & rituals	39	18	0.55

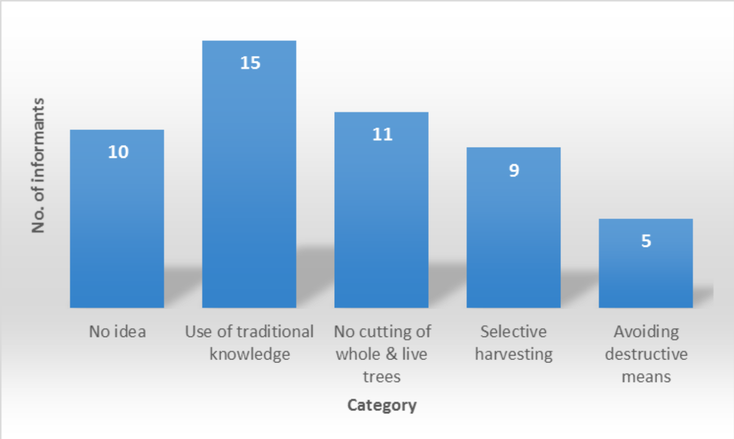

Figure 3. Conservation methods in use in the district

Factors affecting plant diversity in the district

Indigenous forest resources in the district face the challenges that were grouped into seven categories (Figure 4). The factors affecting plant diversity in the district included lack of information by the informants which recorded 16 (25%) informants who failed to cite any threat of forest resources. The second highest category was the problem of population growth and expansion that was noted by 15 (24%) participants followed by forest invaders that was cited by 9 (14%) informants. Fourth category was the problem of overgrazing recording 8 (13%) informants whilst veld fire had 7 citations (11%). At sixth position was illegal logging of trees with 5 citations (8%) and lastly the problem of excessive wind outbreaks that only had 3 citations (5%).

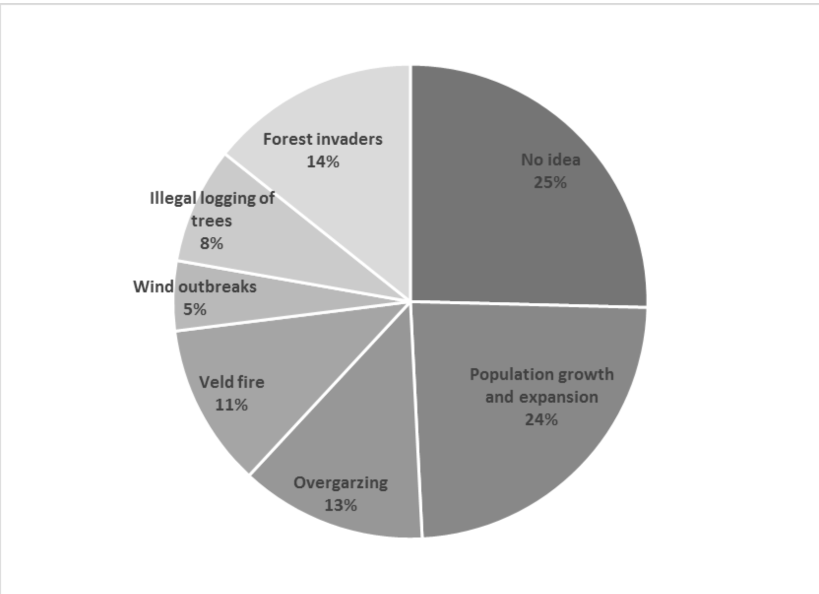

Figure 4. Major threats to indigenous plants used in the district

Discussion

Demographic features of the informants

There is a diversity of knowledge between the informants that took part in the survey based on the number of indigenous plants cited to be in use in the district. However, the knowledge of plant species used in the district showed that the plants are greatly exploited for different reasons that benefit the local the people. These local plants help to sustain the lives of the people in the district through their diversity of use. The basic uses of the named plant species ranged from food, ethnoveterinary medicines, timber, religious ceremonies and for tools and making household implements. Interestingly, in a study conducted by Bersamin *et al.* (2020) in the Philippines, the local community based their cultural knowledge through the development of unique ways to use plants as ornaments, fences, food, and construction material. Some of the plants were sold, with the proceeds significantly contributing to the people's household income, thereby improving food security, reducing poverty, and reducing community vulnerability. This goes on to show that forest products serve as important safety-nets in times of crises such as cushioning them from income shortages, unexpected drought and subsequent crop failure (Shackleton & Shackleton 2004). The local people are able to gather the wild plant resources from the forests and sale them for a living and even compensate on their food requirement needs as well as sending their children to school.

Culturally, the knowledge about traditional uses of plant resources differs between cultures. Studies on factors influencing knowledge of plant use such as family size, gender, age, ethnicity and occupation amongst others have been done (Atreya *et al.* 2018; Reyes-Garcia *et al.* 2006). The people of Gokwe South showed that they know their local plants and their diversity of uses. This knowledge was found across all the age groups interviewed in the study reflecting that knowledge is transmitted in the district. The focus of the study of exploring the available indigenous knowledge found in the district and their diversity of plant use is important in order to comprehend the use trends, determine their harvesting levels and predict their sustainable use. The information gained is useful because it establishes a baseline against which conservation and sustainable use strategies can be developed in order to avoid their over harvesting, misuse and overexploitation.

The greater number of women participants concurs with a study by Asfaw *et al.* (2013) which showed that the use of gender can be used to show the relation between people and their forest. It is assumed that females are more likely to be more dependent on forest resources when compared to their male counterparts due to their constant interaction with the environment (Heltberg *et al.* 2000). Generally, the knowledge shown by women on the local plants used for different purposes can be said to be greater when compared with men and can be explained based on the roles played by women in every household when comparing to gender-based roles. However, if the community helps each other to accomplish their gender-based roles, they would be no significant difference in the knowledge as it would be caused by their continual connection with the forest as they harvest forest produce together. In our case one-way ANOVA revealed that there was no significant difference in gender-based knowledge of indigenous use of traditional medicinal plants ($p = 0.290$). Similar findings of men becoming engaged in activities such as firewood collection was also noted, and it contributed to men and women sharing indigenous knowledge on plant uses (Mikolo *et al.* 2008). Interestingly, studies on the knowledge differences between males and females in Samburu District of Kenya showed that there was no significant differences in the average number of plant species reported between male and female informants (Nanyingi *et al.* 2008).

The results of the Independent t-test showed that there were significant differences of the mean plant use knowledge between the Karanga and Ndebele ($t = 4.106$; $p = 0.068$) as well between Manyika and Zezuru ($t = 0.655$, $p = 0.586$). The results justify that there are gender based. Ethnicity can influence the usage of plant resources and help to predict important forest products in use. This is because ethnic groups differ in their cultural, traditional and social backgrounds and have their ideologies and way of practices embodied in their culture and history (Bussman 2006). As such their geographical location influences the way they use forest resources and thus, varying in their diversity of use patterns.

The age of rural dwellers is a major contributor to the number of number of plants they know, the higher their number of years in age, the greater the assumption that the elderly people have a greater knowledge of use of forest products when compared to the young generation. This was demonstrated by a study established that ethnobotanical knowledge increases with an individual's age (Mahwasane *et al.* 2013). The reason could be due to the assumption that as one increases in age, they have more time to interact and accumulate more wealth of knowledge on the uses of indigenous plants than the younger generation. Whilst it could be true that the elderly have more time, others see the effects of changing socio-economic and cultural changes limiting the amount of indigenous knowledge young generation can acquire. This traditional indigenous knowledge which is often times passed down over the generations by way of oral communication is prone to be lost as most young people migrate into towns, becoming more drawn to modern lifestyles and less interested in traditional way of life. Therefore, the lesser the transmission of indigenous knowledge to the next generation, the lesser the knowledge on indigenous plant use by the young generation. The study findings concur to those of that there is a risk of disappearance of indigenous knowledge amongst the young generations and it greatly impacts on knowledge transfer to the next generation (Cheikhyoussef *et al.* 2011).

Traditionally used plants and their diversity of use

The 89 indigenous plant species recorded in the district demonstrates the crucial roles indigenous plants play. As such, there is a need to further investigate the integral role played by biodiversity in providing people with a livelihood that is important for the sustenance of indigenous cultural and social practices. The greater the access any given community has to the forest produce and product the greater the diversification of use. In this study the forest resources recorded seven major utilitarian roles suggesting that the local communities extensively rely on the forest for their day to day living, health and well-being. The use categories play significant roles for provision of day to day running of the local communities through exploitation for food, timber, during constriction for fuel supplies and some are sold such as fruits and wild vegetables. This concurs to the findings by (Shackleton & Shackleton 2004).

Traditionally used food plants

The food that is gathered from the forest by the local people are important in that they add to the nutritional needs of the community. They also provide an available and accessible source of a diverse range of foods that could alleviate hunger problems and nutritional deficiency diseases. The district recorded food plants which included leafy vegetables, fruits, nuts, wild edible roots, plants used as jam and teas. The most important food plant recorded based on its use value was *Parinari curatellifolia.* Its fruits are used to make a variety of food items that are of nutritional value. The fruits can be eaten whilst fresh and the nuts inside can be made into peanut butter that can be added to vegetable relish making it an important seasoning or added to porridge. This is because the nuts make vegetable oil that is rich and nutritious in content (Duguma 2020). An example is the use of *Sclerocarya birrea* seeds which make good vegetable oil, the fruits can also be dried and made into a porridge that is important in alleviating nutritional deficiency diseases especially in young children. Most of the indigenous fruits ripen during different times of the season and their collection is thus spread throughout the year. Studies have shown that fruits from *Adansonia digitata* are a source of high calcium and vitamin C in addition to other minerals. Their consumption will help in alleviating nutritional problems, supply alternative food sources during famine periods and shortages thus, improving the populations diet (Duguma 2020). The other common fruit trees cited for use in the district included *Strychnos madagascariensis*, *Flacourtia indica, Azanza garckeana* and *Vitex payos.*

The most preferred leafy vegetable in the district was *Bidens pilosa and Cleome gynandra* which are consumed fresh or they can be dried and consumed later during the year. This is important in the continual supply of vegetables throughout the year (Maroyi 2013). The tender soft and young leaves are plucked off during harvesting periods and cooked before serving with the traditional staple food that is a carbohydrate known as pap (sadza) and stew. The high frequency of citation showed that the indigenous local community places cultural importance on *Bidens pilosa*, *Cleome gynandra* and *Sesamum calycinum.* They are a great source of vitamins and minerals that are frequently deficient in most diets. Interestingly, the local communities are able to identify leafy vegetables in the forest, harvesting the specific plant parts which are the tender soft leaves and young leaves and process them through local cooking methods that make them palatable (Purba & Silalahi 2021). A study by Maroyi (2013) showed that the Amaranthaceae and Asteraceae were the highest plant families to be used in the Shurugwi district of Zimbabwe as wild edible plants offering alternative nutritious vegetables to the diet. Ndinya *et al.* (2020) concurred with the findings of Maroyi (2013) that the most used leafy vegetables in western Kenya were *Cleome gynandra* and *Amaranthus* species which are harvested from the wild a similar trend noticed in Gokwe South District. Interestingly, the leafy vegetables make a good source of phenolic compounds that are health- promoting compounds, thus, help in the promotion of health and well-being of the local communities (Seifu *et al.* 2017).

Such diversity in the use of foods plants play noteworthy roles and contributions in the district that help the local communities to meet their daily nutritional requirements and increase food security and increase in their dietary diversity. They act as important sources of nutrients needed by the human body and therefore, supplying important nutrition. The use of roots and other edible plants such from *Manihot esculenta* is important in quenching hunger and thirst whilst in the forest and some have known aphrodisiac properties. Therefore, the use of food from indigenous plants helps in creating self-sustaining communities that are self-reliant on their natural resources.

Useful plants for timber and construction material

The physical features and characteristics of indigenous plants used to make timber and construction material is important and their constant availability, durability and workability are some of the considerations for use (Braet & Standa-Gunda 2000). The shape and thickness of the branches and truck are considered before extracting the plants for use. The most preferred timber is one that is straight and thick, and fiber is also needed to help tie the roof trusses, fences and other household implements. During construction, fiber that is strong, durable and can be removed easily is preferred. Other small branches and thorny trees are considered to be good in making fences with more strength that help deter livestock away from homestead and entering fields. In the district timber is collected commercially from the third indigenous forest reserve known as Mapfungautsi Forest Reserve. Timber that is valued highly due to its good quality is sold to potential sawmills and clients by way of permit system through the Forestry Commission of Zimbabwe. This enables a systematic follow-up and prevents illegal timber logging by poachers and other violators who are liable to persecution if found in possession of timber without a valid license. The collection of timber plant species ranges from *Pterocarpus angolensis, Afzelia quanzensis* and *Baikiaea plurijuga.* These findings are similar to a comparative study done between Zimbabwe and South Africa on their pattern of use (Maroyi & Rasethe 2015). However, *Pterocarpus angolensis* recorded the highest number of informants claiming its use for timber and construction material due to its long durability and it not affected by termites thus, the building is able to last long. These result findings concurred with those of Braedt & Standa-Gunda (2000). *Terminalia sericea* was highly citied due to its branches that produce straight poles. The local informants cited plant use for construction of thatch house, animal kraals, fencing and making wardrobes, tables and chairs. The commercialization of such important tree species such as *Afzelia quanzensis* and *Burkea plurijuga* are important in that they are also used extensively as medicinal plants and their continual harvest from the wild could affect the supply of important medicinal plants.

Plants that have other uses

The category for other use was meant to include plants used as dyes, tannins, shade plants, fodder, ornamental plants, paint and cobra. *Pterocarpus angolensis* was noted to be used for making paint and cobra. Its red bark produces red cobra used in houses as floor polish that leaves a shiny red colour that improves the esthetic of the house. *Berchemia discolor* and *Cleome gynandra* on the other hand was stated to be used to make a dye that is used in the district to paint baskets that are commercially sold for an extra income by the rural community. The use of plants as natural dyes has been a technique used throughout human civilization. Pigment from leaves, roots and seeds have been used to dye clothing material or as paint for painting different art and handicraft (Divya Lekshmi & Ravi 2013). With the rise in issues of land pollution and degradation caused by toxic synthetic dyes, the exploration and use of natural plant-based dyes which are environmentally friendly and easily degradable could help solve the crisis. The *Hyphaene* sp. in the community was used to make baskets, tables and chairs (Dowo *et al.* 2018). Fodder plants in the district were cited to be used for supplementing livestock feed because they offer alternative nutritional values.

Traditional plants used as ethnoveterinary medicines

The study of the local people in Gokwe South showed that they use 11 plants for ethnoveterinary medicines and only *Cissus quadrangularis* recorded two citations from the informants whilst the rest of the plants only had one informant citing its use. Previous study had cited *C. quadrangularis* as being used for herbal medicine in traditional veterinary practices of the local people (Dowo *et al.* 2018). Ethnoveterinary medicines are important for the health and well-being of livestock in the district and are being used to manage, prevent and cure various diseases and ailments such as blood water in cattle. The natural medicines have an advantage over synthetic drugs in that they are readily available, easy to use and cheap. These findings in the district are similar with findings by Luseba & Tshisikhawe (2013) that most farmers tend to prefer the traditional use of ethnoveterinary methods because of their ease of access, constant availability and low costs. The common livestock that are treated by use of ethnomedicinal practices are cattle and chickens, which are treated for diarrhoea, skin diseases and wounds (Khunoana & McGaw 2019, Maroyi 2021). In Zimbabwe, plants such as *Cissus quadrangularis*, *Lippia javanica* and *Aloe zebrina* Baker species have been used as ethnoverterinary medicines to cure livestock parasites in semi-arid smallholder farming areas of Zimbabwe (Nyahangare *et al.* 2015). The *Aloe zebrina* species has been central in the provision of health and well-being of livestock (Dowo *et al.* 2018). As such, the continual use prevents loss of animals to diseases thereby increasing their source of food sources, income and social security. However, the low number of citations by the informants show that there is probably less transmission of ethnoveterinary knowledge in the district.

Plants used during religious ceremonies and rituals

There were 16 plant species that were noted to be used in the district for religious ceremonies and rituals. The uses of plant species included magic and spiritual uses. Ritual plants are used as a religious tradition that forms any part of a culture to help in regulating their utilization through taboos and sacrifices. Taboos are rules and regulations that are set to monitor the use of plants and acts a means of plant species conservation through guiding their utilisation. These findings in the district support the findings of Gadgil *et al.* (1993) that plants have been used in religious ceremonies in some cultures to provide protection from misuse and overexploitation through the use of taboos such as totems. Typical examples of ritual and religious ceremonies in Zimbabwe are the rainmaking ceremony that is done under *Parinari curatellifolia* and is usually conducted in the forest. The use of plants for religious purposes forms a spiritual link with their environment and helps create positive attitudes towards their environment (Duri & Mapara 2007). The most religious plants are the most heavily protected, and they cannot be cut down for use. Some forests are considered sacred and entry into the forest is strictly by permission from the local authority. This was a similar observation done by Tanyanyiwa & Chikwanha (2011) they noted that some mountains are sacred and special ritual are performed before one can have access to it. Through the observation of local culture and traditional practices, the cultural importance of plant species can be determined through the use of ethnobotanical indices and can help to uphold the culture of local communities and help in the prevention of cultural erosion (Sujarwo *et al.* 2020).

Plant species important for firewood and charcoal production

Most rural areas rely on plant species as firewood and charcoal because electrification has been slow, and some areas do not have access to electricity (Baydoun et al. 2017). However, a study by Kyaw *et al.* (2020) showed that at least 80% of the people in Myanmar rely on the use of firewood. *Colophospermum mopane*, *Julbernardia globiflora* (Benth.) Troupin and *Terminalia sericea* where the listed trees that make good quality fire and produce quality charcoal that last long (Table 2). Interestingly, *C. mopane* was the most preferred tree species for use in a study by Dowo *et al.* (2020) in periphery areas of Gonarezhou National Park. The local communities showed that they rely on firewood and charcoal production for their energy needs such as cooking and heating. On the other hand, the cutting down of trees for firewood supplies often results in their overharvesting and the continual use leads to deforestation and plant species loss causing the economic welfare and growth of communities to be greatly affected. When local people select tree species to use as firewood, they tend to harvest plant species that produce hot flames that are long lasting and have long lasting embers. The firewood should also be able to burn without producing much smoke, without any sparks and odor. Tree species from the Apocynaceae and Euphorbiaceae are not preferred for use as firewood as they produce a milky latex that hinder them to be burned (Bauer *et al.* 2014).

The collection of firewood is usually done by women and young girls who take twigs and branches from dead wood from nearby woodlands, forest and forest reserve. However, due to the high demand for fuel, men are gathering plant species from whole trees for sale in urban centers. There is also a growing trend of use of charcoal amongst the people due to its lightweight, less bulkiness and can be stored for long. It is very efficient in heating and produces a steady heat with no smoke. However, it is produces from a large amount of wood and thus, it can be considered as being wasteful. The harvesting of whole plants is a destructive means that greatly affects its population and therefore, threatens their survival, diversity and composition. Many woody plants take a long time to reach maturity and possess a low ratio of production to biomass thus, affecting their growth. Therefore, ethnobotanical research on the uses of plants plays vital roles in the determination of plant importance indices and could contribute greatly to the sustainable use and conservation of many plant species.

Traditional plants used to make tools and handicraft

Terminalia sericea and *Pterocarpus angolensis* had the highest number of citations from the informants due to their durability and production of good quality products. The commonly cited tools used by the indigenous people in the district were cooking spoons, drums, pestle and mortar, walking sticks and wooden spoons amongst other households implements such as hoe handles, stools, beds, ladders and cattle yokes. The production of handicraft provides a means of supplementing income to the local indigenous people. *Sclerocarya birrea* was cited to be used to make traditional drums that are light yet durable.

Informant Consensus Factor

The highest informant consensus factor was recorded for firewood and charcoal production of 0.75 means that there is a high level of agreement on the use of cited plants in the district. Timber and construction material was cited at 0.69 to suggest a high level of agreement of their plant use. The low ICF recorded for food (0.04) could suggest low communication methods between the informants about plant species used in the district or the plants are not distributed evenly in the study area. Another probable suggestion would be that the variation in ICF indices could be due to how close the informants live near the forest areas. If the informants live far away, they have no time to explore the different plant species found in the district. As such, the limited access to forest resources based on their physical location determine the extent of forest products use and experimentation.

Local plant conservation practices

The findings of this study revealed that conservation practices in the district are carried out by the local community although there are 20% of informants who did not have any knowledge of conservation practices. There were five major categories that were grouped into the same category based on their similarity of function. (Figure 3). The first was the use of traditional practices such the collection of dry twigs and branches from trees for firewood, indigenous fruits are collected in limited measure that allows each household to harvest enough fruits for consumption as well as adhering to specific days of going into the forest to gather forest products. For instance, days such as Thursdays are considered sacred days and the local people do not carry out activities such as firewood collection. The second category prohibited the cutting down of whole live trees, only dry trees are to be cut for their use as firewood, timber and other uses. The third category was the use of selective harvesting when collecting forest products, certain trees are not collected for household use as they are regarded sacred or sometimes collection is based on the locals' preferences. The last category was on the harvesting method, the use of destructive methods to collect firewood or timber by using an axe or machete in the forest is prohibited. All the conservation methods in the district are based on taboos, folktales and totemism (Mawere 2013), and could form a basis to conserve plant resources that is more efficient and reliable when compared to use of rule of law (Liu *et al.* 2002).

Factors affecting plant diversity in the district

As the community use indigenous plant resources, their activities pose major threats of the plant species. The threats were listed, coded and placed into seven categories based on their similarity of function (Figure 4). The first category was the increasing population growth and expansion that leads to the continued cutting down of trees and clearing of the land. The second category was overgrazing, the effects of overgrazing are felt on the ecosystem and leads to land degradation and plant species abundance declines. The third category was veld fire, the use of fire to clear agriculture fields or used during hunting of wild animals in the forest has a negative bearing on plant species. The fourth category was due to natural phenomenon of excessive wind outbreaks in the forest. Too much wind causes tree branches to fall and in extreme cases small growing plant species are vulnerable and are easily broken thereby affecting their growth and survival. The fifth category was caused by the illegal logging of trees for use as timber and construction material and for firewood and charcoal production. The timber in the district is considered to be of high value and consists of tree species such as *Afzelia quanzensis*, *Baikiaea plurijuga* and *Pterocarpus angolensis* and are found in the protected Mapfungautsi Forest Reserve. Due to their high value and great importance, illegal tree loggers who intend to benefit from their sale evade buying the timber from the Forestry Commission of Zimbabwe and poach the wood during the night. The last threat that is experienced in the district is the issue of illegal forest invaders who reside in the forest areas. They cause massive land clearing so that they can build their houses and make their agricultural fields and destroying important tree species

Conclusion and recommendations

There is a heavy reliance of traditional plant species by the local people in Gokwe South District and they obtain their livelihood, sustenance and social stability and security from their utilization. The indigenous knowledge about the different plant resources used in the district is based on the cultural practices of the community. It is only through the use of local knowledge of plants that issues to deal with severe food shortages and malnutrition problems can be resolved through use of traditional plants to supplement livelihoods. Common livestock diseases can also be cured through the use of ethnoveterinary medicines and could help improve the health and well-being of animals in the district and improve their social and economic status. The study recorded 89 plant species used in seven categories of uses and these utilization patterns cannot be undermined as they suggest a growing cultural and traditional practice of plants. As such, the use of plants plays a significant role in the lives of the community through their social, economic and cultural contributions. As such it is more justified to scientifically document the traditional knowledge on plant resources use patterns and their cultural importance so that it is not lost and becomes easily retrievable. The research was based on documenting other utilitarian roles provided by medicinal plants.

The data gathered on the conservation strategies and factors affecting plants in the district showed that there is a need to raise awareness and campaigns for the community to take note of and adhere to strategies implemented.

This is because the continual extraction of forest resources unsustainability could lead to serious species depletion and possible extinction. Interestingly, since no study of this kind had been done before in the district, this survey forms a baseline for data that can be used for future research and make sound recommendations. The data obtained showed that the plant resources in the area have multipurpose uses and their continual use and exploitation leads to their continual depletion from the wild. Therefore, this information will serve as the foundation for developing sustainable use and conservation management plans to be formulated that will supplement the existing conservation management. It will prevent plant species from being depleted from wild forests indefinitely, as reliance on forest products can have an impact on the health of their forests.

Declarations

List of abbreviations: SDGs = Sustainable Development Goals; WWF = World wide Fund; SRGH = National Herbarium and Botanic Gardens, Harare; RF = relative frequency of citation; UV = use value; FC = frequency of citation; N = total number of participants; SPSS = Statistical package for the Social Sciences; ANOVA = analysis of variance; U = use reports.

Ethics approval and consent to participate: Ethical clearance was sought from Midlands State University, (FSTech 007/01/21). Permission for the study was also sought from the local authorities including district administrator, chiefs, headmen and village heads. All participants provided written prior informed consent.

Consent to publish: The paper does not show any personal data or photographs.

Availability of data and materials: The authors will provide the raw data on request without the names of informants.

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