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The Utilization and Conservation of Indigenous Wild Plant Resources in the Limpopo Province, South Africa

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Abstract

The knowledge pertaining to uses of indigenous wild plants and their conservation methods by the rural communities of the Limpopo Province (South Africa) is not fully reconnoitered. The available data highlighting these aspects are scattered in general ethnobotanical literatures. The current study therefore sought to collate, analyze, and describe such information. Search engines and local libraries were used to document information. A total of 50 useful wild plant species belonging to 32 botanical families, mainly the Fabaceae (28%, $n = 9$) and Cucurbitaceae (13%, $n = 4$), were harvested by rural communities inhabiting the Limpopo Province. These species were mainly exploited wholly for medicinal (62%, $n = 31$) and food (20%, $n = 10$) purposes. Leaves, bark, fruits, and roots, respectively, were the most commonly used plant parts. Overall, the traditional conservation approaches employed by the indigenous people to ensure continual supply of these organs for different livelihoods encompass traditional beliefs and taboos, sustainable harvesting practices as well as domestication of plants. However, not all these approaches promote effective conservation and sustainable utilization of wild plant resources.

Keywords: indigenous plants, Limpopo province, management, traditional conservation methods, useful wild plants

1. Introduction

Throughout history, plant resources have supported human being, providing goods such as food in the form of fruits and vegetables, materials for a variety of utensils, fodder, construction timber, fuel wood, and medicinal plants [1–5]. In addition, plants have also provided man with a range of cultural services, including spiritual services, inspiration, and esthetic values [6]. Therefore, sustainable plants harvesting and uses are fundamental for human survival, especially since gathering activity continue to increase in importance, in response to a growing demand for the wild plants products [7].

Globally, loss of habitat by deforestation and unsustainable harvesting methods, among other factors, threatens the survival of the plant resources in the

wilderness [8–11]. This situation is dire in various African countries wherein the majority of people depend heavily on plants to meet their livelihoods [12]. Consequently, the wild plant resources are rapidly diminishing, indicating a need to adopt the management techniques that promote a sustainable harvesting practice to ensure the continual supply of plant products to meet various human livelihoods.

In Africa as is the case in other continents of the world [13–16], natural plant resource utilization and management has been in the traditions of local communities, expressed variously in the beliefs as well as practices employed in their conservation [17]. These practices includes among others, removal of few roots from plants, harvesting of a bark that is the size of the palm of one's hand, taboos and social controls promoting sustainable harvesting of plants [18]. Studies conducted in countries such as Kenya [19], Ghana [20], Lesotho [21], Zimbabwe [22], Nigeria [3], Tanzania [23], Uganda [24], Benin and Gabon [25], Rwanda [26], and Ethiopia [27] indicated that these practices are very common among the indigenous communities and have evolved through the historical interaction of people and their environment.

However, in South Africa, data on indigenous wild plant resource utilization and associated management/conservation practices are scattered in general ethnobotanical literatures [28–32]. This makes it difficult for policy makers and conservationists to realize the potential of traditional conservation and innovation techniques in wild indigenous plant resource conservation. The current study therefore sought to collate and describe uses of the indigenous wild plants by rural communities in the Limpopo Province (South Africa), and implemented practices contributing to the conservation as well as the management of these plants.

2. Materials and methods

Overall, the data set used in this study was created by selecting articles that focused on the utilization and conservation of indigenous wild plant resources in the Limpopo Province, South Africa. The search for these articles was obtained from the main online scientific sites including Science Direct, SciFinder, Pubmed, Google Scholar, Medline, and SCOPUS. Searches were also undertaken in the library, University of Venda, University of Limpopo, and the search engines like ProQuest, Open-thesis, OATD, and EThOS [33]. The species name, botanical families, plant authority, and synonyms were verified using books, journal articles, and Internet sources such as the International Plant Name Index (www.ipni.org).

The articles selected met the pre-determined criteria, namely, inclusion and exclusion. The inclusion criteria encompass: (1) the articles reporting on the studies conducted in the Limpopo Province that highlighted or focused on the use and conservation of indigenous wild plant resources, (2) the identity of the utilized species including use part/s and traditional value/application/s and associated conservation strategy implemented, (3) the articles published between 1950 and May 2019, and (4) the articles that are written in English. The exclusion criteria include articles published as abstract, letters, and data that could not be extracted or overlapped with data from other articles. Of 410 collected articles published in the period between 1950 and May 2019, 52 met the exclusion criteria, thus did not form part of this book chapter. The conservation status of the plants was determined via the South African National Red Data List of Plants [34]. Generally, data were independently evaluated for completeness and reliability. Descriptive statistics such as frequencies and percentages were used in the analysis.

3. Results and discussion

3.1 Diversity of useful wild indigenous plant resources

The present study documented a total of 50 useful plant species belonging to 32 botanical families, mainly the Fabaceae (28%, $n = 9$) and Cucurbitaceae (13%, $n = 4$), that are harvested by rural communities inhabiting the Limpopo Province of South Africa (**Table 1**). These families are repeatedly recorded in various ethnobotanical studies conducted in South Africa [45, 46] and elsewhere [46–48], as being highly represented with a greater number of plants exploited by indigenous people to meet their livelihoods. Cucurbitaceae and Fabaceae are not only widespread in communal lands of the Limpopo Province but they also comprise many plants commonly known as foods and natural medicine. Therefore, their predominance in this study came as no surprise. According to de Albuquerque [49], indigenous people highly value and experiment on plants that are more accessible or locally abundant. However, plant species from the rest of the botanical families were rarely harvested for their products, perhaps due to their less adaptation in a wide range of altitudes across the aforementioned province. As such, they are less susceptible targets of the local people to experiment with.

3.2 Plant utilization categories

The consumption of wild plants is an ancient African tradition which serves multiple purposes. In the present study, analysis of ethnobotanical uses categories indicated that more taxa were exploited exclusively for medicinal ($n = 32$) and food ($n = 10$) purposes. Some of the commonly harvested medicinal plants documented include *Elaeodendron transvaalense* (Burt Davy) R.H.Archer (HIV/AIDS), *Hypoxis hemerocallidea* Fisch., C.A.Mey. and Avé-Lall. (Gonorrhea and HIV/AIDS), *Leonotis leonurus* (L.) R.Br. (asthma and chest pain), and *Lippia javanica* (Burm.f.) Spreng. (asthma, rhinitis sinusitis, and tuberculosis), used as therapies for the mentioned ailments (**Table 1**). Therapeutic applications of these species are well supported by scientific studies [36, 50, 51], thus partly explaining their utilization by people of the Limpopo Province. Plant-based medicines such as *Alepidea amatymbica* Eckl. and Zeyh, *Brackenridgea zanguebarica* Oliv., *Celtis africana* Burm.f., *Encephalartos transvenosus* Stapf and Burt Davy, *Mundulea sericea* (Willd.) A. Chev, *Rauvolfia caffra* Sond., and *Sclerochiton ilicifolius* A. Meeuse were considered as having mysterious and magical powers used to expel evil, fight opponents, and as luck charms (**Table 1**). For the food plant category, all the species were reported to be either eaten as leafy vegetable with porridge (*Momordica balsamina* L., *Momordica boivinii* Baill, and *Vigna unguiculata* L.) or exploited for their edible fruits (*Berchemia discolor* (Klotzsch) Hemsl, *Dovyalis caffra* (Hook. F. and Harv.) Hook. F, *Grewia bicolor* Juss., *Pappea capensis* Eckl. and Zeyh, *Vangueria infausta* Burch, and *Ximenia caffra* Sond.). The consumption of these plants by indigenous people in the Limpopo Province is primarily attributed to multiple factors including food scarcity, nutri-medicinal value, and local cultural practices.

Other categories that had explicit use were for provision of livelihoods such as firewood ($n = 2$; *Vachellia karroo* Hayne and *Vachellia rehmanniana* Schinz), water storage ($n = 1$; *Breonadia salicina* (Vahl) Hepper and J.R.I. Wood.). *Vachellia karroo* and *V. rehmanniana* are preferred as firewood species due to both their local availability and long burning period, which provide lasting heat and light [41].

The remaining plants, namely, *Anthocleista grandiflora* Gilg (used to cover maize grains to encourage germination when malt is prepared, and female bodies during rituals, and as medicine for high blood pressure), *Boscia albitrunca* Gilg and

Botanical family and species name	Used part	Traditional value	Conservation status (red data list)	Traditional plant conservation practices
Acanthaceae <i>Sclerochiton ilicifolius</i> A. Meeuse	Root	Used to guard against evil spirits and fight enemies	Least concern	Only harvested by people who are trained in harvesting rituals, and are not collected from areas where people frequent, as it is believed this will diminish the effectiveness of the plant [35]
Alliaceae <i>Tulbaghia violacea</i> Harv. var. <i>violacea</i>	Bulb	Nasal congestion and tuberculosis (TB)	Least concern	Harvesting involves their cutting with a knife from the base leaving roots in ground intact [36]
Apiaceae <i>Alepidea amatymbica</i> Eckl. and Zeyh	Rhizome	Used to guard against evil spirits and fight enemies	Endangered A2d	Only harvested by people who are trained in harvesting rituals, and are not collected from areas where people frequent, as it is believed this will diminish the effectiveness of the plant [35]
Apocynaceae <i>Rauvolfia caffra</i> Sond.	Whole plant	Believed to attract rain	Least concern	Prohibited from being harvested [37]
Asteraceae <i>Kleinia longiflora</i> DC	Twig	Chest pain, painful eyes, pneumonia and sore throat	Least concern	Harvested by hand via breaking of the required amounts in the wild [36]
Asphodelaceae <i>Aloe falcata</i> Baker	Leaf	Chest pain and fatigue	Least concern	Harvesting involved removal of few leaves with a knife far from to the base [36]
<i>Aloe marlothii</i> A. Berger subsp. <i>Marlothii</i>	Leaf	Chest pain, sore throat and pneumonia	Least concern	Harvesting involved removal of few leaves with a knife far from to the base [36]
Amaryllidaceae <i>Gethyllis namaquensis</i> (Schonland) Oberm.	Bulb	Chlamydia and diabetes mellitus	Least concern	Cultivated in home gardens [38]
Anacardiaceae <i>Sclerocarya birrea</i> (A. Rich.) Hochst.	Bark	Female infertility	Least concern	Cultivated in home gardens [38]
	Leaf	Fodder		Protected within dryland agricultural farming system [39]. Fruits can only be harvested when they have fallen to the ground. Failure to adhere is believed to cause fever or snakes would appear in homesteads [40]
	Fruit	Traditional beer		
	Whole plant	Rituals ceremonies are performed on the tree as a way of appeasing the ancestors		

Botanical family and species name	Used part	Traditional value	Conservation status (red data list)	Traditional plant conservation practices
Cannabaceae <i>Celtis africana</i> Burm.f.	Stem	Used to make magical sticks which are driven into the ground to protect against witchcraft	Least concern	Tree cannot be planted in the homestead. Taboos associated with the tree are enforced through beliefs such that violators or the community will experience illnesses [40]
Capparaceae <i>Boscia albitrunca</i> Gilg and Gilg-Ben.	Root	HIV/AIDS	Least concern	Cultivated in home gardens [38]
	Fruit	Eaten as food		Protected within dryland agricultural farming system [39]
Celastraceae <i>Elaeodendron transvaalense</i> (Burt Davy) R. H.Archer	Root	HIV/AIDS	Near threatened A4ad	Cultivated in home gardens [38]
<i>Gymnosporia senegalensis</i> (Lam.) Loes	Root	Blood disorders	Least concern	Only small quantity of lateral roots are harvested [41]
Cucurbitaceae <i>Citrullus lanatus</i> (Thunb.) Matsum. and Nakai	Fruit	Headache	Least concern	Hand-picked and some fruits with seeds are left behind to allow natural regrowth during favorable season [36]
<i>Cucumis zeyheri</i> Sond.	Fruit	Lack of appetite and TB	Least concern	Hand-picked and some fruits with seeds are left behind to allow natural regrowth during favorable season [36]
<i>Momordica balsamina</i> L.	Leaf	Edible vegetable eaten with porridge	Least concern	Only the tender leaves are selected allowing the leaves to reach maturity [40]
<i>Momordica boivinii</i> Baill.	Leaf	Edible vegetable eaten during times of drought	Least concern	Only the tender leaves are selected allowing the leaves to reach maturity. Leaves must not be harvested or touched by menstruating women; otherwise, it is believed that the vegetable will shrink in size [40]
Dioscoreaceae <i>Dioscorea sylvatica</i> Eckl.	Tuber	Gonorrhea	Vulnerable A2cd	Cultivated in home gardens [38]
Fabaceae <i>Vachellia karroo</i> Hayne	Stem	Firewood	Least concern	Harvesting and felling of species from the graveyard are forbidden, because graveyards are believed to be the home of the ancestors [41]
<i>Vachellia rehmanniana</i> Schinz.	Stem	Firewood		

Botanical family and species name	Used part	Traditional value	Conservation status (red data list)	Traditional plant conservation practices
<i>Cassia abbreviata</i> Oliv. subsp. beareana (Holmes) Brennan	Bark	Chest pain, fatigue, and sore throat	Least concern	Stripped only on the eastern side leaving other sides untouched [36]
<i>Colophospermum mopane</i> Kirk ex Benth.	Stem and leaf	Firewood and fodder	Least concern	Protected within dryland agricultural farming system [39]
<i>Dichrostachys cinerea</i> (L.) Wight and Arn.	Stem	Construction of huts and livestock enclosures	Least concern	The harvesting is restricted to matured branching stems. Felling of immature species is prohibited [42]
	Whole plant	Firewood		Collection is confined to the dead wood. A fine is imposed on people who cut live wood [41]
<i>Erythrina lysistemon</i> Hutch	Bark	Chest pain, sore throat, and TB	Least concern	Stripped only on the eastern side leaving other sides untouched [36]
Mundulea sericea (Willd.) A. Chev	Root	Protect against witchcraft	Least concern	The tree is prohibited from being used as firewood in homesteads where cattle are present [40]
<i>Peltophorum africanum</i> Sond.	Bark	Post-partum	Least concern	Cultivated in home gardens [38]
<i>Vigna unguiculata</i> L.	Leaf	Eaten as vegetable	Not evaluated	Hand-picked [43]
Gentianaceae	Bark	High blood pressure	Not evaluated	There are taboos preventing this species from being cut down, used as firewood or taken back to the homestead [40]
<i>Anthocleista grandiflora</i> Gilg	Leaf	Used to cover maize grains to encourage germination when malt is prepared Used to cover female bodies during rituals		
Hyacinthaceae	Bulb	Female infertility, impotence, gonorrhea, HIV/AIDS, and hypertension	Data deficient — taxonomically problematic	Cultivated in home gardens [38]
<i>Drimia sanguinea</i> (Schinz) Jessop	Bulb	Chest pain, pneumonia, and TB	Near threatened A2d	Harvesting involved cutting with a knife from the base leaving roots in the ground intact [36]
Hyacinthaceae	Bulb	Aphonia, chlamydia, fatigue, impotence, sore throat, and TB	Near threatened B2ab (v)	Harvesting involved cutting with a knife from the base leaving roots in the ground intact [36]
<i>Eucomis pallidiflora</i> Baker. subsp. pole-evansii (N. E.Br.) Reyneke				
Hypoxidaceae	Tuber	Gonorrhea and HIV/ AIDS	Least concern	Cultivated in home gardens [38]. Harvesting involves cutting with a knife from
<i>Hypoxis hemerocallidea</i>				

Botanical family and species name	Used part	Traditional value	Conservation status (red data list)	Traditional plant conservation practices
Fisch., C.A.Mey. and Avé-Lall				the base leaving roots in the ground intact [36]
Flacourtiaceae <i>Dovyalis caffra</i> (Hook. F. and Harv.) Hook. F	Fruit	Eaten as food	Least concern	Protected within dryland agricultural farming system [39]
Kirkiaceae <i>Kirkia wilmsii</i> Engl	Tuber	Used to treat hypertension	Least concern	Only the older tubers are being harvested [35]
Lauraceae <i>Cryptocarya transvaalensis</i> Burt Davy	Bark	Asthma, pneumonia, sore throat, and TB	Least concern	Stripped only on the eastern side leaving other sides untouched [36]
Lamiaceae <i>Leonotis leonurus</i> (L.) R.Br.	Leaf	Asthma and chest pain	Least concern	Acquired by handpicking without breaking the twigs in homegardens [36]
Malvaceae <i>Adansonia digitata</i> L.	Fruit	Eaten as food	Least concern	Protected within dryland agricultural farming system [39]
<i>Grewia bicolor</i> Juss	Fruit	Eaten as food	Least concern	Protected within dryland agricultural farming system [39]
Moraceae <i>Ficus burkei</i> (Miq.) Miq.	Fruit	Headache	Least concern	Hand-picked, throwing of stones at the tree to detach fruits, knocking them down with long sticks and collecting them from the grounds [36]
Rhamnaceae <i>Berchemia discolor</i> (Klotzsch) Hemsl	Fruit	Eaten as food	Least concern	Protected within dryland agricultural farming system [39]
Rubiaceae <i>Vangueria infausta</i> Burch	Fruit	Eaten as food	Least concern	Only collected from the ground [42]
<i>Breonadia salicina</i> (Vahl) Hepper and J.R.I. Wood	Whole plant	Tree used to store water	Least concern	Tree is prohibited from entering homesteads, and a failure to adhere to the taboo results in sterility among household members. The species is also prohibited from being used for firewood, hedge fencing, building work, or wood carving [40]
Rutaceae <i>Zanthoxylum capense</i> Harv.	Root	HIV/AIDS	Least concern	Cultivated in home gardens [38]

Botanical family and species name	Used part	Traditional value	Conservation status (red data list)	Traditional plant conservation practices
<i>Zanthoxylum humile</i> (E.A. Bruce) P.G. Waterman	Root	HIV/AIDS	Least concern	Cultivated in home gardens [38]
Ochnaceae <i>Brackenridgea zanguebarica</i> Oliv.	Bark	Protect people against witchcraft; protect the whole homestead from evil people and for discouraging opponents in sporting events such as soccer Used as catalyst for other medicines to enhance its potency	Critically endangered A2ad; B1ab (ii, v)	After the collection of plant materials for medicinal or magical purposes, it is prohibited to take them to the house or be touched by women because they may hamper menstruation [44] Tree is prohibited from entering homesteads, and a failure to adhere to the taboo results in sterility among household members. The species is also prohibited from being used for firewood, hedge fencing, building work, or wood carving [40]
Olacaceae <i>Ximenia caffra</i> Sond.	Fruit	Eaten as food	Least concern	Only collected from the ground [42]
Poaceae Sporobolus pyramidalis P. Beauv	Culm	Broom and fodder	Least concern	The harvesting of the species is restricted to the culms. The base is not harvested to give the species a chance to regrow in the next season [42]
Sapindaceae <i>Pappea capensis</i> Eckl. and Zeyh	Fruit	Eaten as food	Least concern	Cutting of green branches and twigs for harvesting is highly prohibited [41]
Verbenaceae <i>Lippia javanica</i> (Burm.f.) Spreng.	Leaf	Asthma, rhinitis sinusitis, and TB	Least concern	Acquired by handpicking without breaking the twigs in homegardens [36]
Zamiaceae <i>Encephalartos transvenosus</i> Stapf and Burt Davy	Bark	Used to guard against evil spirits and fight enemies	Least concern	Only harvested by people who are trained in harvesting rituals, and are not collected from areas where people frequent, as it is believed this will diminish the effectiveness of the plant [35]

Table 1.
Diversity of useful wild plant resources and traditional conservation strategies in the Limpopo province, South Africa.

Gilg-Ben (eaten as food and HIV/AIDS medicine), *Colophospermum mopane* Kirk ex Benth (firewood and fodder), *Dichrostachys cinerea* (L.) Wight and Arn. (construction of huts and livestock enclosures, and firewood), and *Sclerocarya birrea* (A. Rich.) Hochst (used to treat female infertility, fodder, valued for rituals ceremonies

as a way of appeasing the ancestors and for making traditional beer) fell under the multiple-use category and were cherished for the mentioned livelihoods. Plants belonging to this category are more likely to be overharvested due to their multiple cultural values [52, 53].

Overall, all the above-stated use groups is a reflection of a close relationship between the local people and their natural environment, which has led to the development of a rich knowledge based on plants, plant-use, and related practices [54]. Comparisons of our finding regarding the most dominant plant use category concur to that noted by other researchers in South Africa [55, 56], and other African countries such as Ethiopia [57], Lesotho [58], and Botswana [59]. Contrary findings were noted in Kenya [47], Brazil [60], and India [61]. This may be the result of cultural differences in knowledge of the plant resource uses. Nonetheless, it should be stated that a larger number of wild plants used as medicines and foods for human was expected in this review, first due to the fact that traditional medicine is highly rooted in many cultures of the Limpopo Province [38, 62, 63], and second because rural people in this province grew-up eating wild edible plants and their majority *live below the poverty* line [64]. Thus, it is acceptable to postulate that the use of plant resources for food and medicinal purposes by indigenous people of the Limpopo Province will increase tremendously in the foreseeable future. This is because the indigenous communities have enticements to utilize and conserve wild plants when their livelihoods depend on gathering of their products.

3.3 Plant habit and used plant part/s

The growth form analysis of 50 documented useful plant resources revealed that trees (62%, $n = 31$), herbs (30%, $n = 15$), and shrubs (13%, $n = 4$), respectively, were harvested for their products in the present study. These are the common plant habits exploited by indigenous people in South Africa [55, 65] and other African countries [57, 66] to meet their various needs. It should be stated that the supremacy of trees in the present study is attributed to multifaceted factors including cultural beliefs attached to them (i.e., provision of rain) and their utilization in local ritual ceremonies and a wide range of products (i.e., medicines, foods, fodders, fruits, and firewood, among other provisions) they provide to local communities. Equally, herbaceous taxa were considerably represented mainly due to numerous values they provide (**Table 1**). However, the shrubby species, namely, *Aloe falcata* Baker, *Kleinia longiflora* DC, *Leonotis leonurus* (L.) R.Br. and *Lippia javanica* (Burm.f.) Spreng were only harvested for therapeutic purposes, which probably explain their lower preference by local communities of the Limpopo Province. Generally, sustainable harvesting of products from the afore-stated growth forms should be promoted in the Limpopo Province for the sake of both conservations of the plants and livelihoods of local people.

The actual impact of wild plant harvesting depends on the specific growth form or type of resource that is removed [67]. Different plant exudates from herbs, shrubs, and trees recorded in the current study were obtained by local communities to meet their livelihoods, with fruits, followed by leaves, bark, and roots, respectively, being the most preferred. Other plant parts were used to a lesser extent (**Figure 1**). The widespread use of leaves and fruits by indigenous people to meet their different needs is well documented in ethnobotanical literatures [68–70]. Their high uses in this study are mainly attributed to their economic value (i.e., source of cash generated from the sale of fresh fruits) and use as food supplements by many rural communities in the Limpopo Province. Other factors that contributed to high exploitation of fruits are their local abundance in many free access

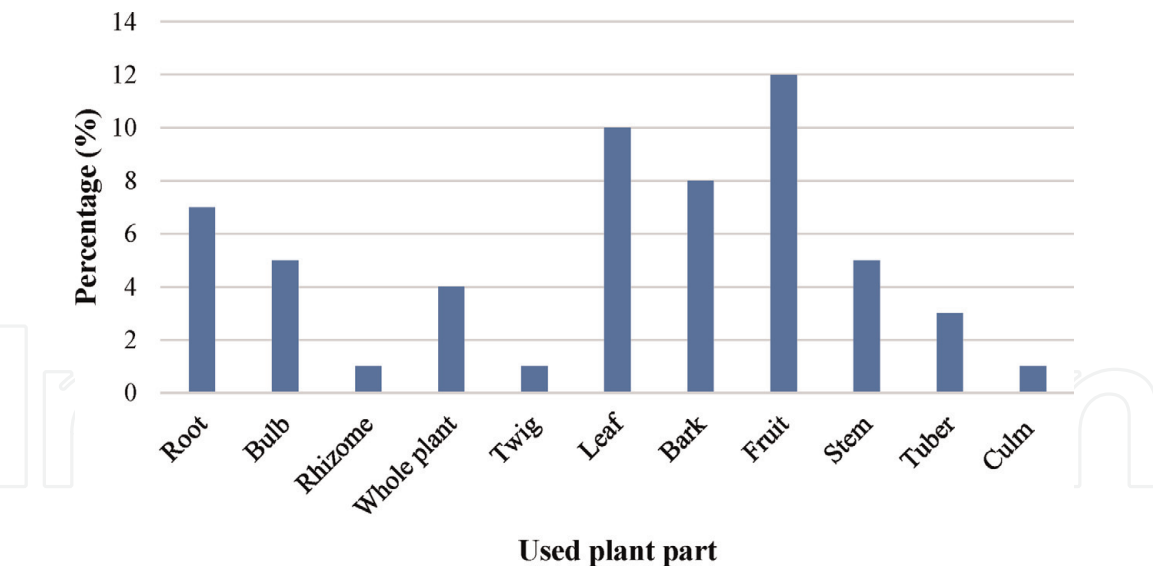


Figure 1.
Plant parts harvested to meet livelihoods.

communal lands of this province and the fact that they are consumed raw without any processing.

Leaves were the second most commonly used plant part and were mainly exploited as medicines and vegetable (**Table 1**). Consumption of leaves for these livelihoods is locally believed to be ascribed to their efficacy as remedies and rich *nutrients*. From a conservation standpoint, the high harvesting of leaves is less destructive to the survival of plants [71, 72]. The opposite of this can be said for bark and roots. High usage of these organs exclusively as medicines in this study is directly linked to the traditional beliefs that they store more healing power than any other plant part [44, 73]. This belief, however, has a great potential to encourage their extensive harvesting, which in turn will make the targeted plant species vulnerable to overexploitation. The rest of morphological plant parts did not appear to be of great value to the indigenous people of the Limpopo Province (**Figure 1**).

3.4 Conservation status of plant species

The present study revealed that all 50 plant resources documented are listed on the South African National Red Data List of Plants, with the majority (82%, $n = 41$) appearing as Least Concern. This finding has a positive conservation implication mainly because more widespread and abundant species in the wild are included in this category [36]. Therefore, it is acceptable to state that most useful taxa in the Limpopo Province might be still fairly abundant within the wilderness.

However, 12% ($n = 6$) of Red Data listed plants recorded in this study are of conservation concern with the following status: Critically Endangered (*Brackenridgea zanguebarica* Oliv.), Endangered (*Alepidea amatymbica* Eckl. and Zeyh.), Near Threatened (*Drimia sanguinea* (Schinz) Jessop, *Eucomis pallidiflora* Baker. subsp. *pole-evansii* (N.E.Br.) Reyneke and *Elaeodendron transvaalense* (Burt Davy) R.H. Archer) and Vulnerable (*Dioscorea sylvatica* Eckl.). The rest as either Not Evaluated (4%, $n = 2$) or have Data Deficient (2%, $n = 1$) status. It is worth stating that most of the abovementioned species are constantly reported by plant resource harvesters in the Limpopo Province as very difficult to find in their natural habitats, with prime rationale being excessive exploitation for commercial purposes [35, 74]. Another factor put forward by indigenous people of the Limpopo Province that jeopardize these plants is gathering by outsiders and other local

people who are not trained on both the traditional harvesting of useful wild plants and approaches to conservation.

3.5 Traditional plant conservation strategies

Interestingly, this study also revealed that the indigenous people of the Limpopo Province, who depend on the recorded wild plant resources for survival, have evolved ways of managing them (**Table 1**). Generally, traditional leaders (i.e., chiefs and headmen) are the ones managing the utilization of these resources via traditional rules and regulations, and this is common practice in other provinces of South Africa [75] and other African countries [76]. On the contrary, Kepe [77] found that in areas that are held as common property by all villagers in Mkambati area of the Eastern Cape Province (South Africa), people do not have to ask for permission to collect wild plant resources. In the present study, anyone who breaks the traditional management strategies were fined a certain amount of money and restricted to harvest wild plant resources for a specified period of time. Overall, the traditional approaches used in this study to conserve plant diversity encompass the following;

3.5.1 Traditional beliefs and taboos

These techniques are used to guide the social behavior of the community members in the harvesting of wild plant resources [78, 79]. For instance, organs from plant species with medicinal value particularly those that are used for magical purposes such as *A. amatymbica* (rhizome), *E. transvenosus* (bark), and *S. ilicifolius* (root) are only collected by people who are trained in harvesting rituals and are not obtained from areas where people frequent, as it is believed this will diminish the efficacy of the medication [35]. Generally, from a conservation standpoint, the effectiveness of traditional practices associated with all the abovementioned magical plants are overshadowed by the fact that they have other values (i.e., non-medicinal magical values), which are not regulated by the traditional beliefs systems. We concur with Mowo et al. [80] who stated that despite the strengths, some traditional practices have weaknesses that may limit their use in management plans that favor sustainability.

Similarly, *C. africana* which is used to make medicine to protect against witchcraft is not allowed to be planted in the homestead, and failure to adhere to this is believed to result in the violators or the community members being infected with illnesses [40]. Although this taboo might create fear among the community members and thus instill the value of respect for the species which will ultimately serve to limit its harvesting, this can only be effective if *C. africana* is wholly used for magical purposes. Unfortunately, studies conducted in the Limpopo Province indicated *C. africana* is a multipurpose tree, that is in addition of being valued for magic purposes, it is also highly harvested as drug for nose, ear, and tooth infections [63], for vegetable and craftwork [45].

The same can be said for *B. zanguebarica*; traditionally, after the collection of materials for medicinal or magical purposes from this tree, it is prohibited to take them to the house or be touched by women because they may hamper menstruation [44]. However, the over-exploitation of *B. zanguebarica* within its natural area of occurrence [81], and its frequent availability in *muthi* shops (shops selling medicinal plants) owned by females across the Limpopo province [35, 41] is a clear indication that most local people, especially commercial harvesters do not follow the traditional taboos that are relevant in promoting the plants' conservation.

Therefore, the use of traditional beliefs as an instrument of conserving *B. zanguebarica* would not be possible without the harvesters' compliance.

Another plant species valued as medicine for magic, *M. sericea*, is prohibited from being used as firewood in homesteads where cattle are present [40]. This however can only aid in the conservation of *M. sericea* in deep rural areas of the Limpopo Province wherein the use of firewood and cattle nurturing is prevalent in many households, but with no additional uses attached to it for other livelihoods. The prohibition of *R. caffra* from being harvested due to the traditional beliefs that it attracts rain, as a conservation strategy [37], will not have great impact due to the fact that local rural communities also rely on the species for the provision of wood for craftwork and medicine [45].

Restricted harvesting and felling of *V. karroo* and *V. rehmanniana* from the graveyards, due to the belief that these areas are ancestral home [41], can only aid in the conservation of these trees found in the graveyards and provided that local community strictly adhere to such belief. Overall, the effectiveness of traditional beliefs and taboos for the conservation of plant resources as instituted by traditional leaders in the Limpopo Province is hindered by numerous factors such as non-compliance by community members, traditional leaders being inexperienced in implementing and enforcing regulations, as well as very young leaders who do not command respect [41]. This is in contrast with the finding of Gwali et al. [24] who stated that in rural areas of Uganda, the enforcement of traditional beliefs and taboos is very difficult due to high economic and social depression resulting from the long and protracted period of political and social instability. Thus, it can be said that certain taboos and traditional bye-laws may not be adequate conservation approaches for wild plant resources in many rural communities of Africa including the Limpopo Province. Comprehensive studies focusing on traditional belief systems used in the management of wild plant resources across this province would shed light on those that promote the effective conservation.

3.5.2 Sustainable harvesting practices

Findings from this study also revealed that indigenous people of the Limpopo Province have developed the sustainable harvesting strategies of diverse parts from the recorded wild plant resources. Harvesting of bulb from *D. sanguinea* (Schinz) Jessop., *E. pallidiflora* Baker. subsp. *pole-evansii* (N.E.Br.) Reyneke, and *Tulbaghia violacea* Harv. var. *violacea* basically involve their cutting with a knife from the base leaving roots in the ground intact. This practice will encourage the reproduction and regeneration of the harvested species, therefore ensuring the continual supply of the product from the same taxa. Similarly, selective collection of only older tubers from *Kirkia wilmsii* Engl. [35] and small quantity of *Gymnosporia senegalensis* (Lam.) Loes lateral roots [41] will not have detrimental effect on the survival of this tree.

Generally, the traditional techniques used to obtain leaves in this study seemed to be sustainable. For instance, their harvesting from species such as *Aloe marlothii* A. Berger subsp. *marlothii* and *A. falcata* Baker involved the removal of few leaves with a knife far from the base. This harvesting technique encourages re-growth of leaves post collection [82]. Similarly, collection of *L. leonurus* by handpicking without breaking and cutting the twigs/branches minimize damages to the trunk, thus leaving the tree less susceptible to disease infestation. The same can be said with the harvesting of *K. longiflora* twigs, which were obtained by hand via breaking of the required amounts in the wild. Explicit harvesting of tender leaves from *M. balsamina*, *M. boivinii*, and *V. unguiculata* for consumption as vegetable allows the leaves to reach maturity [40]. This in turn allows the species to reach maturity stage and regrow in the subsequent season [42].

The methods of obtaining fruits from species such as *Citrullus lanatus* (Thunb.) Matsum. and Nakai, *Cucumis zeyheri* Sond., and *Pappea capensis* Eckl. and Zeyh includes hand-picking without breaking the twigs. This method is also common among indigenous people of Africa [83–85]. In addition to being hand-picked, *Ficus burkei* (Miq.) Miq. fruits were also harvested by throwing stones at the trees to detach them and subsequently collecting from the grounds [36]. Fruits from *Vangueria infausta* Burch. and *Ximenia caffra* Sond. are only allowed to be obtained from the ground following abscission [42]. Although this harvesting method is sustainable, collection of a greater number of fruits from the ground has the potential to inhibit natural seeds dispersal, which will ultimately affect the population expansion. This is because fruits play an important role in the seed dispersal of many of the abovementioned plants.

Bark is harvested from trees such as *Cassia abbreviata* Oliv. subsp. *beareana* (Holmes) Brenan, *Cryptocarya transvaalensis* Burt Davy, *Dichrostachys cinerea* (L.) Wight and Arn., and *Erythrina lysistemon* Hutch., only on the eastern side leaving other sides untouched (**Table 1**). An assessment of the recovery rate of bark growth post-exploitation using this method showed a good healing wound, thus suggesting that the impact of its harvesting does not affect the existence of the species [86]. A possible explanation for this is that tree receives adequate sunlight on the eastern site, which plays a crucial role in the healing process.

3.5.3 Domestication

Two systems of wild plant cultivation practiced by indigenous people of the Limpopo Province include (a) propagation in the home gardens and (b) an agroforestry system where by naturally growing plants are maintained and protected within dryland agricultural farming system. Species domesticated in the home gardens encompassed *B. albitrunca*, *D. sylvatica*, *Drimia elata* Jacq., *E. transvaalense*, *Gethyllis namaquensis* (Schonland) Oberm, *H. hemerocallidea*, *Lippia javanica* (Burm.f.) Spreng, *Peltophorum africanum* Sond., *S. birrea*, *Zanthoxylum capense* Harv., and *Zanthoxylum humile* (E.A.Bruce) P.G.Waterman. Cultivation of these plants is generally attributed to their increasing scarcity in the wilderness. This initiative, nevertheless, has the potential to lessen harvesting pressure of the aforementioned species occurring in the wilderness and ensure instant supply of their required part/s. Furthermore, it will aid in the conservation of threatened therapeutic species such as *D. sylvatica* and *E. transvaalense*. However, this can have conservation impacts only if the users harvest the plants exclusively from their home gardens. Wiersum et al. [87] found that medicinal plant domestication by indigenous people is less based on preserving biodiversity, but more on maximizing harvest to certify individual needs and to generate income.

Native wild trees such as *Adansonia digitata* L., *B. discolor*, *C. mopane*, *D. caffra*, and *G. bicolor* that grew naturally in the local agricultural farming system were managed and conserved in order to obtain sustainable multiple supply of desired products and services from them (**Table 1**). This is a common practice among rural communities in other provinces of South Africa [88], other African countries [89, 90], and elsewhere [91]. Generally, adaptation of agroforestry practices of conserving *A. digitata*, *B. discolor*, *C. mopane*, *D. caffra*, and *G. bicolor* by cultural communities in the Limpopo Province will not only contribute towards the provision of food and cultural materials but will also enhance local environmental resilience. The role of traditional agroforestry practices in this regard cannot be overemphasized [92–95]. To realize the effective role played by these practices in the conservation of wild indigenous plant resources, we recommend that

indigenous communities of the Limpopo Province should prioritize the tree species, which provide multiple useful products and ecosystem services.

4. Conclusions

The present study should be viewed as an initial attempt to comprehend the utilization of wild plant resources and their traditional conservation strategies in the Limpopo Province of South Africa. Overall, this study indicated that rural people are endowed with extensive knowledge on native wild plant uses and associated innovative techniques of conserving them as evidenced in **Table 1**. However, not all the practices associated with the latter promote effective conservation and sustainable use of wild plant resources. As such, those that promote the protection of plants should be promoted and integrated in the local management plans of flora. This is will go a long way in complementing the contemporary conservation approaches (i.e., legislative measures) of wild plant resources, and ultimately ensure the continual availability of these resources for poor rural households of the Limpopo Province and other areas of South Africa.

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Conflict of interest

The authors declare no conflict of interest.

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