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A Review Study on Alternative Conservation and Management Methods to Sustain Medicinal Plants in South Africa

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ABSTRACT

The use of indigenous medicinal plants is still prevalent as the most trusted form of health care, predominantly in developing countries. Overuse of medicinal plant resources, coupled with the negative impacts of unpredictable rainfall and rising temperatures, necessitated the development of local methods to conserve medicinal plants. These indigenous conservation methods have proved to be failing and aggravating threats to medicinal plants. This study aimed to review the alternative conservation and management methods to protect medicinal plants in South Africa. A review of the literature presents in situ, ex situ, natural reserves, wild nurseries, botanical gardens, and seed banks as alternative conservation methods proposed and used by scientists to conserve and manage medicinal plant species. These methods are Western practices introduced to the local communities in an effort to conserve and protect the indigenous medicinal plant species for future use and as a cultural heritage. From a qualitative standpoint, this study adopted the interpretivist research design to offer support to employ the systematic review method. Seminal studies on this subject were purposively collected using keywords extracted from the research topic. The collected data was analysed using the inductive Textual Content Analysis (TCA) method. The results of this study reveal that there are various conservation methods that are implemented as strategies to safeguard the existing medicinal plants, and this proves if these methods are implemented correctly these plants will still be available for future use. It is concluded and recommended that the demand for medicinal plants imposes huge threats to their anticipated availabilities, therefore, the relevant stakeholders need to take urgent corrective measures concerned parties should be consistently exposed to improved resources, advanced training and better education about the benefits and importance of these plants.

Keywords: *Medicinal plants, conservation method, In situ, natural resource*

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INTRODUCTION

Medicinal plants are important to humanity and continue to be used worldwide as a source of food and basic healthcare.[1] Medicinal plants are globally valuable sources of herbal products, and they are

[1] B. A. Rasool Hassan, "Medicinal Plants (Importance and Uses)," *Pharmaceut Anal Acta* 3, no. 10 (2012): 2153–2435.

disappearing at a high rate due to human and environmental factors.[2] Herbal medicines and their preparations have been used for thousands of years throughout the world, both in developing countries such as South Africa and in developed countries. For example, Canada relies on herbal medicine.[3] According to the International Union for Conservation of Nature and the World Wildlife Fund, there are between 50,000 and 80,000 flowering plant species used for medicinal purposes worldwide.[4]

An estimated number of 15,000 medicinal plant species are under threat of extinction.[5] The current loss of medicinal plant species is estimated to be between 100 and 1,000 times greater than the natural extinction rate that is expected and that in every two years, at least one potential drug is lost.[5] Among these, approximately 15,000 plant species are under threat that comes from overharvesting and habitat destruction of these species. Also, about 20% of their wild properties are almost exhausted with the increasing human population and high demand and high consumption. To address these negative factors such as urbanisation, habitat loss and population increase of medicinal plants, knowledge, and skills about the management of biodiversity are required.[6]

Good management and conservation of these species are thus necessary for their continued availability and use to maintain affordable and readily available health care.[7] However, the lack of management of biodiversity may lead to the destruction of resources, which in turn are essential for the survival of people.[8] South Africa tasked the South African National Botanical Institute with developing a generic biodiversity management plan to regulate the use of medicinal plant resources. As a result, the National Environmental Management Biodiversity Act (No. 10 of 2004) and the Biodiversity Management Plans norms and standards were implemented to regulate medicinal plant use. With regard to the conservation of medicinal plants numerous sets of recommendations have been brought together, these include the innovation of systems for plant species inventorying and status monitoring and the need for corresponding conservation methods that will be based on both the in situ and ex situ strategies.[9] Sustainable use of wild resources for plant species with a rising rate of limited supplies can be an effective conservation alternative method.[10] In countries such as China and South Africa, there is a high demand for medicinal plants due to their large populations, resulting in their situation being particularly critical.[11]

Furthermore, in many other parts of the world, South Africa's indigenous plant resources are depleting and good management, as well as investment in the conservation of biodiversity, is necessary. This initiative could improve the availability and sustainability of medicinal plant resources. Conservation of biodiversity in South Africa used to be based on a law enforcement method until recently. It is increasingly evident that the used approach was not effective, and new conservation methods are required.[12] As much as the indigenous conservation practices used by traditional health practitioners and other community members are noticeably useful in the preservation of medicinal plants. Extensive reliance on medicinal plants for primary health care in South Africa is reported in

[2] Brian Czech, Patrick K Devers, and Paul R Krausman, "The Relationship of Gender to Species Conservation Attitudes," *Wildlife Society Bulletin*, (2001), 187–94, 191.
[3] Cumali Keskin, "Medicinal Plants and Their Traditional Uses," *Journal of Advances in Plant Biology* 1, no. 2 (2018): 8–12; Stuart L Pimm et al., "The Future of Biodiversity," *Science* 269, no. 5222 (1995): 347–50.
[4] Y. Uprety, H. Asselin, A. Dhakal, and N. Julien, "Traditional Use of Medicinal Plants in the Boreal Forest of Canada: Review and Perspectives." *Journal of Ethnobiology and Ethnomedicine* 8, no.1 (2012): 7.
[5] G.J. Martin, *Ethnobotany: A Methods Manual*, (Chapman Hall; New York, 1995).
[6] K. R. Stern et al., *Introductory Plant Biology* (New York : Califonia State University-Chicago, 2000).
[7] Y. Steenkamp, *The Concept of Endemicism and the Conservation of Plant Diversity Impact.* (Pamsgale: Impact Printers, 2002).
[8] Witness Maluleke and Nyiko Faith Shibambu, "Exploring Illegal Harvesting and Theft of the Selected South African Endangered Indigenous Plants on the Red Data List: Case Studies of Rural Areas," *ADRRI Journal of Arts and Social Sciences* 18, no. 3 (6) October-December (2021): 244–95, 264.
[9] Czech, Devers, and Krausman, "The Relationship of Gender to Species Conservation Attitudes," 191.
[10] Uprety et al., "Traditional Use of Medicinal Plants in the Boreal Forest of Canada: Review and Perspectives."
[11] Czech, Devers, and Krausman, "The Relationship of Gender to Species Conservation Attitudes," 191.
[12] Tukiso Errol Moeng, "An Investigation into the Trade of Medicinal Plants by Muthi Shops and Street Vendors in the Limpopo Province, South Africa" (2010).

the literature. However, formalised, alternative and effective methods are required to conserve and regulate the use of medicinal plants. Thus, this study seeks to describe the overexploitation and threat to natural resources such as medicinal plants. Numerous efforts have been implemented of late in an attempt to conserve the multiplicity of medicinal plants. Therefore, the present study seeks to recommend an approach to boost the conservation of medicinal plants.[13]

METHODOLOGY

From a qualitative standpoint, this study adopted the interpretivist research design to offer support for employing systematic review methods. This research design is meant to evaluate the improvement in a specific study field- a study on alternative conservation and management of medicinal plants in South Africa.[14] Moreover, the aim of this research design is to recognise, assess and summarise the outcomes of the reviewed research studies by making existing data more accessible to decision-makers.[15]

In this study, the research team used secondary research results on the efforts of government institutions and scientific organizations to conserve and manage the indigenous medicinal plants harvested by traditional health practitioners and ordinary community members to meet primary health care needs. A purposive sampling technique was used to make a collection of reference materials on the use of medicinal plants and the different methods of conservation and management of the species. When researchers rely on their own judgement, choosing elements of the sample is called a non-probability sampling method of purposive sampling. Researchers often have faith that they can gain an illustrative sample by using sound judgment, which will result in saving time and money. Seminal studies on this subject were purposely collected using keywords extracted from the research topic. Only sources with integrated ideas and not separate writings on this topic were reviewed. The reviewed documentary studies were demarcated into recent studies—not older than 15 years from the time this study was conducted. Other considered studies outside this projection provided greater significance to the research topic and offered relevance and trustworthiness. Again, the researchers used Textual Content Analysis (TCA) to analyse consulted textual materials and to collect as well as categorise relevant data on this subject.[16]

RESULTS AND DISCUSSION

Alternative Conservation and Management Methods

Extensive reliance on medicinal plants for primary health care in South Africa is reported in the literature. However, formalised, alternative and effective methods are required to conserve and regulate the use of medicinal plants.[17] Numerous efforts have been implemented of late in an attempt to conserve the multiplicity of medicinal plants.[18]

The review presents six main themes as the main alternative ways to protect and manage medicinal plants.

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[13] N. F. Shibambu, M. K Malatji, and W. Maluleke, "The Effects of Urbanisation on the Availability of Medicinal Plants (Red Data Species) In Limpopo Province, South Africa: A Literature Analysis," *Social Science International Conference* , (2021), 1–16.

[14] Viorela Dan, "Empirical and Non-Empirical Methods," *Int Encyclopedia Commun Res Methods* 1 (2017): 1–3.

[15] Sarah M Yannascoli et al., "How to Write a Systematic Review: A Step-by-Step Guide," *University of Pennsylvania Orthopaedic Journal* 23 (2013): 64–69, 66; Osward Bwanga, "How to Conduct a Qualitative Systematic Review to Guide Evidence-Based Practice in Radiography," *International Journal of Sciences: Basic and Applied Research* 52, no. 1 (2020): 205–13, 208.

[16] Alan Bryman and Duncan Cramer, *Quantitative Data Analysis with IBM SPSS 17, 18 & 19: A Guide for Social Scientists* (Routledge, 2012); Robert Matthews and Elizabeth Ross, *Research Methods: A Practical Guide for the Social Sciences* (Pearson Education Ltd, 2010).

[17] Venkata Naveen Kasagana and Swathi Sree Karumuri, "Conservation of Medicinal Plants (Past, Present & Future Trends)," *Journal of Pharmaceutical Sciences and Research* 3, no. 8 (2011): 1378.

[18] E.T. Moeng and M. J. Potgieter, "The Trade of Medicinal Plants by Muthi Shops and Street Vendors in the Limpopo Province, South Africa," *Journal of Medicinal Plants Research* 5, no. 4 (2011): 558–64.

In situ conservation

Most of the common medicinal plants in South Africa are said to be endemic because they make secondary metabolites when they respond to things in their natural original surroundings.[19] The in situ conservation methods in a complete setting allow the safeguarding of medicinal plants and protection of the natural environment together with the complex relations that exist between them.[20] Moreover, it is proven that in situ conservation can increase the quantity of variety that can be protected and can give strength to the relationship between medicinal conservation and its sustainable use.[21] In situ conservation has been shown to put efforts into a world range that is concentrated on forming the conservation areas and taking a view that is ecosystem-oriented, instead of species-oriented.[22] In situ conservation that is successful is guided by a set of guidelines, protocols, and potential compliance of medicinal plants around the area.[23]

Ex situ conservation

Ex situ conservation is not usually clearly differentiated from in situ conservation. However, it is an effective conservation practice, especially for medicinal plants that are overexploited and under threat with a low level of growth, scarcity, and high susceptibility to replanting diseases.[24] The main aim of ex situ conservation is to cultivate and naturalize endangered medicinal plant species to ensure that they continue to survive and sometimes to produce large amounts of plant material used to create medicine, and action is often taken immediately to conserve medicinal plant resources.[25] Moreover, the majority of medicinal plant species from the previous wild can retain high influence when grown in protected areas that are far away from the areas where they naturally grow. Furthermore, they can also have their reproductive resources taken and stored in conservation areas such as seed banks for the future.[26]

In 'In Situ and Ex Situ' conservation are the two main methods for the conservation of indigenous plant species.[27] In South Africa, the law enforcement approach was used for the conservation of medicinal plants, however, the approach has evidently been unsuccessful and new, effective and participatory methods are needed to protect medicinal plants.[28] To answer to the overexploitation and threat of natural resources such as medicinal plants, numerous efforts have been implemented of late in an attempt to conserve the multiplicity of medicinal plants. It is highlighted that Community-Based Natural Resources Management is responsible for the conservation of medicinal plants.[29]

Recommendation of the in situ and ex situ conservation practices is based on the observations that whereas medicinal plant conservation is aimed at supporting the sustainable development of natural

[19] Czech, Devers, and Krausman, "The Relationship of Gender to Species Conservation Attitudes," 191.
[20] Paul Gepts, "Plant Genetic Resources Conservation and Utilization: The Accomplishments and Future of a Societal Insurance Policy," *Crop Science* 46, no. 5 (2006): 2284.
[21] Félix Forest et al., "Preserving the Evolutionary Potential of Floras in Biodiversity Hotspots," *Nature* 445, no. 7129 (2007): 757–60, 759.
[22] Jianzhang Ma, Ke Rong, and Kun Cheng, "Research and Practice on Biodiversity in Situ Conservation in China: Progress and Prospect.," *Biodiversity Science* 20, no. 5 (2012): 551.
[23] Sergei Volis and Michael Blecher, "Quasi in Situ: A Bridge between Ex Situ and in Situ Conservation of Plants," *Biodiversity and Conservation* 19 (2010): 2448.
[24] Hua Yu et al., "TCMGIS-II Based Prediction of Medicinal Plant Distribution for Conservation Planning: A Case Study of Rheum Tanguticum," *Chinese Medicine* 5 (2010): 5.
[25] A. S. Van Wyk and G. Prinsloo, "Medicinal Plant Harvesting, Sustainability and Cultivation in South Africa," *Biological Conservation* 227 (2018): 337.
[26] Czech, Devers, and Krausman, "The Relationship of Gender to Species Conservation Attitudes," 191.
[27] Moeng and Potgieter, "The Trade of Medicinal Plants by Muthi Shops and Street Vendors in the Limpopo Province, South Africa," 561.
[28] Moeng and Potgieter, "The Trade of Medicinal Plants by Muthi Shops and Street Vendors in the Limpopo Province, South Africa," 561.
[29] Gepts, "Plant Genetic Resources Conservation and Utilization: The Accomplishments and Future of a Societal Insurance Policy," 2284.

resources, habitats and ecosystems,[30] gatherers of medicinal plants utilize different methods of harvesting some of which threaten the future existence of medicinal plants. Examples of such methods include removing parts of the bulk, collecting the root and bulb, uprooting the whole plant and cutting the stems and leaves off.[31] Many of the conservation methods used by medicinal plant collectors are harmful. For example, harvesting large quantities of medicinal plants is of conservation concern,[32] as many species may be endangered in the collection process. These practices would ultimately endanger the species' lifeform. It is confirmed that the plant species generally die off and face extinction when the bark, roots, or entire parts of the plant are harvested. [33] Although the gathering of leaves, flowers, fruits, and seeds is considered less damaging, severe pruning may negatively impact the plant's reproductive potential and future existence. However, alternative conservation methods are proposed to conserve plant genetic resources.[34] The plant generally dies and faces extinction when the bark, roots, or entire parts of the plant are harvested. The gathering of leaves, flowers, fruits, and seeds is considered less damaging. However, severe pruning affects a plant's dynamism and reproductive potential and future existence. The sustainable rate of harvesting is determined by the category of vegetation that is being collected, from which kinds of plants or parts of the plants are collected, their richness, and growth rates.[35] However, natural reserves and wild nurseries are distinctive models of retaining the medical effectiveness of plants in their natural environments, while other conservative measures such as botanic gardens and seed banks are seen to be significant examples for ex situ conservation and the future. The geographic supply and biological physiognomies of medicinal plants must be known in order to guide conservation events, for instance, to measure whether the conservation of species should take place in nature or in a nursery.[36]

Natural Reserves

One of the major causes of medicinal plant extinction or scarcity is the degradation and destruction of natural resources such as land.[37] Natural reserves are protected areas set up to protect the important medicinal plants that are still growing in South Africa.[38] For the natural reserves to know which key natural habitats of medicinal plants to protect, they need to look at how humans affect and affect the ecosystem.[39]

Medicinal plant conservation is concerned with the long-term management of natural resources in order to preserve and protect medicinal plants by employing methods that do not jeopardize the existence and availability of medicinal plants or methods that do not destroy important inhabitants and ecosystems until they become extinct.[40] Natural reserves and wild nurseries are typical examples of

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[30] Marula Triumph Rasethe, Sebua Silas Semenya, and Alfred Maroyi, "Medicinal Plants Traded in Informal Herbal Medicine Markets of the Limpopo Province, South Africa," *Evidence-Based Complementary and Alternative Medicine* 2019 (2019); Moeng and Potgieter, "The Trade of Medicinal Plants by Muthi Shops and Street Vendors in the Limpopo Province, South Africa," 561..

[31] Jeffrey D Camm et al., "Nature Reserve Site Selection to Maximize Expected Species Covered," *Operations Research* 50, no. 6 (2002): 948.

[32] Rasethe, Semenya, and Maroyi, "Medicinal Plants Traded in Informal Herbal Medicine Markets of the Limpopo Province, South Africa."

[33] Rasethe, Semenya, and Maroyi, "Medicinal Plants Traded in Informal Herbal Medicine Markets of the Limpopo Province, South Africa."

[34] Rasethe, Semenya, and Maroyi, "Medicinal Plants Traded in Informal Herbal Medicine Markets of the Limpopo Province, South Africa"; Dan, "Empirical and Non-Empirical Methods."

[35] Rasethe, Semenya, and Maroyi, "Medicinal Plants Traded in Informal Herbal Medicine Markets of the Limpopo Province, South Africa."

[36] Czech, Devers, and Krausman, "The relationship of gender to species conservation attitudes,"191.

[37] Camm, Norman, Polasky, and Solow, "Nature Reserve Site Selection to Maximize Expected Species Covered."

[38] Jon Paul Rodríguez et al., "The Application of Predictive Modelling of Species Distribution to Biodiversity Conservation," *Diversity and Distributions*, (2007), 246.

[39] Jianguo Liu et al., "Ecological Degradation in Protected Areas: The Case of Wolong Nature Reserve for Giant Pandas," *Science* 292, no. 5514 (2001): 100.

[40]Moeng, and Potgieter, "The Trade of Medicinal Plants by Muthi Shops and Street Vendors in the Limpopo Province, South Africa," 561.

retaining the medical efficacy of plants in their natural habitats, while botanic gardens and seed banks are the most significant patterns for ex situ conservation and future replanting of plant species.[41] The geographic supply and biological physiognomies of medicinal plants must be known in order to guide conservation events, for example, to measure whether the conservation of species should take place in nature or a nursery.[42] Natural reserves are conservative areas that are implemented in order to safeguard the essential medicinal plants that still exist in South Africa.[43] Natural reserves are helpful in the preservation of known scarce medicinal plants in natural habitats.[44]

Wild Nurseries

Due to cost considerations and the amount of land coverage, it may not be true to consider a natural wild plant environment to be an area that is protected.[45] A wild nursery is a convenient area for species-oriented nurturing and domestication of plant species that are assumed to be under threat in a protected environment, natural environment, or an area that is not far from where medicinal plants naturally grow.[46] Even though the populations of medicinal plants are under threat due to overexploitation, urbanisation, habitat degradation, climate change, and invasive species, amongst others, wild nurseries are meant to offer an effective approach for in situ conservation of medicinal plants that are common or endemic, under threat, endangered, and in high demand.[47]

Botanic Gardens

Botanic gardens are part of ex situ conservation and they execute an essential role in conserving medicinal plant resources. In particular, they maintain the ecological unit to improve the survival of scarce and endangered medicinal plant species.[48] Even though most existing collections of plants only have a few examples of each species and aren't very useful for protecting genetic diversity, botanic gardens have a lot of unique features.[49] They are made up of a wide diversity of medicinal plants that grow together under mutual conditions and frequently contain taxonomically and organically different flora.[50] Botanic gardens can further play a part in the conservation of medicinal plants through developing propagation and tilling procedures along with using programs of nurturing and diversity breeding.[51] Most of the time, endangered medicinal plant species are grown and released into the wild to make sure they stay alive and sometimes to get many plant materials that can be used to make medicine. Action is often taken right away to protect medicinal plant resources.[52] Moreover, the majority of medicinal plant species from the previous wild can retain high influence when grown in protected areas that are far away from the areas where they grow naturally. Furthermore, they can also have their reproductive resources taken and stored in conservation areas such as seed banks for the future.

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[41] Czech, Devers, and Krausman, "The Relationship of Gender to Species Conservation Attitudes,"191.
[42] Samuel Zerabruk and Gidey Yirga, "Traditional Knowledge of Medicinal Plants in Gindeberet District, Western Ethiopia," *South African Journal of Botany* 78 (2012): 166.
[43] Rodríguez et al., "The Application of Predictive Modelling of Species Distribution to Biodiversity Conservation," 246.
[44] Liu et al., "Ecological Degradation in Protected Areas: The Case of Wolong Nature Reserve for Giant Pandas," 100.
[45] Andrea T Kramer and Kayri Havens, "Plant Conservation Genetics in a Changing World," *Trends in Plant Science* 14, no. 11 (2009): 604.
[46] Czech, Devers, and Krausman, "The Relationship of Gender to Species Conservation Attitudes,"191.
[47] Liu Chang, Yu Hua, and Chen Shi-Lin, "Framework for Sustainable Use of Medicinal Plants in China," *Plant Diversity* 33, no. 01 (2011): 66.
[48] Czech, Devers, and Krausman, "The relationship of gender to species conservation attitudes,"191.
[49] Qing-Jun Yuan et al., "Impacts of Recent Cultivation on Genetic Diversity Pattern of a Medicinal Plant, Scutellaria Baicalensis (Lamiaceae)," *BMC Genetics* 11, no. 1 (2010): 7.
[50] Yuan et al., "Impacts of Recent Cultivation on Genetic Diversity Pattern of a Medicinal Plant, Scutellaria Baicalensis (Lamiaceae)."
[51] Mike Maunder, Sarah Higgens, and Alastair Culham, "The Effectiveness of Botanic Garden Collections in Supporting Plant Conservation: A European Case Study," *Biodiversity & Conservation* 10 (2001): 386.
[52] Nigel D Swarts and Kingsley W Dixon, "Terrestrial Orchid Conservation in the Age of Extinction," *Annals of Botany* 104, no. 3 (2009): 550; Van Wyk and Prinsloo, "Medicinal Plant Harvesting, Sustainability and Cultivation in South Africa," 337.

Seed Banks

Seed banks are ways to store the genetic variety of the majority of the medicinal plants ex situ, as compared to botanic gardens, and they are recommended in order to help safeguard the biological and genetic features of plant species. Seed banks allow comparatively quick access to samples of plants to evaluate their features, thus contributing effective data for safeguarding the remaining population of planned species.[53] The difficult duties of seed banking are how to reinstate the plant back to its original environment in the wild and how to effectively help in the refurbishment of wild populations of species.[54] Seed banks are seen to be a better technique to store the genetic variety of the majority of medicinal plants for ex situ conservation as compared to botanic gardens, and they are suggested in order to help safeguard the biological and genetic features of plant species.[55] The difficult duties of seed banking are how to reinstate the plant back to its original environment in the wild and how to effectively help in the restoration of wild inhabitants of species.[56] Seed banks allow comparatively quick access to samples of plants to evaluate their features, thus contributing effective data for safeguarding the remaining population of planned species.[57] The difficult duties of seed banking are how to reinstate the plant back to its original environment in the wild and how to effectively help in the restoration of wild populations of species.[58]

RECOMMENDATIONS

The results of this study reveal that there are various alternative conservation and management methods to sustain medicinal plants in South Africa, and this proves that when these methods are implemented correctly these plants will still be available for future use. Moreover, the majority of medicinal plant species from the previous wild can retain high influence when grown in protected areas that are far away from the areas where they grow naturally. Equally, the relevant stakeholders concerned parties should be consistently exposed to improved resources, advanced training and better education about the benefits and importance of these plants.

CONCLUSION

It is evident from the literature that the use of indigenous medicinal plants is prevalent globally, with its use mainly predominant in developing countries. The aim of this study was to review alternative conservation and management methods to protect medicinal plants in South Africa. It is evident from the literature that medicinal plants are still trusted as the source of medicine administered for primary health care needs. In South Africa, this reliance and the negative impacts of climate change put pressure on medicinal plant resources. Medicinal plant users have developed and used local conservation methods to sustain medicinal plant resources. Although proven to be effective in the conservation of medicinal plants, many scientists contend that these methods have contributed to the extinction and scarcity of important medicinal plant species. However, this review presents six conservation methods proposed and used by scientists to conserve and manage medicinal plant species. These methods are Western practices introduced to the local communities in an effort to conserve medicinal plant species. The methods have proved effective in many cases. For example, many known medicinal plants are conserved in botanical gardens.

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[53] De-Zhu Li and Hugh W Pritchard, "The Science and Economics of Ex Situ Plant Conservation," *Trends in Plant Science* 14, no. 11 (2009): 618.
[54] Czech, Devers, and Krausman, "The Relationship of Gender to Species Conservation Attitudes,"191.
[55] Li and Pritchard, "The Science and Economics of Ex Situ Plant Conservation," 618.
[56] Zerabruk and Yirga, "Traditional Knowledge of Medicinal Plants in Gindeberet District, Western Ethiopia," 166.
[57] Li and Pritchard, "The Science and Economics of Ex Situ Plant Conservation," 618.
[58] Czech, Devers, and Krausman, "The Relationship of Gender to Species Conservation Attitudes,"191.

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