

**A mini-review of conservation challenges and sustainable use of *Lippia javanica* (Zumbani):
A case of developing countries**

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Abstract

The use of *Lippia javanica* is expanding in developing nations due to its value as a source of herbal products, including food, personal care items, and herbal medications. For example, the Covid-19 pandemic caused a spike in the utilization of this herbal plant. As a result, maintaining the *L. javanica* species through sustainable management and conservation is now vital to prevent the extinction of this useful plant. There are currently insufficient in-depth review articles that concentrate on *L. javanica* conservation and management. Consequently, to close this knowledge gap, the current research assumes that overexploitation of *L. javanica* is occurring as a result of unsustainable harvesting practices, habitat damage, and climate change. This review examines the use of *Lippia javanica* in developing nations using reputable academic sources like Google Scholar, Web of Science, Scopus, and ScienceDirect. Based on current information, *L. javanica* is used as a preservative, food source, insecticide, acaricide, remedy for food poisoning, healthcare medicine, security measure, and a host of other applications. Analysis of various harvesting methods and their effects are also included. Moreover, various approaches to *Lippia javanica* conservation and management are also proposed. Prospects for future research are addressed by emphasizing the significance of developing inventory and status monitoring methods and promoting the cultivation of *L. javanica*. This mini-review paper offers sustainable techniques for *L. javanica* management and conservation, to protect it for the benefit of the present generation as well as for future generations.

Key words: Medicinal plant harvesting; Conservation; *Lippia javanica*; Sustainable

Introduction

Lippia javanica is an erect, tiny, woody annual shrub with several stems that grows to a height of 1 to 4.5 m. It has strong, aromatic leaves that smell like lemons, as well as a little nutlet that contains an endosperm-free seed. Its creamy white flowers contain didynamous stamens and are grouped in a thick, spherical spike at the tip of the stalk. *L. javanica* is a member of the Verbenaceae, sometimes known as the vervain, family, which includes over 840 species of trees, shrubs, and herbaceous plants divided into 32 genera [1-3]. The plants, in the vervain family, grow fast and thrive in most soil types in sunny regions when grown from seeds or cuttings. In Africa, *L. javanica* is found in central, eastern, and southern parts. It is predominantly found in the margins of woods, grasslands, stream banks, open bushveld and open woodlands. *L. javanica* can be farmed or found growing in the wild [4-6].

According to estimates from the World Health Organisation (WHO), among other sources, 70–95% of people in developing countries still primarily obtain their basic treatment from medicinal plants [7]. The use of these medicinal plants has resulted in livelihood improvement through income generation and access to readily available and cheap healthcare [8, 9]. One of the herbal plants that have captured the interest of the botanical world is *L. javanica*, due to its significance in various applications [10].

Due to its chemical composition and medicinal properties, *L. javanica* is widely used in developing countries in a wide range of application that includes (1) food additives and beverage, (2) ethnoveterinary medicine, (3) treatment of human ailments such as malaria, skin infections, respiratory problems and gastrointestinal diseases and (5) used in repellents and (6) use in aromatherapy [1, 11, 12]. All these applications are a result of the presence of several minerals and bioactive phytochemical compounds such as tannin, phenolic glycosides, alkaloids, amino acids, flavonoids, iridoids, and essential oils. The essential oils include linalool, myrcene, limonene, 2,6-dimethylstyrene, neral, geranial and geraniol [13, 14].

The composition of chemical compounds varies from place to place according to geographic region and this difference can be attributed to geographic differences in type of soil, levels of precipitation, temperature, light intensity, humidity, etc [15]. The presence of these phytochemical compounds and minerals also (1) brings about the different pharmacological activities of the plant such as antioxidant, anticancer, antimalarial, antidiabetic and better free radical scavenging activity, (2) protects the plant from diseases and damages and (3) brings about the colour and aromaticity of the plant. *L. javanica* essential oils have been shown to have antibacterial action against respiratory infections, which explains why the plant is often used to treat respiratory conditions like bronchitis, colds, and coughs [16]. Ngassapa et al [5] also reported the exhibition of antimicrobial activity by *L. javanica* as a result of the presence of natural oils. Bhebbhe et al [17] reported the presence of phenolic compounds (tannins) in *L. javanica*. The presence of phenolic compounds in *Lippia javanica* can inhibit enzymes linked to the development of human diseases and has been used to treat a variety of common human ailments, including hypertension, metabolic issues, incendiary infections, and neurodegenerative diseases. Therefore, these results support the widespread use of *L. javanica* as a refreshing beverage.

In another study, Osunsanmi et al [13] investigated the phytochemicals present in *L. javanica* and their antioxidant potential. Results showed that the plant is a good source of natural antioxidants due to the presence of phenols. This makes the plant the best candidate in the management of oxidative stress diseases. Recently, *L. javanica* saw an upsurge in use during the COVID-19 pandemic, primarily in underdeveloped nations for the prevention and treatment of respiratory symptoms [18-20]. Although *L. javanica* is listed as a Least Concern (LC) species in official records [21], overuse in recent years has threatened the plant with extinction [22].

Most research on *L. javanica* has focused on its uses; very few, however, have highlighted the issues related to the plant's management and conservation. Therefore, this review article focuses on the updated uses of *L. javanica*, and the challenges associated with each application. Furthermore, conservation and management challenges with the usage of *L. javanica* are addressed, along with recommendations for remedies. Ultimately, the goal of this review study is to offer broad technical recommendations for the sustainable use and preservation of *Lippia javanica* in developing countries.

Table 1: Uses of *Lippia javanica* in developing countries.

Country	Uses	Part of plant	Plant harvesting method	Ref
Kenya	Preservative effect on milk	Stem	-	[23]
Zimbabwe	acaricidal activity against cattle ticks	leaves	-	[24]
Malawi	Insecticidal	Mature leaves	-	[14]
Zimbabwe	Neuroprotective effects	dry leaves	-	[25]
South Africa	disinfection of meat that has been infected with anthrax	leaves	-	[26]
Botswana	used as a caffeine-free tea	leaves	-	[27]
South Africa	decongestant for colds and coughs	Leaves		[16]
South Africa	dietary inclusion on broiler chicken feed	leaves	hand collected	[28]
South Africa	antidote for food poisoning	Roots		[26]
Botswana	Used as an antidote for food poisoning	Roots	-	[29]
Mozambique	Influenza	Leaves and roots	-	[30]
South Africa	good insect-repellent activity	Leaves and flowers		[31]

Ivory Coast	Antimalarial activity in vitro on <i>Plasmodium falciparum</i> .	leaves and stalks	-	[32]
Kenya	Food additive	Leaves, twigs	-	[33]
Swaziland	Pubic sores	Leaves		[34]
Zimbabwe	Abdominal pains	Leaves	-	[35]
Ethiopia	Fence	Whole plant Planted around homesteads		[36]

Method

University thesis repositories, Clarivate's Web of Science, Scopus, Research Gate, Google Scholar, and ScienceDirect were among the academic databases from which relevant information was retrieved to meet the objectives. "Developing countries" and " *Lippia javanica*" were searched terms that were used. A second search was done on the conservation and sustainable harvesting of both *Lippia javanica* and other medicinal plants.

Results and Discussion

Conservation concerns and management strategies of Lippia javanica

Concerns regarding the conservation and management of medicinal plants such as *L. javanica* have been raised by the growing commercialization of their sale and the increasing reliance on herbal products. Unsustainable harvesting, climate change, and habitat loss are the main challenges threatening *L. javanica*'s survival. There is proof that these activities are destroying *L. javanica* to the point that conservation efforts must increase to save the plant so that it can support a variety of human lifestyles [37, 38].

Unsustainable harvesting

Table 1 illustrates how *L. javanica* is a multipurpose plant with several uses for its entire parts. As a result, the plant should be harvested in a way that will guarantee its survival throughout the landscape as well as in designated collecting areas. However, a lot of individuals, mainly in nations with limited resources, indulge in non-sustainable harvesting practices. Destructive harvesting methods and over-exploitation are examples of these unsustainable harvesting practices. Unsustainable *L. javanica* harvesting has come from the removal of the plant from wild populations without any kind of oversight or control, ignorance of sustainable harvesting methods, and unclear land use rights [39].

The primary environmental impact of non-sustainable harvesting methods is the decline in the rates of reproduction, growth, and survival of the intended species. The gathering of *L. javanica* from the veld by cutting the plant and uprooting it entirely attests to some of the extraordinary destructive harvesting methods [37]. Even though removing only the most desirable portions of the plant is advantageous for plant survival and regrowth, harvesting of *L. javanica* is not a more common example of a situation where this practice is followed. For example, in an investigation reported by Mpofu et al [28], they harvested both the stems and the leaves of *L. javanica* for their feeding trials yet their study only used the leaves. The destructive harvesting of *L. javanica*, in which the stem was taken along with the leaves even though the leaves were the only portion that would be valuable, is further illustrated in Figs. 1a and b. A sustainable approach in each of these cases would have been to remove the leaves (Fig. 1.c and d) rather than trimming the stems or striping the leaves to promote rapid plant regeneration.

Additionally, irresponsible harvesting causes damage to the plant, making it more vulnerable to disease. Removing leaves from the tree without breaking them and trimming the stem and twigs also helps to reduce damage to the trunk. [40, 41]. Further beneficial methods for harvesting *L. javanica* include: (1) carefully removing the roots without damaging the tap root; (2) carefully removing the stem or bark without damaging the innermost layer that aids in the plant's drying out; and (3) carefully plucking the leaves without breaking the shoots [42, 43]. *L. javanica* over-exploitation and destructive harvesting can be prevented by: (1) using ex-situ conservation by propagating the plant in farms and home gardens; (2) limiting access to or encroachment on forest resources; and (3) embracing indigenous conservation strategies like social controls and taboos

like harvesting plants no larger than the palm of a hand. These actions could be very helpful in both producing huge amounts of *L. javanica* and safeguarding these resources from unsustainable harvesting techniques [39].



Fig 1(a & b). Unsustainable harvesting practices (c&d) sustainable harvesting practices [44]

Climate change and habitat loss

Climate change is well acknowledged to have substantial effects on the existence of medicinal plants. There have been reports linking the decline in medicinal plants like *L. javanica* to climate change. Climate change can lead to a scarcity of *L. javanica* by raising temperatures and reducing rainfall, which will prevent the plant from growing to its maximum potential and from regenerating after being harvested [45-47]. For instance, Rankoana [48], reported that, during very hot seasons a reduction in the growth rate of *L. javanica* can cause the plant to die before maturity. In another study, Singini et al [49] studied the effect of temperature on the medicinal properties of *L. javanica*.

The findings indicated that *L. javanica* exhibited coping strategies for a short period against high temperatures, but that longer exposure caused more harm. Climate change will therefore adversely affect a plant's ability to develop, the chemical composition of its phytochemicals, and its defence mechanisms. The effects of climate change as well as harmful substances and pesticide pollution on *L. javanica* can all be addressed through cultivation. Stable production is ensured by controlled growing conditions during cultivation, which also increase active compound yields and decrease harvest volume.

Anthropogenic factors like deforestation, urbanization, land preparation and mining have been shown to further threaten *L. javanica* existence through habitat loss. Therefore, efforts must be focused on essential habitats, such as secondary forests, disturbed regions, and agro landscapes to conserve these species. [50-52]. The management of *L. javanica* for present and future use can be aided by ex-situ conservation in the form of seed banks and botanical gardens in the event of significant or minimal loss of wild habitat [53]. *Lippia javanica* can be managed more effectively in situations where its habitat is lost if it is harvested from an area where the plant is abundant while preserving healthy populations [54]. The anthropogenic activities that result in habitat loss can also be lessened through the implementation of traditional management practices, rooted in cultural norms, taboos and religious beliefs, even though officially backed programs tend to ignore them. These techniques have proven to be effective in encouraging sustainable usage and biodiversity conservation, by helping in the regulation of activities that impact the environment and control the collecting and harvesting of this medicinal plant with minimal loss and damage to the plant [55].

Conclusion and Future Perspectives

Research on the conservation and management of *L. javanica* is scarce in the majority of developing nations. Therefore, empirical investigations that rely on the observation and assessment of the sustainability and management of *L. javanica* that the researchers themselves have direct involvement with may be considered for future research.

Excessive exploitation of this herbal plant through unsustainable harvesting, overharvesting, climate change and loss of habitat due to anthropogenic activities cause resource damage to the point that more conservation work is required to keep such resources safe. It is also necessary to examine both the positive and the harmful practices so that the positive practices are encouraged while the harmful ones are discouraged. Maintaining and preserving the community's expertise in using native plant species is also beneficial to the preservation of its cultural legacy. Cultivating *L. javanica* is an appealing solution for its management since it can provide optimal levels of environmental conditions and nutritional requirements. Cultivation is beneficial because it can increase the population of some plant species, which lessens the harvest strain on naturally occurring species. In addition to expanding their availability for commercial use, large-scale *L. javanica* cultivation has the potential to create jobs. The issues of sustainable harvesting of herbal plants such as *L. javanica* are to some extent addressed in the environmental statute and in the draft policy for the regulation of the work of users but very little is known beyond the national institutions about these policy guidelines. Therefore, implementing legislative actions and strategies that advise users on sustainable harvesting of *L. javanica* is also a necessary way that can be used to prevent the medicinal plant's extinction in light of its steadily increasing uses [56]. The establishment of inventory and status monitoring systems can also be used in the management of *L. javanica*.

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