

Review

Warburgia salutaris (Bertol. f.) Chiov.: A multi-use ethnomedicinal plant species

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Accepted 29 August, 2012

Warburgia salutaris (Bertol. f.) Chiov. is used in many parts of Southern Africa to treat various human ailments. *W. salutaris* forms an integral part of Changana, Shona, Siswati, Sotho, Tsonga, Venda, and Zulu traditional healing systems particularly, in regions where the plant species is still found in the wild or cultivated in home gardens. *W. salutaris* has undergone a considerable decline throughout its natural habitat in Southern Africa due to over-exploitation for medicinal purposes. This review aims to collate the fragmented information on the pharmacological properties, past and present uses of *W. salutaris* throughout its geographical range.

Key words: Ethnobotanical uses, pharmacological properties, Southern Africa, *Warburgia salutaris*.

INTRODUCTION

The genus *Warburgia* Engl. (family Canellaceae) was named after Dr Otto Warburg (1859 to 1938), who was born in Hamburg, Germany. He was a lecturer in botany at the University of Berlin and author of several botanical papers. *Warburgia* is the only genus of family Canellaceae that extends into the African mainland (Verdcourt, 1956, 1990). In Southern Mozambique, *Warburgia* is commonly referred to as *Chibaha* (*Xibaha*) and hence Bertolini's original generic name *Chibaca* Bertol. f. *Warburgia* is a small genus of four species (Table 1), occurring in Democratic Republic of Congo (DRC), Ethiopia, Kenya, Malawi, Mozambique, South Africa, Swaziland, Tanzania, Uganda, Zambia, and Zimbabwe.

Warburgia salutaris (Bertol. f.) Chiov. (Figure 1) is the only species of *Warburgia* that extends into Southern Africa. It is most commonly known as the pepper-bark tree; other common names are given in Table 2. The specific name '*salutaris*' means health giving (Schmidt et al., 2002), in reference to its medicinal properties. Most traditional remedies of *W. salutaris* are made from the inner bark of the tree, which smells of cinnamon and tastes burny, peppery and pungent, and hence, the common English name. *W. salutaris* is characterized by the production of aromatic oils (Hollmann and Van der Schijff, 1996; Rabe and van Staden, 2000; Schmidt et al.,

2002). The tree is found in evergreen montane forest including wooded ravines and evergreen forest along the coasts (Palgrave, 2000; Venter and Venter, 2002). The tree is known from only a few localities in the North-eastern parts of South Africa, Swaziland, South-eastern Zimbabwe and Southern Mozambique. It is also found in Malawi and Zambia (Palgrave, 2000). *W. salutaris* is differentiated from *Warburgia ugandensis* Sprague, which occurs in East and Central Africa on the basis of differences in numbers of ovules, placentation and fruit size (Hollmann and Van der Schijff, 1996; Verdcourt 1956, 1990).

The following description of *W. salutaris* is based largely on those of Codd (1976), Palgrave (2000), Palmer and Pitman (1972), Schmidt et al. (2002), Venter and Venter (2002), and Verdcourt (1956, 1990). *W. salutaris* (Figure 1) is an evergreen, medium sized tree, usually between 5 and 10 m in height and a stem diameter of up to 30 cm. The trunk is rather short with a dense, erect canopy. Its bark is smooth, white to light grey when young but brown, splitting into irregular plates and rough with prominent yellowish corky lenticels on older branches and stems. Inner bark is reddish brown in colour, bitter, with a peppery and pungent smell. The leaves have a bitter, burning, and aromatic taste when crushed and this helps in identifying the species in the

Table 1. Distribution of *Warburgia* species

Species	Habitat	Distribution	Reference(s)
<i>W. elongata</i> Verdc.	Undergrowth of coastal riverine and swamp forest	Endemic to Uzaramo district of Tanzania	Verdcourt (1956)
<i>W. salutaris</i> (Bertol. f.) Chiov.	Evergreen forest, lowland scrub and along the coast in sandveld forest	Mozambique, South Africa, Malawi, Swaziland, Zambia and Zimbabwe	Codd (1976); Palgrave (2000); Verdcourt (1956, 1990)
<i>W. stuhlmanii</i> Engl.	Coastal forest of the <i>Albizia-Ostryoderris</i> type and in open woodland	Endemic to the coastal provinces of East Africa (Kenya and Tanzania)	Verdcourt (1956)
<i>W. ugandensis</i> Sprague ssp <i>longifolia</i> Verdc.	Lowland rainforest	Endemic to Southern Tanzania	Verdcourt (1956)
<i>W. ugandensis</i> Sprague ssp <i>ugandensis</i>	Lowland rainforest, evergreen and swamp forest	Democratic Republic of Congo, Ethiopia, Kenya, Malawi, Tanzania, and Uganda	Verdcourt (1956, 1990)

Table 2. Local names of *W. salutaris*.

Local name	Language/Country/Region	Reference(s)
Amazwecehlabayo	Zulu, South Africa	Hutchings et al. (1996)
Chibaha	Changana, Tsonga, Mozambique	Krog et al. (2006), Verdcourt (1990)
Fever tree	English, South Africa	Hutchings et al. (1996)
Isibaha	Zulu, Venda, South Africa	Hutchings et al. (1996), Scott-Shaw et al. (1998)
isiBhaha	Zulu, South Africa	Hutchings et al. (1996), Scott-Shaw et al. (1998); Van Wyk et al. (1997)
Koorsboom	Afrikaans, South Africa	Hutchings et al. (1996)
Manaka	Venda, South Africa	Van Wyk et al. (1997)
Molaka	Sotho, South Africa	Scott-Shaw et al. (1998)
Mulanga	Venda, South Africa	Botha et al. (2004), Van Wyk et al. (1997)
Muranga	Shona, Zimbabwe	Gelfand et al. (1985), Mukamuri and Kozanayi (1999)
Peperbasboom	Afrikaans, South Africa	Hutchings et al. (1996), Van Wyk et al. (1997)
Pepper-bark tree	English	Hutchings et al. (1996), Van Wyk et al. (1997)
siBhaha	Siswati, South Africa, Swaziland	Hutchings et al. (1996)
Shibaha	Tsonga, South Africa	Scott-Shaw et al. (1998), Van Wyk et al. (1997)
Xibaha	Tsonga, Mozambique, South Africa	Botha et al. (2004); Hutchings et al. (1996), Verdcourt (1990)

field. The leaves are simple, alternate, elliptic to lanceolate, glossy, dark green above, paler green, and dull below with entire margins. The leaves are pellucid-dotted with transparent oil glands.

The midrib of the leaves is usually slightly off-centre with tapering apex and base. The flowers are small, bisexual, white to greenish in colour, solitary, axillary or occur in a few-flowered head borne on short, robust stalks in leaf axils. The filaments are fused forming a prominent staminal tube in the centre of the flower. The flowers develop into round, oval berries, narrowed towards the base, dark green and turning purple when ripe. The fruits are leathery in texture, covered with glands and containing two or more seeds with oily endosperm, turning purple to black when mature.

W. salutaris is categorized as endangered (A1acd) on the IUCN Red List (IUCN, 2012), primarily because of reduction in population size based on decline in area of occupancy, extent of occurrence and/or quality of habitat, and actual or potential levels of exploitation. At the national level, *W. salutaris* is categorized as vulnerable in Mozambique (Izidine and Bandeira, 2002), endangered in Malawi (Msekandiana and Mlangeni, 2002), and South Africa (Williams et al., 2008), critically endangered in Swaziland (Dlamini and Dlamini, 2002) and extinct in the wild in Zimbabwe (Maroyi, 2008). *W. salutaris* is very popular and over-collected in Southern Africa for herbal medicine. The species is also generally slow growing in the wild; and its limited distribution and low abundance makes it vulnerable to human-induced habitat

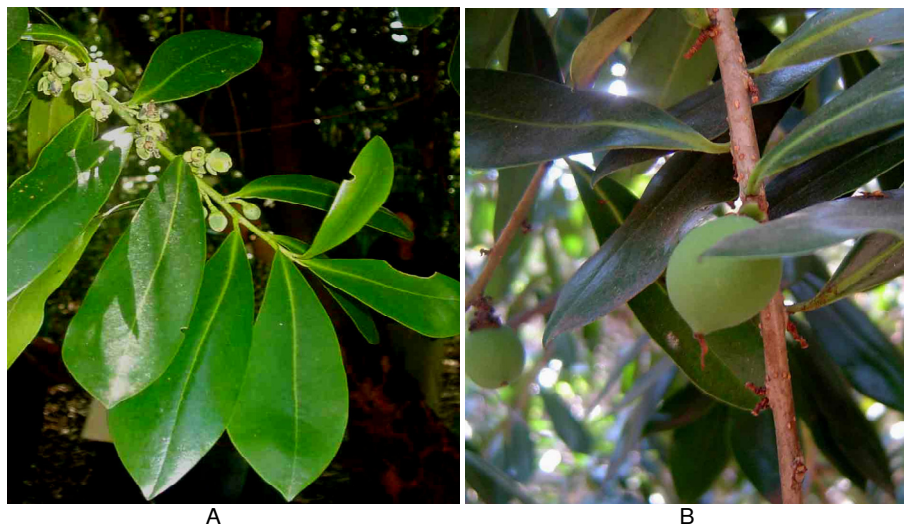


Figure 1. *Warburgia salutaris*: (A) flowers and leaves (Photo: M.A. Hyde) and (B) fruit and leaves (Photo: B.T. Wursten).

degradation and over-exploitation as a medicinal plant.

Significant advances in all aspects of *W. salutaris* research have been made over the years, and also an increasing number of commercial products of the species have appeared in the market. *W. salutaris* is available in tablet form to treat bronchitis, chest infections and ulcers (Botha et al., 2004). Tablets made from the leaves are also used as a natural antibiotic, thought to be effective against oral and oesophageal thrush (Botha et al., 2004; Van Wyk et al., 1997). Small plantations of *W. salutaris* have been established in South Africa and Zimbabwe to address the high demand for herbal bark supplies. Apart from the general scientific and commercial interest in *W. salutaris*, the species is also widely used in cultural activities of the Changana, Shona, Siswati, Sotho, Tsonga, Venda and Zulu people in Southern Africa. This review, therefore, will give an overview of the traditional uses, local knowledge and pharmacological properties of *W. salutaris*. Furthermore, the review attempts to discuss all literature to date pertaining to the uses and pharmacological properties and biological activity of *W. salutaris*.

REVIEW PROCEDURE

The ethnobotanical uses and pharmacological properties of *W. salutaris* were collated over its geographical range. The scientific studies published in journals, books, book chapters, theses and abstracts were reviewed. Literature was searched in different electronic databases such as ISI Web of Science, MEDLINE, Scopus, Science Direct and Google Scholar. Suitable books or potential literature sources were identified in online databases by searching for the terms ethno medicine, traditional medicine, folkloric uses, folk medicine, horticultural uses,

indigenous medicine, ethno botany and botanical medicine uses, cultural uses, economic uses, phytochemistry, and pharmacological properties of *W. salutaris*.

ETHNOMEDICINAL USES

W. salutaris is one of most valuable medicinal plant species in Southern Africa with its bark, leaves and roots widely used as traditional medicine (Table 3). It is inherently linked to local traditional medicine systems of the Changana, Shona, Siswati, Sotho, Tsonga, Venda, and Zulu cultural groups. *W. salutaris* is used to treat various conditions which are summarized in Table 3. Forty three ethnomedicinal use records were collected for *W. salutaris* in Southern Africa, referring to a variety of preparations used for topical and internal administration. *W. salutaris* is also used as a hedge, ornamental, food, ethnoveterinary medicine and timber (Table 3).

The bark, leaves, stems, and roots are used to treat numerous health complaints, including abdominal pains, backache, blood disorders, chest complaints, colds, coughs, febrile complaints, fever, headache, inflammations, influenza, irritations, malaria, respiratory complaints, rheumatism, sores, stomach ulcers, toothache, and venereal diseases (Table 3). The bark and leaves of *W. salutaris* have been used to treat yeast, fungal, bacterial, and protozoal infections for centuries (Gericke, 2001). *W. salutaris* is used for serious cough which usually results in purulent sputum (Van Wyk et al., 1997). The preparation and administration of traditional remedies to treat these ailments do however vary. For coughs, the bark of *W. salutaris* is sometimes smoked mixed with *Cannabis sativa* (Hutchings et al., 1996). For burns, dermatological ailments, irritations, sores and

Table 3. Ethnobotanical uses of *W. salutaris*

Use	Plant part(s) used and preparation	Country practised	Reference(s)
Medicinal use			
Abdominal pains	Bark decoction	Zimbabwe	Gelfand et al. (1985)
Abortion	Bark decoction	Zimbabwe	Gelfand et al. (1985), Mukamuri and Kozanayi (1999)
Aid to divination	Bark boiled and chewed	Zimbabwe	Gelfand et al. (1985)
Aphrodisiac	Bark	South Africa, Zimbabwe	Hollmann and Van der Schijff (1996), Mabogo (1990), Mukamuri and Kozanayi (1999)
Backache	Bark	South Africa, Zimbabwe	Mabogo (1990), Mukamuri and Kozanayi (1999)
Blood disorders	Bark	South Africa	Hollmann and Van der Schijff (1996)
Charm	Bark	Zimbabwe	Mukamuri and Kozanayi (1999)
Chest complaints	Bark	South Africa	Hollmann and Van der Schijff (1996), Mabogo (1990)
Colds	Bark	South Africa	Hollmann and Van der Schijff (1996), Mabogo (1990), Rabe and van Staden (2000)
	Bark and root smoked	Southern Africa	Watt and Breyer-Brandwijk (1962)
Constipation	Bark	South Africa	Felhaber and Mayeng (1997)
	Bark decoction of <i>W. salutaris</i> or smoked with <i>C. sativa</i>	South Africa	Bryant (1966)
Cough	Cooked roots	South Africa	Gerstner (1939)
	Smoked	South Africa	Rabe and van Staden (2000)
	Bark	South Africa	Hollmann and Van der Schijff (1996)
	Bark and root	Southern Africa	Watt and Breyer-Brandwijk (1962)
Diarrhoea	Bark	Zimbabwe	Mukamuri and Kozanayi (1999)
Emetic	Bark	South Africa	Hutchings et al. (1996)
Expectorant	Bark, root	Southern Africa	Watt and Breyer-Brandwijk (1962)
Febrile complaints	Bark	South Africa	Hutchings et al. (1996)
Fever	Bark	Zimbabwe	Mukamuri and Kozanayi (1999)
Headache	Powdered bark of <i>W. salutaris</i> and <i>E. lasianthum</i> taken as snuff	South Africa	Hutchings et al. (1996)
	Bark powder applied on incision	Zimbabwe	Gelfand et al. (1985)
Indigestion	Bark	Zimbabwe	Mukamuri and Kozanayi (1999)
Inflammation of the urethra	Powdered bark of <i>W. salutaris</i> mixed with leaves of <i>H. surratensis</i> and fat used as an ointment	South Africa	Hutchings et al. (1996)
Influenza	Bark decoction	South Africa	Rabe and van Staden (2000), Van Wyk et al. (1997)
Irritation	Powdered bark of <i>W. salutaris</i> mixed with leaves of <i>H. surratensis</i> and fat used as an ointment	South Africa	Hutchings et al. (1996)

Table 3 Contd.

Loss of appetite	Bark	Zimbabwe	Mukamuri and Kozanayi (1999)
Malaria	Bark	South Africa	Hollmann and Van der Schijff (1996), Mabogo (1990), Van Wyk et al. (1997)
Nightmares	Bark	South Africa	Hollmann and Van der Schijff (1996)
Penial irritation	Powdered bark mixed with fat used as ointment	South Africa	Hutchings et al. (1996)
Pneumonia	Bark, roots	Zimbabwe	Mukamuri and Kozanayi (1999)
Purgative	Bark	South Africa	Hutchings et al. (1996), Mabogo (1990)
Remedy for all diseases (panacea)	Bark decoction	Zimbabwe	Gelfand et al. (1985)
Respiratory complaints	Bark decoction	South Africa	Rabe and van Staden (2000)
Rheumatism	Bark or leaf infusion	South Africa	Hollmann and Van der Schijff (1996), Hutchings et al. (1996), Van Wyk et al. (1997)
Sinus	Bark decoction	South Africa	Rabe and van Staden (2000)
Skin complaints	Bark	South Africa	Mabogo (1990)
Skin irritations	Ointments made from pounded leaves and stalks, mixed with bark and fat	South Africa	Hutchings et al. (1996)
Snake bites	Bark	Zimbabwe	Mukamuri and Kozanayi (1999)
Sores on the penis	Powdered bark of <i>W. salutaris</i> mixed with leaves of <i>H. surratensis</i> and fat used as an ointment	South Africa	Hutchings et al. (1996)
Skin sores	Bark	South Africa	Felhaber and Mayeng (1997), Hollmann and Van der Schijff (1996)
Sores	Ointments made from pounded leaves and stalks, mixed with bark and fat	South Africa	Hutchings et al. (1996)
Sore throat	Bark	South Africa	Hollmann and Van der Schijff (1996)
Stomach pain	Bark	South Africa	Felhaber and Mayeng (1997)
Stomach ulcers	Bark	South Africa	Hollmann and Van der Schijff (1996), Mabogo (1990), Van Wyk et al. (1997)
To increase blood in body	Fungus on <i>W. salutaris</i> bark swallowed	Zimbabwe	Gelfand et al. (1985)
Toothache	Bark	South Africa	Hollmann and Van der Schijff (1996), Van Wyk et al. (1997)
Venereal diseases	Bark	South Africa, Zimbabwe	Gelfand et al. (1985), Hollmann and Van der Schijff (1996), Mabogo (1990), Van Wyk et al. (1997)
Other uses			
Barrier, hedge, ornamental or shade	Can be grown around boundaries or as hedge	South Africa	Symmonds and Nichols (2005), Venter and Venter (2002)
Chilli substitute	Fresh or dried leaves used in various dishes to add an aroma and peppery taste.	South Africa	Venter and Venter (2002)

Table 3 Contd.

Ethnoveterinary medicine	Bark used to treat a wide spectrum of chicken diseases	Zimbabwe	Mukamuri and Kozanayi (1999)
Fodder	Consumed by Hippos	South Africa	Nichols (2005)
Timber	Wood works well	South Africa, Zimbabwe	Goldsmith and Carter (1981), Schmidt et al. (2002)

wounds, powdered bark of *W. salutaris* is often mixed with fat and used as an ointment or wound dressing. In some cases, powdered bark powder is applied on an incision made in the head to treat recurring headaches (Gelfand et al., 1985). Bark, leaf and root decoctions and infusions are often used to treat abdominal pains, blood disorders, chest complaints, febrile complaints, fever, influenza, malaria, respiratory complaints, rheumatism, stomach ulcers, toothache and venereal diseases (Table 3). Mono therapies based on preparations made from *W. salutaris* only are the most dominant; although, powdered bark of *W. salutaris* is often mixed with leaves of *Hibiscus serratensis* or *C. sativa* or *Erythrophleum lasianthum* (Hutchings et al., 1996). These mixtures are often smoked or applied topically as an ointment mixed with animal fat (Hutchings et al., 1996).

W. salutaris bark is used during the ritual strengthening of men whose wives are accused of infidelity (Mukamuri and Kozanayi, 1999). It is also associated with many magical and ritual applications. Chewing of boiled bark is believed to induce trances or to invoke the goodwill of the ancestors (Gelfand et al., 1985). Other social uses include its application as an antifertility agent to induce abortion, as an aphrodisiac and as a remedy for nightmares (Table 3). The bark is believed to be a charm which brings good luck to the bearer (Mukamuri and Kozanayi, 1999). According to Gelfand et al. (1985), *W. salutaris* is a panacea (remedy for all diseases), and some

traditional healers include *W. salutaris* bark in almost all the concoctions of herbs they prescribe to their patients regardless of the illness (Mukamuri and Kozanayi, 1999).

PHARMACOLOGICAL PROPERTIES OF *W. SALUTARIS*

A number of drimane sesquiterpenes have been isolated from the stem bark of *W. salutaris*, *Warburgia stuhlmanii* and *W. ugandensis* (Frum et al., 2005; Frum and Viljoen, 2006; Jansen and de Groot, 1991; Kioy et al., 1990). Drimanes can be held responsible for a wide variety of biological activities including antibacterial, antifungal, antifeedant, plant-growth regulatory, cytotoxic, phytotoxic, piscicidal, and molluscicidal properties (Jansen, 1993). Drimane sesquiterpenes that have been isolated from *W. salutaris* include: warburganal (Mashimbye et al., 1992), polygodial (Mashimbye, 1993), salutarisolid (Frum et al., 2005; Frum and Viljoen, 2006; Mashimbye et al., 1999a), muzigadial (El-Ferally et al., 1978; Rabe and van Staden, 2000), ugandensidial, isopolygodial (Mashimbye et al., 1999a), and mukaadial (Mashimbye et al., 1999b). *W. salutaris* is also said to contain mannitol (Watt and Breyer-Brandwijk, 1962).

The antifungal and antibacterial activity of warburganal, polygodial, and muzigadial against a range of organisms, including *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Candida utilis*,

Bacillus subtilis, and *Escherichia coli*, has been demonstrated (Jansen and de Groot, 1991). Taniguchi et al. (1983) demonstrated using a two-fold dilution method that warburganal exhibited a broad antimicrobial activity against all yeasts and filamentous fungi tested and that it was highly active against *Saccharomyces cerevisiae*, *C. utilis* and *Sclerotinia libertiana*. Fractionation of the ethyl acetate extract of the stem bark of *W. salutaris* by chromatographic techniques yielded muzigadial which exhibited antimicrobial activity against Gram-positive bacteria (Rabe and van Staden, 2000). Muzigadial was found to be the main antibacterial agent in the bark of *W. salutaris* (Rabe and van Staden, 2000), with a minimum inhibitory concentration (MIC) of 12.5 µg/ml against both *S. aureus* and *B. subtilis*. Ethanol, dichloromethane and water extracts at 2.5, 5, 10, and 30% concentrations of *W. salutaris* exhibited anthelmintic effects against *Haemonchus contortus* (Ahmed et al., 2012). Aqueous extracts of South African dried leaf samples of *W. salutaris* were assessed for *in vitro* molluscicidal activity against *Bulinus africanus* and were found to be active (LC₅₀: 2.483 mg/ml) (Clarke and Appleton, 1997). Warburganal has shown effective molluscicidal activity (Appleton et al., 1992; Nakanishi and Kubo, 1977). Mannitol is used medicinally for dyspepsia, as a diuretic and sweetener for diabetics (Van Wyk et al., 1997). Fractionation of the toluene:ethyl acetate (7:93 v/v) extract of the stem bark of *W. salutaris* by Chromatographic techniques yielded (5Aα, 9Aα,

9B β)-5,5A, 6, 7, 8, 9, 9A, 9B-Octahydro-6, 6, 9A-trimethylnaphtho[1, 2c] furan-1-(3H)-one (drimenin) and 5, 10-Dihydro-6, 7-dimethyl-4H-benzo [5, 6] cyclohepta [1, 2-b]-furan which exhibited antimicrobial activity against Gram-positive bacteria (Mohanlall and Odhav, 2009). Due to its antioxidant properties, extracts of *W. salutaris* showed protective effects against crystalline silica induced inflammatory cytokine expression, activation of nuclear transcription factor- κ B, DNA strand breakage, and lipid peroxidation (Leshwedi et al., 2008). Hence, *W. salutaris* may be a potential therapeutic agent against the fibrogenic and carcinogenic effects of crystalline silica (Leshwedi et al., 2008). Madikane et al. (2007) isolated a novel drimane sesquiterpenoid lactone, 11a-hydroxycinnamosmolide from *W. salutaris* stem bark. Madikane et al. (2007) showed that extracts and a purified drimane sesquiterpenoid lactone, 11a-hydroxycinnamosmolide exhibit antimycobacterial activity against *Mycobacterium tuberculosis* H37Rv and *Mycobacterium bovis* BCG pasteur. These studies showed that *W. salutaris* is a useful source of antitubercular compounds and supports the hypothesis of a link between N-acetyltransferase (NAT) inhibition and antimycobacterial activity.

FUTURE PROSPECTS AND CONCLUSIONS

W. salutaris represents a plant species that can significantly contribute to human health and livelihood. Its use as a medicinal plant in Southern Africa has a long history (Gerstner, 1939). Local knowledge on the medicinal uses of *W. salutaris* is extensive, and recent ethnopharmacological studies have confirmed the effectiveness of many of its applications; however, some uses appear not to have a physiological basis and others have not been investigated. Further pharmacological studies of *W. salutaris* may lead to the production of less expensive therapies. Moreover, the use of *W. salutaris* in some communities with limited access to modern medical facilities represents a viable primary health care alternative. Nevertheless, the interest in and intrinsic value of *W. salutaris* is not only attributed to the lack of access to modern medical services. Even in cities where modern health services are more accessible and specialized, many people continue to use *W. salutaris* and its products showing the cultural acceptability of the species.

There is also growing interest in *W. salutaris* owing to its importance in the livelihoods and poverty alleviation of rural as well as urban communities involved in the harvest of the species and marketing of its products. The increased demand has led to significant decline in wild stocks and considerable local scarcity. In South Africa, *W. salutaris* is nowadays propagated from cuttings (Esterhuysen, 1996). Although, establishment of cultivation systems for the species seems useful for *W. salutaris*;

there appears to be little adoption among rural farmers, mainly because of socio-economic factors. Research on *W. salutaris* in South Africa and Zimbabwe has shown that cultivation is ecologically feasible, but hampered by lack of seedlings, particularly in Zimbabwe. These efforts may also favour *W. salutaris* production in other countries where it is not indigenous. The species has considerable potential as an ornamental plant. Introduction into other locations such as botanical gardens and reforestation sites should be encouraged. These *ex situ* conservation initiatives will provide a refuge for *W. salutaris*.

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