Introduction
Lesotho is one of the Southern African countries that is rich with indigenous medicinal plant resources. In fact, the flora of Lesotho is said to encompass around 200 families, assigned to 800 genera and 3,000 species. Historically, 303 of these have been used medicinally by Basotho. The fact that medicinal plants are still viewed as the most cost-effective and accessible therapy by many rural dwellers in Lesotho cannot be denied. As a result, the demand and use of herbal medicines are high, especially in developing countries and globally. According to the 2019 World Health Organization (WHO) Global Report on Traditional and Complementary Medicine, 88% of WHO Member States use traditional and complementary medicines. In 2019, the global herbal medicine market size was US$ 138,350 million and it is expected to reach US$ 218,940 million by the end of 2026, with a compound annual growth rate (CAGR) of 6.7% during 2021–2026. Herbalists and traditional healers in Lesotho continue to dispense a wide range of topical herbal medicinal preparations for the treatment of minor wound infections, while severely infected wounds need appropriate medical attention.

Skin is important as one of the largest organs in the body. It provides first-line protection against infections by acting as a physical barrier. A large number of microorganisms that colonise and infect wounds are the patient’s own endogenous normal flora. These pathogens are mainly gram-positive Staphylococcus aureus, coagulase-negative staphylococci, Enterococci and gram-negative bacteria such as Escherichia coli, Pseudomonas aeruginosa, and Klebsiella species. Among fungal pathogens, Candida albicans is the most frequent cause of infections of the skin.

The antimicrobial activities of medicinal plants are thought to depend on the active phytochemicals present, their concentrations as well as their synergistic actions. They act by various mechanisms, including inhibition of bacterial nucleic acid synthesis, inhibition of cytoplasmic membrane function, and inhibition of energy metabolism.

Conventional medicines previously isolated from plants
Frequently encountered medicines in clinical settings that are originally from medicinal plants include:
• Digoxin is a cardiac glycoside native to European and Mediterranean regions, *Digitalis purpurea* commonly known as foxglove was used by traditional healers and physicians from time immemorial. It strengthens the force of contraction of weakened heart muscles in heart failure.19,20

• Morphine is an alkaloid obtained from opium, air-dried milky latex obtained by incision from the unripe capsules of *Papaver somniferum* native to Asia, Europe, and northwestern Africa. It is a narcotic agonist-analgesic of opiate receptors that produces analgesia by inhibiting ascending pain pathways.21 These medicines were discovered through a systematic examination of traditional medicinal plants and associated traditional knowledge.19

African herbal medicines frequently sold in pharmacies include:

• Kaloba Pelargonium, often marketed for the treatment of cough and colds, is the root extract of *Pelargonium sidoides* a plant native to coastal South Africa.22 Its mechanism of action may include a cytoprotective effect against viral attack, an antimicrobial effect through the release of defensins from neutrophilic granulocytes, and an immune-stimulating effect through the release of tumour necrosis factor, nitrous oxide, and an increase in natural killer cell activity.23,24

• Hedera, an expectorant, is a leaf extract of *Hedera helix* a plant with wide distribution including North Africa. Pharmacological studies showed that *H. helix* possessed respiratory, anti-inflammatory, analgesic, immunological, antitumour, antitumugenic, antimicrobial, anti-parasitic, gastrointestinal, and antithrombin activity.25

• Devil’s claw, often marketed for the treatment of painful chronic arthritic conditions, is an extract obtained from the root of *Harpagophytum procumbens* a plant native to the Kalahari region in Southern Africa. It is effective for the treatment of chronic arthritic conditions because of its pain-relieving and anti-inflammatory actions26 and

• Hoodia, an appetite-suppressant and dietary supplement, is extracted from a cactus-like succulent plant *Hoodia gordonii* native to the Kalahari desert in Southern Africa.27 A steroidal glycoside isolated from this plant is believed to produce a loss of appetite through the central (CNS) mode of action.28

These medicines have been used as commercial products due to their use in traditional medicine.

**Plants used to treat minor wound infections in Lesotho**

Although Basotho have been using medicinal plants to treat minor wound infections for over 100 years, their antimicrobial efficacies remained a mystery until recently. In 1999, Shale and his colleagues examined about ten (10) plant species from Lesotho used in wound care and found that six plant species had antibacterial activities against both gram-positive and gram-negative bacteria relevant to the skin; with a wider spectrum on gram-positive bacteria.8 Seleteng Kose and Mugomeri and their colleagues documented related traditional knowledge through interviews of Lesotho traditional healers, herbalists, and pharmacists.5,6 Thereafter, the mysteries of the efficacies of herbal preparations used for wound care were further exposed by the studies conducted outside Lesotho which disclosed the actual active principles.29-31 Table I summarises names, method of preparation, and in vitro antimicrobial assays of medicinal plants commonly used by Lesotho herbalists and traditional healers. Medicinal plants whose in vitro antimicrobial activity had not yet been evaluated and those plants whose in vitro antimicrobial studies shown no activity were excluded.

Most plants are applied directly to the wounds, either as a dried and crushed powder or as an infusion to clean the wounds, thus minimising their systemic effects and possible interactions with the conventional medicines. The phenolic compounds which constitute the flavonoids and salicinoids were frequently isolated and were proven to be responsible for antimicrobial efficacies of most plants. These are followed by anthraquinones and alkaloids. *Aloe ferox* Mill., *Hypoxis hemerocallidea*, *Malva parviflora* L. var. *parviflora* and *Withania somnifera* (L.) were highly active species, with *Aloe ferox* Mill. showing activity to even methicillin-resistant *S. aureus* (MRSA). Due to increasing antimicrobial resistance, these plants can provide the leads to new antibiotic drug discovery.

**The role of the pharmacist in Lesotho in the use of herbal medicines for minor wound care**

The demand for use of herbal medicines is increasing as Basotho still views medicinal plants as the most cost-effective and accessible therapy. The majority of the patients that present in pharmacies with small wounds have used or are using the herbal medicinal products that are dispensed by traditional and herbal healers to treat minor wound infections. The pharmacist must keep abreast of the knowledge of the existing efficacies of traditional medicinal plants to be able to make recommendations to other healthcare providers and patients. In addition, pharmacists can also perform a specific patient pharmacological review to identify those oral conventional medications such as anticoagulants and immunosuppressants that are known to inhibit wound healing and could interact with the topical wound care herbal products.10,40

Moreover, pharmacists can undertake small scale manufacture and packaging of herbs used in wound care as processed powders or plant extracts. Herbal medicines should be manufactured following good manufacturing practice (GMP) guidelines to ensure the uniform quality and safety of the products.41,42 To maintain a sustainable harvest of medicinal plant species, cultivation appears to be an important strategy for meeting the growing demand. Cultivation and domestication studies should be carried out through a dialogue between pharmacists on one hand, and agriculturists and botanists on the other.43 Such collaboration, which would link the knowledge of safety and efficacy of medicines with the science of cultivating and knowledge of plants life, could result in a sustainable supply of inexpensive and high-quality medicinal herb raw materials for pharmaceutical, perfumery, and...
<table>
<thead>
<tr>
<th>Scientific name/Family</th>
<th>Vernacular name (Sesotho)</th>
<th>Method of preparation</th>
<th>In vitro antimicrobial assay against common skin pathogens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aloe ferox Mill. (Aloaceae)</td>
<td>Lekhala la quthing</td>
<td>Leaves juice extracts are mixed with water for wounds</td>
<td>Staphylococcus aureus, Methicillin-resistant S. aureus (MRSA), S. epidermidis, Bacillus cereus, B. subtilis, Escherichia coli, Shigella sonnei, Candida albicans</td>
</tr>
<tr>
<td>Boophone disticha (L.) Herb. (Amaryllidaceae)</td>
<td>Leshoma</td>
<td>Leaves placed on circumcision wounds and infusion of bulbs used to clean wounds</td>
<td>S. aureus, E. coli, K. pneumoniae, Bacillus subtilis</td>
</tr>
<tr>
<td>Bulbine frutescens (L.) Wild. (Asphodelaceae)</td>
<td>Sereleli</td>
<td>Fresh leaf sap is applied to the wounds</td>
<td>S. aureus, B. subtilis, E. coli, Micrococcus kristinae</td>
</tr>
<tr>
<td>Bulbine nasi sulifolia</td>
<td>Khomo-ea-balisa</td>
<td>Leave sap or roots extracts for wounds</td>
<td>S. aureus, B. subtilis, Micrococcus kristinae</td>
</tr>
<tr>
<td>Chenopodium album L.</td>
<td>Seruoe</td>
<td>Decoction used to treat wounds</td>
<td>S. aureus, S. epidermidis, B. subtilis, E. coli, K. pneumoniae, M. luteus, P. aeruginosa</td>
</tr>
<tr>
<td>Cheilanthes sp.</td>
<td>'Mamauoaneng/ 'Mamarakoaneng</td>
<td>Slightly roasted whole plant material is applied to wounds</td>
<td>S. aureus, S. typhi, E. coli, Enterobacter sp, S. paumphi, and S. mutans</td>
</tr>
<tr>
<td>Rothea chirsute (Cleodendrum glabrum) E.Mey. (Verbenaceae)</td>
<td>Khopha</td>
<td>Decoction of leaf applied to wound</td>
<td>S. aureas, K. pneumoniae, E. coli, C. Albicans, Cryptococcus neoformans</td>
</tr>
<tr>
<td>Cussonia paniculata Eckl. Zeyh. ssp. Sinuata (Reyneke &amp; Kok) De Winter (Araliaceae)</td>
<td>Mots'ret'se</td>
<td>Leaf infusion is used to clean wounds</td>
<td>S. aureus, P. aeruginosa, and N. gonorrhoeae</td>
</tr>
<tr>
<td>Gunnera perpensa L. (Gunneraceae)</td>
<td>Qobo</td>
<td>Leaves as a hot poultice for wounds and rhizome decoction is applied as wound dressing</td>
<td>C. Albicans, E. coli, S. aureus, Shigella sonnei, K. pneumonia, S. epidermidis, Salmonella paratyphi, S. typhimurium</td>
</tr>
<tr>
<td>Hypoxis hemerocallidea</td>
<td>Qololbo</td>
<td>Crushed roots used as a plaster for wounds</td>
<td>S. epidermidis, B. subtilis, P. aeruginosa</td>
</tr>
<tr>
<td>Malva parviflora L. var. parviflora (Malvaceae)</td>
<td>Tika-motse</td>
<td>Tubular roots dried powder is applied into clean wounds</td>
<td>S. aureus, S. epidermidis, B. subtilis, E. coli, K. pneumoniae, M. luteus, P. aeruginosa</td>
</tr>
<tr>
<td>Rumex acetosella L. (Polygonaceae)</td>
<td>Bolilanyane</td>
<td>Crushed roots decoction used to bath wounds</td>
<td>B. subtilis, E. coli, K. pneumoniae, M. luteus, P. aeruginosa, S. aureus, S. epidermidis, C. albicans</td>
</tr>
<tr>
<td>Salix mucronata Thunb. (Salicaceae)</td>
<td>Molouane</td>
<td>Preparation of plant to treat burn wounds</td>
<td>K. pneumoniae, S. aureus, B. subtilis, E. coli</td>
</tr>
<tr>
<td>Solanum aculeatissimum Jacq. (Solanaceae)</td>
<td>Thola</td>
<td>Powdered plant is rubbed into wounds</td>
<td>B. subtilis, E. coli, K. pneumoniae, M. luteus, P. aeruginosa, S. aureus, S. epidermidis, C. albicans</td>
</tr>
<tr>
<td>Withania somnifera (L.)</td>
<td>Mofera-ngope</td>
<td>Paste of leaves applied to wounds</td>
<td>S. aureus, S. epidermidis, N. gonorrhoea and C. albicans, B. subtilis, E. coli, K. pneumoniae, Micrococcus pyogenes, Sacetromyees cerevisiae, S. typhi, Shigella dysentriae, Vibrio cholerae</td>
</tr>
</tbody>
</table>
cosmetic industries while conserving the environment. Testing of herbal products for heavy metal and microbial contaminants before packaging them is highly recommended, and may become mandatory. 

Furthermore, pharmacists can compound over-the-counter (OTC) topical herbal medicinal products. Using bases or carriers, easily compoundable herbal extracts can be compounded into wound care formulations as creams, ointments, or powders. For example; the gel of Aloe vera leaf can be easily compounded into creams or dried gel powder into powders for promotion of wound healing. While green propolis extract can be easily compounded as a cream to aid the wound healing process by decreasing the inflammation at the site of injury through a combination of antimicrobial and anti-inflammatory activities.

Potential side-effects and toxicities of topical herbal medicines

It is popularly perceived by societies that herbal products, compared to products made from synthetic chemical ingredients. However, herbal ingredients in cosmetics products have been associated with hypersensitivity reactions resulting in inflammatory skin eruptions characterised by pruritis, erythematous vesicles, and papules. For instance: eucalyptus oil, famous for its antibacterial, antiviral, antifungal, and anti-inflammatory properties, is regarded as safe and is included in topical antiseptics, soaps, mouthwashes as well as balms. Nonetheless, some reports implicate its main constituent, 1,8-cineole, as the causative allergen in some side-effects. Indeed, the potential of encountering side-effects with herbal medicines could be greater when herbs are used in their crude forms, such as bulb, roots, bark, leaves, flowers, or seeds, compared to herbal formulas. Although the knowledge about which herbs are potentially toxic in Lesotho has passed from one generation to another through oral traditions, and most topical herbs are used without any problem, toxicities do occur possibly due to contamination with toxic medicinal plants and/or plant parts. Other toxic contaminants could include heavy metals from the soil where the plants are grown or traces of pesticides.

The contaminants that are most hazardous to health, especially in wound care products, are pathogenic bacteria which may include Salmonella spp., E. coli, S. aureus, and Shigella spp. They have the potential to wound infections and can complicate wound healing.

Advice to patients in Lesotho who treat minor wounds themselves

It is always important for patients to consult with community pharmacists or other health professionals before using any remedy, even for minor wounds caused by minor accidents, sports injuries, or sunburns, rather than to simply self-treat. Notwithstanding, many rural communities in Lesotho, especially those inhabiting the mountainous areas of the country, usually resort to consulting with the nearby traditional healers and/or to home treatment using medicinal plants probably due to their ease of access and cost-effectiveness as well as perceived safety. Pharmacists should therefore advise patients who self-treat using herbs to avoid secondary infections and optimise wound healing by following the first aid wound care protocols:

- clean the affected area thoroughly with soap and running water to remove the foreign matter,
- apply a thin layer of gel from freshly cut antibiotic medicinal plant such as A. ferox to minimise infections, and
- cover the affected area with a clean ironed or sterile cotton cloth to create a moist healing environment.

Gels and extracts from the genus Aloe, including A. vera and A. ferox, have been successfully used for wound healing in communities and commercially and are thus recommended as the first-choice treatment for self-medication by patients. Patients should avoid plants that require storage and processing as this could introduce contaminants, including pathogenic microbes. The practice of planting medicinal plants is encouraged to avoid their uncontrolled harvesting from nature, and thus protect the environment. Although the WHO has developed GMP guidelines to maintain the quality of herbal medicines, most distributors including traditional practitioners and handlers or processors, and consumers are not particularly aware of those guidelines.

Conclusion

The demand for and use of herbal medicines and herbal medicinal products are increasing. More than a dozen plants used in Lesotho for minor wound care contain active phytochemicals with proven antimicrobial efficacies. This information is important to pharmacists in order to be able to make recommendations to other healthcare providers and patients. By actively embracing this opportunity pharmacists will become recognised experts in this rapidly growing field of phytomedicine. While studies on the majority of medicinal plants have been limited to in vitro and/or animal models, large randomised human studies are needed. Finally, studies to isolate active phytochemicals and establish their mode of action, as well as toxicology studies of those compounds are recommended.

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Conflict of interest

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Ethical approval

The current study is a review of the secondary data from published sources and does not involve any human or animal studies. Thus, there is no ethical consideration to be disclosed.