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A REVIEW OF MEDICINAL PLANTS USED BY THE BASOTHO FOR TREATMENT OF SKIN DISORDERS: THEIR PHYTOCHEMICAL, ANTIMICROBIAL, AND ANTI-INFLAMMATORY POTENTIAL

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Abstract

Background: While the incidence of skin diseases is high in developing countries, they are not regarded as priority due to low mortality rates, however, they are a major concern due to their co-occurrence with HIV/AIDS. Due to lack of accessibility to healthcare facilities and unaffordability of conventional medicines, many people in rural areas resort to medicinal plants. The aim of the study is to document the plants used for treating skin afflictions by the Basotho people residing in Lesotho and the Free State Province of South Africa.

Materials and Methods: A comprehensive survey of existing ethnobotanical literature including numerous books was carried out. Electronic databases such as Google Scholar, PubMed, and ScienceDirect were also used to obtain information on the anti-inflammatory, antimicrobial, and phytochemical activities of the medicinal plants.

Results and discussion: 57 plant species are utilised for the treatment of various skin ailments with a majority of them used for wounds (26 species) and venereal sores (19 species). The plants are distributed in 39 families with the Asteraceae being the most represented with seven species, followed by Solanaceae and Asphodelaceae with four species each. 38 species have previously been evaluated for their phytochemical properties, 40 for their anti-microbial potential, while 29 have been assessed for their anti-inflammatory activity. Of the 57, 13 species have not been evaluated for any of the three categories.

Conclusion: Many of the plants have been shown to have anti-microbial, anti-inflammatory, and phytochemical properties, which then validates their traditional use.

Key words: anti-inflammatory, antimicrobial, herpes, sores, venereal sores, wounds

Introduction

It is important to note that Basotho people inhabit both Lesotho and the Free State Province of South Africa. Information on the epidemiology of skin diseases in these two countries is scarce, in South Africa very few studies have been conducted but these were limited to regional level and/or population group, e.g. black population in Durban, KwaZulu-Natal (Dlova et al., 2015), Johannesburg (Hartshorne, 2003), paediatric skin conditions in KwaZulu-Natal (Katibi et al., 2016), no such studies have been reported for Lesotho. Although the incidence of certain skin diseases is high in developing countries, "they have so far not been regarded as a significant health problem in the development of public health strategies" [World Health Organization (WHO), 2005]. Skin disorders are of particular concern in Africa due to their co-infection with human immunodeficiency virus/ acquired immune deficiency syndrome (HIV/AIDS) (De Wet et al., 2013). According to the WHO (http://www.worldlifeexpectancy.com/cause-of-death/skin-disease/by-country/) Lesotho ranks 31 in the world in mortality rates due to skin diseases, furthermore skin diseases rank 35 among the top 50 causes of death in that country. With high levels of poverty, the astronomical prevalence of HIV/AIDS and Tuberculosis (TB) (ranked third and fourth highest in the world respectively), the high co-infection rate of these two diseases, as well as the rapidly increasing occurrence of non-communicable diseases in Lesotho (WHO, 2005), the country is faced with major challenges in ensuring provision of sufficient medical health facilities. South Africa on the other hand ranks 46 in the world in mortality rates due to skin diseases, with the latter ranked 33 among the top 50 causes of death (http://www.worldlifeexpectancy.com/cause-of-death/skin-disease/by-country/).

The lack of attention to skin disorders is a world-wide phenomenon, globally they are regarded as less important due to the fact that mortality rates are considered to be low. However, according to WHO (Mathers et al., 2006), skin diseases were implicated in 20,000 mortalities in sub-Saharan Africa in 2001. These figures are comparable to mortality rates caused by illnesses such as meningitis, hepatitis B, obstructed labour, and rheumatic heart disease. It is well-known that skin diseases affect the quality of life since they are often persistent and difficult to cure (Afolayan et al., 2014), most importantly they pose a significant

burden on health systems. Hay et al. (2014) have reported that a study conducted in 2010 on Global Burden of Disease (GBD), revealed that skin conditions were the 4th leading cause of nonfatal disease burden. The study therefore recommended that skin disease prevention and treatment should be included in future global health strategies. In Africa, there are over 55 common skin disorders (Van Hees & Naafs, 2009): Eczema (e.g. atopic, infantile, infective, Pityriasis alba), fungal infections (e.g. mycids, tinea corporis, candidiasis), bacterial infections (e.g. impetigo, folliculitis, secondary syphilis), viral infections (e.g. HIV, herpes, warts, chickenpox), parasitic infections (e.g. scabies, leishmaniasis, creeping eruption), auto-immune disease (e.g. Alopecia areata, vitiligo), miscellaneous skin diseases (acne, psoriasis, urticarial, malignant melanoma).

The reasons people in rural areas opt for traditional medicines are not well-documented, however, many authors have argued that the use of these medicines, especially in Africa, is due to lack of accessibility to healthcare facilities and the unaffordability of conventional medicines (e.g. Abdullahi, 2011; Seleteng Kose et al., 2015; Wachtel-Galor and Benzie, 2011). In so far as southern Africa is concerned, only a handful of articles have been published on the ethnobotany of medicinal plants used specifically for skin disorders, with one review covering the region (Mabona and Van Vuuren, 2013). In South Africa, only one review reported on the country as a whole (Lall and Kishore, 2014), other studies are based on population group and/or region, but only two provinces, namely Eastern Cape and KwaZulu-Natal are represented, for example Eastern Cape (Afolayan et al., 2014; Grierson and Afolayan, 1999) and northern Maputaland, KwaZulu-Natal (De Wet et al., 2013). No such data has been published for the rest of the country, however several other ethnobotanical surveys have been conducted in other regions (as well as the above mentioned provinces), the most studied being in the Limpopo Province (e.g. Chauke et al., 2015; Mahwashane et al., 2013; Semenya and Maroyi, 2012; Semenya and Potgieter, 2014), and a few in the North West Province (Van der Merwe et al., 2001), the Northern Cape Province (Monakisi, 2007; Nortje, 2011), and the south-eastern Karoo (Van Wyk et al., 2008), with the Free State and Mpumalanga Provinces neglected. As far as Lesotho is concerned only two ethnobotanical surveys have so far been conducted, one on medicinal plants used for inflammation and bacterial infections in two districts (Shale et al., 1999) and the other on plants used to treat diseases in general, in the Maseru District (Seleteng Kose et al., 2015). The aim of this study is therefore to document medicinal plants used for the treatment of skin diseases by the Basotho people (residing both in Lesotho and the Free State Province in South Africa). Since many skin diseases are associated with microbial infections and inflammation, the antimicrobial and anti-inflammatory activity of the plants are also explored, as well as their chemical properties.

Methods

Ethnobotanical data was obtained through a comprehensive literature survey, including a review article on the medical ethnobotany of Lesotho (Moteetee and Van Wyk, 2011), a recently published article based mainly on an ethnobotanical survey on medicinal plant use conducted in the Maseru district of Lesotho (Seleteng Kose et al., 2015), several relevant books (e.g. Hutchings et al., 1996; Moffett, 2010; Phillips, 1917; Van Wyk and Wink, 2004; Van Wyk et al., 2009; Watt and Breyer-Brandwijk, 1962), and the first author's first-hand experiences growing up in rural areas in Lesotho. For phytochemical, antimicrobial and anti-inflammatory properties of the plants, databases such as: Google Scholar, PubMed, ScienceDirect were searched using scientific names of the plants and keywords such as antibacterial, antimicrobial, anti-inflammatory, chemical constituents, phytochemicals, skin ailments, skin diseases, and skin disorders.

Results and Discussions

The plants used by the Basotho for skin disorders are listed in Table 1, including their major chemical compounds (where there is no information available, compounds recorded for other species in the same genus are indicated in brackets), their recorded antimicrobial and anti-inflammatory activities.

Table 1: Medicinal plants used for treatment of skin conditions in Lesotho; their main uses, chemical compounds, biological activity and references

Species	**Family**	**Main uses**	**Main chemical compounds**	**Known *in vitro* antimicrobial activity**	**Known anti-inflammatory activity**
Afroaster hispida (Thunb.) J.C.Manning & Goldblatt	Asteraceae	Mixed with *Scabiosa columbaria* for scab in humans, sores, syphilitic sores, wounds (Hutchings et al., 1996; Jacot Guillarmod, 1971; Moffett, 2010; Moteetee & Van Wyk, 2011; Pooley, 1998; Schmitz 1982; Shale et al., 1999; Van Wyk et al., 2009; Watt and Breyer-Brandwijk, 1962)	Terpenoids (Mugomeri et al., 2014)	High activity against *Bacillus subtilis, Escherichia coli, Klebsiella pneumoniae, Micrococcus luteus Pseudomonas aeruginosa, Staphylococcus aureus* (Shale et al., 1999)	Not yet evaluated
Agapanthus campanulatus Leighton ssp. *campanulatus*	Agapanthaceae	Sap from leaves for skin rash in children and 'crust' on infants' heads (Hutchings et al., 1996; Jacot Guillarmod, 1971; Maliehe, 1997; Moteetee & van Wyk, 2011; Schmitz, 1982)	Alkaloids, ecdysteroids, flavonoids, saponins (Fawole et al., 2009a, b; Savchenko et al., 1997)	Noteworthy activity against *B. subtilis, Candida albicans* (Fawole et al., 2009a)	Cyclooxygenase assay: ± 90% COX-1 and 70% COX-2 inhibition at 250 µg/ml (Fawole et al., 2009b)
Agave americana L. ssp. *americana*	Agavaceae	Herpes sores/ulcers, skin problems (Moteetee and Van Wyk, 2011; Seleteng Kose et al., 2015; Watt & Breyer-Brandwijk, 1962)	Flavonoids, saponins, glycosides (Tinto et al., 2005)	Active against *B. subtilis, S. aureus, Salmonella choleraesuis* (Khan et al., 2010)	Oedema assay: 81% inhibition at 6 mg/ear (Monterrosas-Brisson et al., 2013)
Albuca cooperi Baker	Hyacinthaceae	Wounds in animals (Phillips, 1917; Watt & Breyer-Brandwijk, 1962)	No records	Not yet evaluated	Not yet evaluated
A. setosa Jacq	Hyacinthaceae	Wounds in animals (Jacot Guillarmod, 1971; Moteetee & Van Wyk, 2011; Phillips, 1917; Watt & Breyer-Brandwijk, 1962)	Saponins (Mulholland et al., 2013)	Negative antibiotic activity (Mulholland et al., 2013)	Oedema assay: 43-55% at 159 mg/kg; 68-85% at 300mg/kg (Umapathy et al., 2011)
Aloe ferox Mill.	Asphodelaceae	Eczema, skin problems, herpes sores/ulcers (Maliehe, 1997; Moffett, 2010; Moteetee & Van Wyk, 2011; Van Wyk et al., 2009; Van Wyk & Gericke, 2000; Van Wyk and Wink, 2004; Watt & Breyer- Brandwijk, 1962)	Aloin, anthraquinones, glycoproteins (Chen et al., 2012)	Noteworthy activity against *Neisseria gonorrhoea, C. albicans* (Kambizi et al., 2008)	Oedema assay: 78.2% inhibition at 400 mg/kg; 72.1 % at 100 mg/kg (Mwale and Masika, 2010)
A. striatula Haw. var. *striatula*	Asphodelaceae	Burns, wounds (Jacot Guillarmod, 1971); Maliehe, 1997; Moteetee & Van Wyk, 2011, Moffett, 2010; Van Wyk & Gericke, 2000)	No records (aloin, anthraquinones)	Low activity against *E. coli* (Bisi-Johnson et al., 2011)	Not yet evaluated
Arundinella nepalensis Trin.	Poaceae	Lotion prepared from the plant used for washing wounds (Jacot Guillarmod, 1971; Moteetee & Van Wyk, 2011); Phillips,	No records	Not yet evaluated	Not yet evaluated

		1917; Watt & Breyer-Brandwijk, 1962)			
Aster sp.	Asteraceae	Sores, wounds (Shale et al., 1999)		Medium inhibitory activity against *E. coli*, but no activity against *B. subtilis, K. pneumoniae, M. luteus, P. aeruginosa, S. aureus, Staphylococcus epidermidis* (Shale et al., 1999)	
Berkheya setifera DC.	Asteraceae	Herpes sores/ulcers (Maliehe, 1997; Moteetee & van Wyk, 2011; Pooley,1998; Schmitz, 1982); Watt and Breyer-Brandwijk, 1962)	Saponins, glycosides, alkaloids, terpenoids (Muleya 2013)	Good to moderate activity against *Enterococcus faecalis, E. coli, P. aeruginosa, S. aureus, Aspergillus fumigatus, C. albicans* (Muleya et al., 2014)	Lipoxygenase assay: 80% 15-LOX inhibition at 25 μg/ml (Muleya et al., 2014)
Boophone disticha (L.f.) Herb.	Amaryllidaceae	Leaves placed on circumcision wounds, infusion of bulbs for wounds (Jacot Guillarmod, 1971); Moteetee & van Wyk, 2011); Phillips, 1917; Shale et al., 1999)	Alkaloids (Nair & Van Staden, 2014)	Noteworthy activity against *E. coli, K. pneumoniae, S. aureus* (Cheesman et al., 2012; Nair & Van Staden, 2014)	Cyclooxygenase assay: 55% COX-1 inhibition (Jäger et al., 1996; Nair & Van Staden, 2014); 65% COX inhibition (Shale et al., 1999)
Buddleja salviifolia (L.) Lam.	Buddlejaceae	Eye ointment, herpes sores/ulcers (Seleteng Kose et al., 2015)	Flavonoids (Pendota et al., 2014)	Noteworthy activity against *B. subtilis, E. coli, K. pneumoniae, S. aureus, C. albicans* Pendota et al (2013)	Cyclooxygenase assay: isolated compounds **1, 2, 3**) exhibited high COX-2 inhibition (70%, 80%, 90% respectively) (Pendota et al (2014)
Bulbine asphodeloides (L.) Spreng	Asphodelaceae	Leaf juice applied to cracked lips, crushed leaf as dressing for burns (Jacot Guillarmod, 1971; Maliehe, 1997; Moteetee & Van Wyk, 2011; Seleteng Kose et al., 2015)	No records (anthraquinones, glycosides) (Qhotsokoane-Lusunzi and Karuso, 2001)	Not yet evaluated	Not yet evaluated
B. frutescens (L.) Willd.	Asphodelaceae	Fresh leaf sap for treatment of ringworm, eczema, wounds, burns, cracked lips (Iwu (2014);	anthraquinones, alkaloids, flavonoids, glycoproteins, saponins, tannins (Abegaz, 2002; Van Staden & Drewes, 1994)	Noteworthy activity against *B. subtilis, E. coli, Micrococcus kristinae, S. aureus* (Coopoosamy, 2010; Opinde et al., 2016)	Cyclooxygenase assay: 34% COX-1 and COX-2 inhibition (Gaidamashvili & Van Staden; 2002)
Cheilanthes hirta SW.	Sellaginaceae	Herpes sores/ulcers (Seleteng Kose et al., 2015)	No records (flavonoids, glycosides) (Imperato, 1992)	Not yet evaluated	Not yet evaluated
Chenopodium sp.	Chenopodiaceae	Sores, wounds (Shale et al., 1999)		*Active against *B. subtilis, E. coli, K. pneumoniae, M. luteus, P. aeruginosa, S. aureus, S. epidermidis* (Shale et al., 1999)	
Clerodendrum glabrum E.Mey.	Verbenaceae	Decoction of leaf applied to wounds (Watt and Breyer-Brandwijk, 1962)	Glycosides, triterpenoids (Masevhe et al., 2013; Wanas et al., 2013)	Isolated compounds active against *C. albicans, Cryptococcus neoformans*; low activity against tested bacteria (Masevhe et al., 2013)	Cyclooxygenase assay: 88% COX inhibition (Jäger et al; 1996)

Cotyledon orbiculata L. var. *oblonga* (Haw.) DC.	Crassulaceae	Boils, mouth ulcers (Moteetee and Van Wyk, 2011)	*Phenols, saponins, tannins (Molefe, 2013)	*Not active against *B. subtilis, S. aureus, E. coli, K. pneumoniae* (Aremu et al., 2010) and *Propionibacteria acnes* (Sharma and Lall, 2014)	*Oedema assay: 51% inhibition at 100 mg/kg; 76% inhibition at 400 mg/kg (Amabeoku & Kabatende, 2012)
Cussonia paniculata Eckl. Zeyh. ssp. *sinuata* (Reyneke & Kok) De Winter	Araliaceae	Sores, wounds (Jacot Guillarmod, 1971; Maliehe, 1997; Moteetee and Van Wyk, 2011; Phillips, 1917; Seleteng et al., 2015; Watt and Breyer-Brandwijk, 1962)	Triterpene glycosides (Dovgii et al. 2005)	Noteworthy activity against *P. aeruginosa* and *N. gonorrhoeae* (De Villiers et al., 2010)	*Oedema assay: 92.4 % inhibition at 200 mg/kg (2hrs) (Adedapo et al., 2008)
Cymbopogon dieterlenii Stapf. ex E.Phillips	Poaceae	Lotion prepared from the plant used for washing wounds Jacot Guillarmod (1971); Phillips (1917); Watt & Breyer-Brandwijk (1962)	No records (alkaloids, phenols, saponins, tannins, essential oils) (Ekpenyong et al., 2015)	Not yet evaluated	Not yet evaluated
Cynoglossum lanceolatum Forsk.	Boraginaceae	Crushed root used as a plaster for wounds Watt & Breyer-Brandwijk (1962);	Alkaloids (Sharma et al., 2009)	Inactive against *C. albicans, E. coli, S. aureus, Shigella sonnei, K. pneumonia,* Noteworthy activity against *S. epidermidis, Salmonella paratyphi, S. typhimurium* (Shinwari et al., 2015)	Oedema assay: 88.5% suppression at 200 mg/kg (Yu et al., 2012)
Datura stramonium L.	Solanaceae	Hot leaves for abscesses, bruises, and boils (Maliehe, 1997; Phillips, 1917, Watt & Breyer-Brandwijk, 1962)	Alkaloids, glycosides saponins, steroids, tannins, terpenoids (Singh and Singh, 2013)	Active against *E. coli, P. aeruginosa, S. aureus, Aspergillus flavus, A. niger, Fusarium culmorum, Rhizopus stolonifer* (Sharma et al., 2013)	Oedema assay: 46.7% inhibition at 200 mg/kg (Sonika et al., 2010)
Dicoma anomala Sond. ssp. *anomala*	Asteraceae	Powdered flowers as ointment for sores and wounds, ringworm, skin lesions (Jacot Guillarmod, 1971; Maliehe, 1997; Moteetee and Van Wyk, 2011; Schmitz, 1982; Shale et al., 1999; Van Wyk et al., 2009; Watt and Breyer-Brandwijk, 1962)	Sesquiterpene lactones (Becker et al., 2011)	No activity against *E. coli, P. auruginosa, S. aureus, Streptococcus pyogenes* (Shale et al.,1999; Steenkamp et al., 2004)	Cyclooxygenase assay: 86% COX inhibition (Shale et al., 1999)
Elephantorrhiza elephantina (Burch.) Skeels	Fabaceae	Herpes sores/ulcers (Seleteng Kose et al., 2015)	Flavonoids, tannins, terpenoids (Mpofu et al., 2014a)	Noteworthy activity against *E. coli, E. faecalis, P. aeruginosa, S. aureus, Shigella typhi, S. flexneri, Vibrio cholerae* (Mathebe et al., 2006)	Oedema assay: 93.7% inhibition at 50 mg/kg (Lall & Kishore, 2014; Maphosa et al., 2009)
Euphorbia clavarioides Boiss var. *clavaroides*	Euphorbiaceae	Acne, cancerous sores, cracked heals, herpes sores, leprosy, skin rash in children (Jacot Guillarmod, 1971); Maliehe, 1997; Moteetee & Van Wyk, 2011; Pooley, 1998; Seleteng et al., 2015; Shale et al., 1999; Watt & Breyer- Brandwijk, 1962)	No records (phenolics) (Gopi et al., 2015)	Low activity against *B. subtilis* and *S. epidermis* (Shale et al., 1999)	Not yet evaluated

Gnidia gymnostachya (C.A. Mey) Gilg.	Thymelaeaceae	Decoction of plant to wash bruises and wounds (Moteetee & Van Wyk, 2011; Phillips, 1971)	No records (alkaloids, coumarins, flavonoids, glycosides, lignans, terpenoids) (Bhandurge et al., 2013)	Not yet evaluated	Not yet evaluated
Gunnera perpensa L.	Gunneraceae	Leaves as hot poultice for boils and wounds, sores (Maliehe, 1997; Moteetee & Van Wyk, 2011; Phillips, 1917; Van Wyk et al., 2009)	Benzoquinones (Drewes et al., 2005)	Good activity of compound 1 against *S. epidermidis* and compound 2 against *C. albicans* and *Cryptococcus neoformans* (Drewes et al., 2005). Noteworthy activity against *E. faecalis, E. coli, P. aeruginosa, S. aureus, A. fumigatus, C. albicans* (Muleya et al. (2014)	Oedema assay: 59.2% inhibition at 150 mg/kg (Lall & Kishore, 2014; Nkomo et al., 2010)
Hermannia coccocarpa K.Schum.	Sterculiaceae	Crushed roots as a plaster for burns and wounds (Phillips, 1917; Watt & Breyer-Brandwijk, 1962)	No records	Not yet evaluated	Not yet evaluated
Hypoxis argentea Harv. ex Baker var. *sericea* Baker	Hypoxidaceae	Sores on horses and cracked teats in cows (Phillips, 1917; Watt & Breyer-Brandwijk (1962)	No records	Not yet evaluated	Not yet evaluated
H. rigidula Baker	Hypoxidaceae	Infusion used to treat wounds and skin rash (Shale et al., 1999)	Organic acids, phenolic compounds (Ncube et al., 2013)	No activity against most bacteria tested, but low activity against *B. subtilis* and *S. epidermidis* (Shale et al., 1999)	Not yet evaluated
Lasiosiphon kraussianus Hutch. & Dalz.	Thymelaeaceae	Decoction of plant to bathe wounds and bruises (Phillips, 1917; Watt & Breyer-Brandwijk, 1962)	Daphnane diterpenes, flavonoids, sterols (Bhandurge et al., 2013)	Not yet evaluated	Not yet evaluated
Leucosidea sericea Eckl. & Zeyh.	Rosaceae	Herpes sores/ulcers (Seleteng et al., 2015)	Alkaloids, flavonoids, saponins, tannins (Aremu et al., 2010)	Noteworthy activity against *B. subtilis, E. coli, K. pneumoniae, S.* aureus; low activity against *C. albicans* (Aremu et al., 2010) and *Propionibacteria acnes* (Sharma and Lall, 2014)	Cyclooxygenase assay: 97% COX-1, 91% COX-2 inhibition at 250 µg/ml (Aremu et al., 2010); triterpenoids: 65.3% COX-1, 82.7 COX-2 (Nair et al., 2012)
Malva parviflora L. var. *parviflora*	Malvaceae	Herpes sores/ulcers, wounds (Seleteng Kose et al., 2015; Shale et al., 1999)	Alkaloids, flavonoids, glucosides, phytosterols, saponins, total phenols (Abdel-Ghani et al., 2013; Shehata and Galal, 2014)	High activity against *B. subtilis, E. coli, K. pneumoniae, M. luteus, P. aeruginosa, S. aureus, S. epidermidis* (Shale et al., 1999)	Cyclooxygenase assay: 98% COX-1 inhibition at 200 µg/ml (Shale et al., 1999; Shale et al., 2005)
Monsonia brevirostrata Knuth	Geraniaceae	Syphilitic sores (Shale et al., 1999)	No records	No antimicrobial activity against tested pathogens (Shale et al., 1999)	Not yet evaluated
Myrsine africana L.	Myrsinaceae	Ringworm, skin diseases (Watt & Breyer-Brandwijk, 1962)	Anthraquinones, flavonoids, saponins,	Good activity against *K. pneumoniae*; low to no activity	Oedema assay: 57% inhibition at 500 mg/kg (Abbhi et al., 2016)

			steroids, tannins (Abbhi et al., 2011)	against *B. pumilus, Enterobacter aerogenes, E. coli, P. aeruginosa, S. epidermidis, Streptococcus pneumoniae* (Ahmad et al. 2011)	
Olea europaea L. ssp. *africana* (Mill.) P.S.Green	Oleaceae	Herpes sores/ulcers (Seleteng Kose et al., 2015)	Flavonoids, glucosides, steroids, tannins, terpenoids (Masoko & Makgapeetja, 2015)	Noteworthy activity against *E. coli, E. faecalis, P. aeruginosa, S. aureus* (Masoko & Makgapeetja, 2015)	Not yet evaluated
Ophioglossum vulgatum L.	Ophioglossaceae	Warm decoction of rhizomes to bath boils (Jacot Guillarmod, 1971; Phillips, 1917)	Flavonoids, glucosides (Markham et al., 1969)	Not yet evaluated	Not yet evaluated
Parapodium costatum E.Mey	Apocynaceae	External tumours (Seleteng Kose et al., 2015)	No records	Not yet evaluated	Not yet evaluated
Pentanisia prunelloides (Klotzsch ex Eckl. & Zeyh.) Walp.	Rubiaceae	Boils, burns, sores (Jacot Guillarmod, 1971; Maliehe, 1997; Moteetee & Van Wyk, 2011; Phillips, 1917; Pooley, 1998; Schmitz, 1982; Van Wyk et al., 2009; Watt & Breyer-Brandwijk, 1962)	Flavonoids, tannins, terpenoids (Mpofu et al., 2014)	Noteworthy activity against *B. cereus, E. faecalis* (Mpofu et al., 2014)	Cyclooxygenase assay: 88% COX-1 inhibition at 0.1 mg/ml (Lall & Kishore, 2014; Yff et al., 2002). Lipoxygenase assay: 79% 15-LOX inhibition at 167 µg/ml (Muleya et al., 2015)
Phygelius capensis E.Mey.	Scrophulariaceae	Herpes sores/ulcers (Seleteng Kose et al., 2015)	No records	Not yet evaluated	Not yet evaluated
Populus sp.	Salicaceae	Herpes sores (Seleteng Kose et al., 2015)	*Glucosides (salicin), glycosides (Wei et al., 2015)	*Noteworthy activity against *B. cereus, E. faecalis, E. faecium, S. aureus, S. pyogenes, C. albicans, C. krusei, Listeria innocua, L. monocytogenes, L. seeligeri, L. welshimeri, Mycobacterium smegmatis* (Ünlü et al., 2008)	*Oedema assay: 62.05% inhibition at 200 mg/kg (5hrs) (Xu et al., 2014)
Rhamnus prinoides L'Her.	Rhamnaceae	Herpes sores/ulcers (Seleteng Kose et al., 2015)	Anthraquinones, flavonoids, glycosides, phenols, saponins, tannins, triterpenoids (Amabye, 2016)	Noteworthy activity against *E. coli, P. aeruginosa, S. aureus, Streptococcus mutans* (Amabye, 2016)	Not yet evaluated
Rumex acetosella L.	Polygonaceae	Crushed roots for skin rash, decoction of plant for wounds and bruises (Moteetee and Van Wyk, 2011; Shale et al., 1999)	Anthraquinones (Vasas et al., 2015)	High activity against *B. subtilis, E. coli K. pneumoniae, M. luteus, P. aeruginosa, S. aureus, S. epidermidis* (Shale et al., 1999)	Not yet evaluated
R. lanceolatus Thunb.	Polygonaceae	Hot lotion to bathe bruises and wounds Jacot Guillarmod (1971); Moteetee and van Wyk, (2011); Phillips (1917); Van Wyk et al. (2009); Watt and Breyer-Brandwijk (1962)	Anthraquinones, glycosides	Not yet evaluated	Not yet evaluated
Salix mucronata Thunb.	Salicaceae	A preparation of plant to treat burn	Alkaloids, flavonoids,	Noteworthy activity against *B.*	Cyclooxygenase assay: up to 94%

		wounds (Jacot Guillarmod, 1971; Phillips, 1917; Van Wyk et al. 2009)	glycosides, phenols, saponins, sterols, tannins, triterpenoids (El-Sayed et al., 2015)	*subtilis, E. coli, K. pneumoniae, S. aureus* (Eldeen et al., 2005)	COX-1 inhibition at 0.25 mg/ml; up to 82% COX-2 inhibition (Eldeen et al., 2005)
Scabiosa columbaria L.	Dipsacaceae	Ointment of charred roots applied to venereal sores (Jacot Guillarmod, 1971; Moteetee and Van Wyk, 2011; Phillips, 1917; Pooley (1998); Schmitz, 1982; Van Wyk et al., 2009; Watt and Breyer-Brandwijk, 1962)	Iridoid glycosides (loganin, sweroside) (Van Wyk et al., 2009)	No noteworthy antimicrobial activity against STI pathogens (*C. albicans, G. vaginalis, T. vaginalis, N. gonorrhoeae, O. ureolytica, Ureaplasma urealyticum)* (Van Vuuren & Naidoo, 2010)	Not yet evaluated
Searsia lancea (L.f.) F.A.Barkley	Anacardiaceae	Herpes sores/ulcers (Seleteng Kose et al., 2015)	Flavonoids, tannins (Angara and Mosase, 2001)	Essential oil active against *Acetobacter calcoaceticus, B. subtilis, Citrobacter freundii, Clostridium perfringens, C. sporogenes, E. coli, K. peumoniae, Proteus vulgaris, P. aeruginosa, S. typi, S. aureus, Yersinis enterocolitica, A. flavus, A. niger, C. albicans, Penicilium notatum* (Gundidza et al., 2008)	Not yet evaluated
Selaginella caffrorum (Milde) Hieron	Sellaginaceae	Herpes sores/ulcers (Seleteng Kose et al., 2015)	No records (alkaloids, flavonoids, coumarins, steroids) (Almeida et al., 2013)	Not yet evaluated	Not yet evaluated
Senecio asperulus DC.	Asteraceae	Herpes sores/ulcers, mouth ulcers (Maliehe, 1997; Moteetee and Van Wyk, 2011; Mugomeri et al., 2014; Schmitz, 1982; Seleteng et al., 2015; Watt and Breyer-Brandwijk, 1962)	Alkaloids, diterpenes, glycosides, phytosterols, flavonoids (Mugomeri et al., 2014)	Not yet evaluated	Not yet evaluated
Sonchus dregeanus DC.	Asteraceae	Lotion from leaves for skin rash in children (Maliehe, 1997)	No records	Not yet evaluated	Not yet evaluated
Solanum aculeatissimum Jacq.	Solanaceae	Powdered plant for wounds (Moffett, 2010; Moteetee and Van Wyk, 2011; Seleteng Kose et al., 2015)	Alkaloids, glycosides, saponins, steroids, tannins (Nabeta, 1993; Yemele et al., 2015)	High activity against, *B. subtilis, E. coli, K. pneumoniae, M. luteus, P. aeruginosa, S. aureus, S. epidermidis* (Shale et al., 1999)	Not yet evaluated
S. nigrum L.	Solanaceae	Skin rash (Shale et al., 1999)	Alkaloids, glycosides, saponins, steroids (Eltayeb et al., 1997; Nawwar et al., 1989)	Noteworthy against *B. subtilis, E.coli, S. aureus, S. cerevisiae, S. dysentriae, S. epidermidis* (Shale et al., 1999)	Cyclooxygenase assay: root and stem hexane extracts exhibited 92% and 83% inhibition respectively (Shale et al., 1999)
Ursinia nana DC. ssp. *nana*	Asteraceae	Burnt plant mixed with ointment for wounds (Jacot Guillarmod, 1971; Moteetee and Van Wyk, 2011; Phillips,	Sesquiterpene lactones (Bohlmann and Gupta, 1982; Jakupovic et al.,	Not yet evaluated	Not yet evaluated

		1971; Schmitz, 1982)	1992)		
Urtica urens L.	Urticaceae	Wounds (Maliehe, 1997; Moteetee and Van Wyk, 2011)	Alkaloids, glycosides, saponins, tannins (Marrassini et al., 2010)	No activity against *E. coli, P. aeruginosa, S. aureus, S. pyogenes, C. albicans* (Steenkamp et al., 2004)	Oedema assay: 41.5% inhibition at 300 mg/kg (Marrassini et al., 2010)
Wahlenbergia banksiana A.DC.	Campanulaceae	Roots to treat bad syphilitic sores (Philips, 1917; Watt and Breyer-Brandwijk, 1962)	No records	Not yet evaluated	Not yet evaluated
Withania somnifera (L.) Dunal	Solanaceae	Paste of leaves applied to sores, wounds (Jacot Guillarmod, 1971; Moteetee and Van Wyk, 2011; Philips, 191); Van Wyk et al., 2009; Watt and Breyer-Brandwijk, 1962)	Alkaloids, glycosides, saponins, steroids (Sahni et al., 2014)	Active against *N. gonorrhoea* and *C. albicans.* No noteworthy activity against *B. subtilis, E. coli, K. pneumoniae, Micrococcus pyogenes, Sacetromyees cerevisiae, S. typhi, Shigella dysentriae, S. aureus, S. epidermidis, Vibrio cholerae* (Malik et al., 2011)	NFkappaB-inhibitory activity, TNTα-inhibitory activity (Kaileh et al., 2007)
Zantedeschia albomaculata (Hook.) Baill ssp. *albomaculata*	Araceae	Mouth ulcers (Jacot Guillarmod, 1971; Maliehe, 1997; Moteetee and van Wyk, 2011; Pooley, 1998; Schmitz, 1982)	No records (terpenoids, sterols) (Greca et al., 1998);	Not yet evaluated	Not yet evaluated

*indicates that the data recorded is for other species, subspecies or variety

Ethnobotanical data

57 plant species distributed in 39 families are used by the Basotho for skin afflictions in both humans and animals. The most represented families are: Asteraceae (seven), Solanaceae (four), and Asphodelaceae (four). The list includes three pteridophyte, 41 dicots, and 13 monocot species. The plants are used to treat a wide array of skin ailments including boils, burns, cracked heels and lips, cracked teats in cows, skin rashes, sores, venereal sores (including herpes and syphilitic sores), and wounds (including circumcision wounds), with the highest number of plants being used for wounds (27) followed by venereal sores (19). Several plants have more than one use, the most used plant being *Euphorbia clavarioides* ssp. *clavarioides* (acne, cancerous sores, cracked heels, leprosy, skin rash in children, venereal sores), four other species of *Euphorbia* (*E. balmifera, E. consorbina, E. inarticulate,* and *E. schimperi*) have also been reported to have wound healing properties (Ahmed et al., 2016). The second most used plant is *Bulbine frutescens* (burns, cracked lips, eczema, ringworm, and other wounds). Other popular plants (with at least three or more uses) include *Afroaster hispida, Dicoma anomala, Gunnera perpensa,* and *Pentanisia prunelloides.* The plants are utilised in many different dosage forms: the plant (mainly leaves) is applied as a hot poultice, an infusion, or a decoction, or the powder of burnt plant is directly applied to the affected area, or it is mixed with fat and used as an ointment.

Plants used for wound healing

Based on Percival (2002), there is no standard classification of wounds, but there are many different ways in which wounds can be described, the most important being "the nature of the injury causing the wound, the timing, whether acute or chronic and the depth of the injury to the skin and underlying tissues", therefore accordingly, injury wounds include shearing, crushing, and burns. Whatever the type of injury, wounds must be sterilised to avoid colonisation by skin bacteria which can cause an infection. Information on the prevalence of wounds both in Lesotho and South Africa is scanty, but in South Africa, it is estimated that 3.2% of the population suffer from burn wounds annually, that thermal injuries are the "commonest external cause of death under the age of 4 years, and that they are the third most common cause of injury mortalities under the age of 18 years" (Rode et al., 2011). Plants have served as agents of wound healing since ancient times (Bhattacharya, 2012). Plants used by the Basotho for such purposes include *Aloe striatula, Boophone disticha, Cussonia paniculata, Malva parviflora, Rumex acetosella, Salix mucronata,* and *Withania somnifera* (as listed in Table 1). Surprisingly, only a few species are used by other cultures in southern Africa or elsewhere for similar purposes, these are *Aloe ferox, B. disticha, Bulbine asphodeloides, B. frutescens, Gunnera perpensa, M. parviflora, Solanum nigrum,* and *W. somnifera.* A different species of *Rumex* (*R. vesicarius* L.) on the other hand is used in Pakistan for wound-healing purposes (Khan et al., 2015).

Aloe species have been reported to have numerous ethnobotanical uses, for example in southern Africa they are utilised for infectious and inflammatory problems associated with the circulatory, digestive, endocrine, genitourinary, and respiratory systems (Grace et al., 2008). *Aloe ferox,* perhaps better known for its laxative properties (dried leaf juice sold commercially as Cape aloes), is also very well-known for its wound healing properties and it is used widely across its geographic distribution in southern Africa (Grace et al., 2008; Van Wyk, 2013; Van Wyk and Wink, 2004). Although the bulb of *B. disticha* is reported to be poisonous, the dry scales are used by the Basotho to bandage circumcision wounds during the initiation of boys, the Xhosa and Zulu people also use them for the same purpose, while they are applied locally by the Manyika "for the relief of urticarial and burns" (Watt and Breyer-Brandwijk, 1962). *Bulbine asphodeloides* "is widely used by the European and African" in which case the leaf juice is applied to wounds (Watt and Breyer-Brandwijk, 1962). According to Van Wyk et al. (2009), the slimy leaves of *B. frutescens* are used for several skin conditions including burns, rashes and wounds. It is reported that *G. perpensa* was used in the Cape for making wound dressing (Watt and Breyer-Brandwijk, 1962). *Malva parviflora* appears to be a popular plant in southern Africa for the treatment of wounds and swellings (Watt and Breyer-Brandwijk, 1962), in a survey conducted by Grierson and Afolayan (1999) in the Eastern Cape, it was found to be one of the most utilised plants. *Solanum nigrum* is also used in Europe for the treatment of ulcers and wounds and *W. somnifera* is used as an ointment for a similar purpose by the Xhosas (Watt and Breyer-Brandwijk, 1962).

Since wound healing is a complex series of events, there are several *in vitro* assays [e.g. Chick Chorioallantoic Membrane (CAM), fibroblast, keratinocytes] and *in vivo* wound models (e.g. excision, incision, burn, dead space) that are used to validate wound healing properties of plants (Thakur et al., 2011). It is therefore prudent to evaluate the wound-healing activity of these plants with such methods, in addition to their anti-inflammatory, antimicrobial, and antioxidant activities. Based on available information, only a few species have been proven to have wound healing properties, for example, some *Aloe* species have been proven to exhibit considerable "wound healing activity *in vivo* with enhancement of granulation and epithelialization, as well as wound healing activity *in vitro* via cell proliferation activity, and enhancement of epidermal tissue, proliferation markers (fibronectin and keratin)" (Farzaei et al., 2014). The leaf gel from *B. frutescens* was shown to improve tensile strength in wounds as well as significantly increase the collagen, protein and DNA content in treated wounds (Pather et al., 2011).

Plants used for venereal sores/ulcers

The majority of the plants used by the Basotho for the treatment of venereal sores are used for herpes (15), these include *Agave americana, A. ferox, Buddleja salviifolia, Elephantorrhiza elephantina, L. sericea, M. parviflora, Olea europaea* ssp. *africana,* and *Searsia lancea,* with only three used for syphilic sores, namely *A. hispida, Monsonia brevirostrata,* and *Wahlenbergia banksiana,* and one (*Scabiosa columbaria*), for the treatment of venereal (unspecified) sores. *Olea europaea* is used widely for other ailments; for example, it is used for treatment of hypertension and tumours in Bangladesh (Rahmatullah et al.,

2010). Some of these medicinal plants have previously been reported to be used for the treatment of other sexually transmitted infections (STIs) such as gonorrhoea and syphilis, but their utilisation for the treatment of herpes in Lesotho was recorded for the first time by Seleteng Kose et al. (2015).

When one considers the high prevalence of STIs in both Lesotho and South Africa, it is not surprising that venereal sores, specifically herpes, are the second most treated skin problems using medicinal plants by the Basotho. While a complete picture on the prevalence of sexually transmitted infections (STI's) in Lesotho is not yet available, based on the incidences of trichomoniasis and syphilis, it is regarded to be high (Corno et al., 2010). No data is available on the epidemiology of herpes in Lesotho, but in sub-Saharan Africa (with the highest prevalence in the world), the incidence of herpes simplex virus type 2 (HSV-2), which is the commonest type of herpes, was reported to be 78.2 million females and 45.5 million men in 2003 (http://www.who.int/bulletin/volumes/86/10/07-046128-table-T2.html). In a survey conducted in 2010 with 3 465 participants from 30 randomly selected villages in Lesotho, the prevalence of syphilis was found not to be very common, with 3.8% testing positive (Corno et al., 2010). National data for the incidence of STIs in South Africa is also not yet available, however in a review of studies conducted on the prevalence of STIs in the country, covering the period of 1985 to 2003, the incidence of certain STIs (in particular HSV-2, trichomoniasis, bacterial vaginosis, and candidiasis) was found to be high, although there was variation between regions (Johnson et al., 2005). In that review, the available data for the Free State Province reported only on syphilis and trichomoniasis and included only women participants. A pilot study in four provinces (Free State not included) by the Ministry of Health also found that the incidence of HSV-2 was high (National Department of Health, South Africa, 2012).

Plants used for other skin disorders

Other skin ailments are treated with medicinal plants as follows: i) Acne is treated with *E. clavaroides.* ii) Boils are treated using either a hot root decoction (e.g. *Pentanisia prunelloides*) or a hot poultice of the leaves of plants such as *Cotyledon orbiculata, Datura stramonium,* and *G. perpensa. Cotyledon orbiculata* is used widely in South Africa for medicinal purposes, for example, the leaf is applied to corns and warts, while the warmed juice is used for earache and toothache (Watt and Breyer-Brandwijk, 1962), it is however reported that ingestion is potentially lethal as the plant is toxic (Van Wyk et al., 2009). *Datura stramonium* is also known to be toxic, especially the seeds, nevertheless the plant has numerous therapeutic applications across the globe for the treatment of abscesses, boils, bronchitis, fever, gout, heart disease, hysteria, jaundice, piles, skin disorders, sore throat, tonsillitis, ulcers, and wounds (Sharma et al., 2013; Van Wyk et al., 2009). *Pentanisia prunelloides,* used widely in southern Africa for numerous illnesses, is known in Sesotho (the language of the Basotho people) as "*setima-mollo*" (fire extinguisher) for its use to relieve the burning pain of boils and reducing fevers (Moteetee and Van Wyk, 2011). iii) Cracked lips are treated with leaf juice from *Bulbine* species, cracked heals with the milky latex of *E. clavarioides*, while cracked teats in cows are treated with *Hypoxis argentea.* Both *Bulbine frutescens* and *B. asphodeloides* are known in the local language as '*sethlare-sa-pekane*' which literally translates to 'medicine for cracked lip', for this particular use. iv) Eczema is treated with two plants (*A. ferox* and *B. frutescens*); v) mouth ulcers with *C. orbiculata, Senecio asperulus,* and *Zantedeschia albomaculata* ssp. *albomaculata.* In South Africa, the latter species is only used for reproductive problems, whereas in Lesotho it is additionally used for a number of other ailments including bladder and kidney infections, headaches, sore throat, mouth ulcers, tumours in womb, and tuberculosis (Seleteng Kose et al., 2015). vi) For ringworm, three plants are used (*B. frutescens, Dicoma anomala,* and *Myrsine africana*). In Africa, *D. anomala* has a wide array of therapeutic applications especially circulatory, digestive, and respiratory problems, and even degenerative conditions such as cancer (Van Wyk et al., 2009). *Myrsine africana* is not used elsewhere in southern Africa for skin conditions, but it is used in India for ringworm and other skin diseases (Watt and Breyer-Brandwijk, 1962), elsewhere in Africa it is better known for its anthelmintic properties (Githiori et al., 2002). vii) To heal skin rashes, six plants including *Agapanthus campanulatus, E. clavarioides,* and *Solanum nigrum* are used with three of them used specifically for children. viii) Sores are treated using ten species, these include *Aster* sp., *Chenopodium* sp., *Cussonia paniculata, E. clavarioides* (for cancerous sores), and *Hypoxis argentea* (sores on horses). *Cussonia paniculata* is widely used in traditional medicine as an analgesic, anti-inflammatory, and for treating malaria, mental illness, and wounds (Adedapo et al., 2008; De Villiers et al. 2010).

Anti-inflammatory activity

Several *in vitro* assays such as albumin denaturation, anti-proteinase action, membrane stabilization, anti-cyclooxygenase, and anti-lipoxygenase activity are utilised to evaluate plant extracts for their anti-inflammatory properties. The current study has revealed that a total of 29 (51%) plants have previously been assessed using the different assays, with many of them showing significant anti-inflammatory activity. Of these, ten species (*A. campanulatus, B. disticha, B. salviifolia, B. frutescens, Clerodendrum glabrum, L. sericea, M. parviflorum, P. prunelloides, Salix mucronata, S. nigrum*) were evaluated using the anti-cyclooxygenase assay, whereby the inhibition of the biosynthesis of the cyclooxygenase isoenzymes (COX-1 and COX-2) indicates anti-inflammatory activity (see Table 1). Anti-inflammatory activity in other *Solanum* species was also observed in *S. rostratum* Dunal and *S. nigrescens* Mart. & Gal. in Mexico (Gutiérrez et al., 2014). In a study by Fawole et al. (2009), leaf extracts of *A. campanulatus* exhibited 92.6% and 72.3% inhibition of COX-1 and COX-2 respectively at 250 μg/ml, while the root extracts showed 97.7% and 78% inhibition respectively. Based on Jäger et al. (1996), ethanolic extracts of *B. disticha* showed 55% inhibition of cyclooxygenase while water extracts had a negative result, which according to these authors does not necessarily mean there is no anti-inflammatory activity. Extracts of *Berkheya setifera* on the other hand, have been evaluated

using the anti-lipoxygenase assay and were found to exhibit 80% inhibition of 15-LOX at 20 µl/ml (Muleya et al., 2014). Anti-inflammatory activity of 12 plants including *A. americana, Albuca setosa, C. paniculata, Cynoglossum lanceolatum, D. stramonium* and *E. elephantina*, has been investigated by means of the rat paw or ear oedema models, for example *A. americana* was tested on 12-O-tetradecanoylphorbol 13-acetate-induced auricular oedema and displayed 81% inhibition at 6 mg/ear (Monterrosas-Brisson et al., 2013). Mwale and Masika (2010) noted that leaf extracts from *A. ferox* demonstrated high anti-inflammatory activity of 78.2% and 89.3% on carrageenan- and formaldehyde-induced rat paw oedema respectively, at a dose of 400 mg/kg. Aqueous extracts of *E. elephantina* roots exhibited considerable inhibition, i.e. 88.3% inhibition of carrageenan-induced rat paw oedema after three hours at 200 mg/kg and 74.7% inhibition of histamine-induced oedema after three hours at 100 mg/kg (Maphosa et al., 2009).

Antimicrobial activity

Of the 58-plant species used by the Basotho for the treatment of skin ailments, 40 (70%) have previously been evaluated for their antimicrobial potential, with many of them showing broad spectrum activity against a number of pathogens, these include *B. setifera, E. elephantina, G. perpensa, S. lancea*, and *Solanum aculeatissimum* (as shown in Table 1). *E. elephantina* exhibited significant activity against a number of bacterial strains, namely *Escherichia coli, E. faecalis, Pseudomonas aeruginosa, Staphylococcus aureus, Shigella typhi, S. flexneri*, and *Vibrio cholerae* (Mathebe et al., 2006). *Gunnera perpensa* has shown noteworthy activity against the bacteria *E. coli, E. faecalis, P. aeruginosa, S. aureus*, and the fungal species *Aspergillus fumigatus* and *C. albicans* (Muleya et al., 2014). Essential oils from *S. lancea* were shown to be active against bacteria such as *Acetobacter calcoaceticus, Bacillus subtilis, Citrobacter freundii, E. coli, Klebsiella peumoniae, P. aeruginosa*, and fungi such as *Aspergillus flavus* and *A. niger* (Gundidza et al., 2008). *Solanum aculeatissimum* demonstrated high activity against *B. subtilis, E. coli, K. pneumoniae, Micrococcus luteus, P. aeruginosa, S. aureus*, and *S. epidermis* (Nabeta, 1993). Eleven plants including *D. anomala, E. clavarioides, Hypoxis rigidula, Myrsine africana, Urtica urens*, and *W. somnifera* have been reported to have shown little or no activity against the tested pathogens. Extracts from *Withania somnifera* for example, used for treating sores and wounds, could not inhibit growth of *B. subtilis, E. coli, K. pneumoniae, Micrococcus pyogens, Salmonella typhi, Shigella dysentriae, S. aureus, S. epidermidis, Sacetromyees cerevisiae*, and *V. cholerae* (Malik et al., 2011).

Skin diseases can be caused by bacteria, fungi, viruses, as well as parasites therefore, in order to validate the efficacy of plant extracts for their ability to inhibit growth of microbes, they must be assessed against the relevant causative pathogens. Despite the fact that several of the listed plants have been tested against some skin related pathogens such as *C. albicans, P. aeruginosa, S. aureus*, and *Streptococcus pyogenes*, many are yet to be tested for their activity against these, for example only 12 plants have been tested against *C. albicans*, 16 against *P. aeruginosa*, 24 against *S. aureus*, and 12 against *S. epidermidis* (although the latter is usually not pathogenic). The situation worsens when other common skin disease-causing agents are considered, according to Mabona and Van Vuuren (2013) for instance, pathogens such as *Microsporum canis, Trichophyton mentagrophytes* and *Epidermophyton floccosum* have not featured in many studies, this has also become evident in the current review. For example, *Myrsine africana* is used for ringworm (the aforementioned fungi being some of the causal agents), however it has so far only been tested against *B. pumilus, Enterobacter aerogenes, E. coli, P. aeruginosa, S. epidermis*, and *S. pneumoniae* for which it has shown low to no activity (Ahmad et al., 2011). Although *E. clavarioides* is used to treat acne, it has not yet been tested against acne causing bacteria such as *Propionibacterium acnes*, it has however shown low activity against *B. subtilis* and *S. epidermidis* (Shale et al., 1999), *Leucosidea sericea* on the other hand, has shown noteworthy activity against this pathogen (Sharma et al., 2014), suggesting that it has potential as an acne treatment.

Phytochemical data

Thirty-eight plant species, representing 67% have been evaluated e.g. *Datura stramonium, Gunnera perpensa, R. prinoides, Salix mucronata, S. nigrum*, and *Withania somnifera* for their chemical properties. Presence of a wide array of chemical compounds has been reported in several plants (number shown in brackets) including alkaloids (15), anthraquinones (8), coumarins (2), flavonoids (19), glycosides (17), saponins (15), tannins (14), and terpenoids (11). Many of these compounds are known to have several pharmacological effects such as anti-allergic, antibacterial, antifungal, anti-inflammatory, anti-mutagenic, antiplasmodial, antioxidant, and anti-tumour, to name but a few. Although many plants are reported here to possess antimicrobial and anti-inflammatory properties, the majority of the studies were performed using extracts (in line with their traditional use), very few studies have focused on the biological activity of actual isolated compounds. For example, Withanolide-A isolated from *W. somnifera* was found to exhibit significant antibacterial activity against *Pseudomonas* and *S. aureus* (Mali and Singh, 2013), while the Withanolide WS-1 showed high activity against *B. subtilis, E. coli, K. pneumoniae, Proteus vulgaris, P. auruginosa, S. typhi*, and *S. aureus* (Kharel et al., 2012). Compounds isolated from *Clerodendrum glabrum* have been found to be active against the fungus *C. albicans* (Masevhe et al., 2013), while isolated essential oils isolated from *Searsia lancea* showed good activity against numerous bacterial and fungal species (Gundidza et al., 2008). Three compounds (4′-hydroxyphenyl ethyl vanillate, acteoside, and quercetin isolated from *B. salviifolia* exhibited high COX-2 inhibition (70%, 80%, and 90% respectively) (Pendota et al. (2014)

Conclusions

The current study has identified a number of gaps in the validation of the efficacy of medicinal plants used by the Basotho for skin diseases, whether on the basis of their antimicrobial, anti-inflammatory, or phytochemical activities. The highest number of these plants (27) is used for treatment of wounds, however only one species, *B. frutescens* has been scientifically

proven to have wound healing properties. Although 40 of the 57 plants used for skin ailments have been reported to have shown noteworthy antimicrobial activity, many of them have not yet been tested against relevant pathogens, particularly fungal species that are usually associated with skin afflictions. For example *B. frutescens* has not been evaluated against any skin pathogens, *B. disticha* has been assessed against *S. aureus*, *A. ferox* against *C. albicans*, while *D. stramonium* and *Malva parviflora* have been tested against *P. aeruginosa* and *S. aureus* only. Although extracts from many of the recorded plants have been found to possess several chemical compounds known to have medicinal properties, the actual active ingredients are yet to be isolated and their biological activities tested. A number of plants (29) has been shown to have anti-inflammatory activity as they inhibit synthesis of molecules that are involved in inflammation (e.g. cyclooxygenase and lipoxygenase), however most plants used to heal wounds have not yet been evaluated. In addition, antimicrobial, anti-inflammatory, and phytochemical properties of 13 plants are not yet known. On the other hand, the study has revealed that many plants do have a potential as alternative medicines for the treatment of skin conditions.

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