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Medicinal plants used for skin-related diseases among the Batswanas in Ngaka Modiri Molema District Municipality, South Africa

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ABSTRACT

Skin diseases have come under the spotlight due to the fact they are the first symptoms associated with many diseases, including AIDS. Although Western medications are available for treating skin diseases, many ethnic groups including the Batswanas in North West Province still consult traditional health practitioners (THPs) for skin diseases. This study was aimed at exploring and documenting indigenous knowledge and medicinal plants used for skin-related diseases by Batswana THPs in North West Province. Ethnobotanical information, including local name of plant, part used, methods of preparation and administration, was captured using semi-structured questionnaires. These questionnaires were administered to 30 purposively selected THPs from 10 villages. Quantitative parameters including use-value (UV), informant consensus factor (ICF) and cultural importance index (CI), were computed to determine the relative importance of plant species locally, the homogeneity of knowledge among THPs and the spread of use and versatility. In total, 80 plants belonging to 40 families and 61 genera were documented as being used in preparation of 36 recipes to treat 43 skin-related diseases grouped into 7 categories. Asparagaceae (seven plants) and Asteraceae (seven plants), Xanthorrhoeaceae (six plants) and Solanaceae (six plants) were the most representative families. The most frequently used plant parts are the roots (31%), whole plant (26%) and leaves (19%), while the most common methods of preparation include concoction (30%), maceration (23%) and decoction (19%). *Hypoxis hemerocallidea* (0.9) and *Helichrysum paronychioides* (0.8) had the highest UV, while *Hypoxis hemerocallidea* (0.4), *Helichrysum paronychioides* (0.4) and *Urginea sanguinea* (0.3) were the most culturally important plants. The highest ICF (0.6) was linked to miscellaneous skin diseases, with rashes (22%) being the most frequently treated in the category. The disease with the highest plant diversity for treatment is chickenpox with 22 plants, followed by yaws with 16 plants, while rashes and boils are treated using 14 plants. The study recorded 38 plants used to treat skin-related diseases for the first time in South Africa. The current findings are an indication that the Batswana traditional medicine pharmacopoeia has rich plant diversity for treatment of skin-related diseases. However, these may come under threat because the young population is not showing interest in indigenous knowledge. The current study has also opened a platform for in-depth scientific analysis to evaluate the pharmacological efficacy and safety of the identified medicinal plants.

1. Introduction

The skin is the largest and one of the most vital organs of the human body. It forms an interface between the body and the environment, hence it is adversely affected by different abiotic and biotic factors (Carman, 2009). It performs salient functions to ensure the well-being of the human body such as sensory, disease control, protection, fluid maintenance, percutaneous absorption and temperature regulation (Abbasi et al., 2010). Globally, skin infections contribute approximately 34% of occupational health diseases (Hay et al., 2014). These infections cut across all ages and present a major problem to public health in both developed and developing countries (Abbasi et al., 2010; De Wet et al., 2013). The symptoms associated with skin infections are highly visible to the patients and other people and impact negatively on the well-being of affected individuals (Carman, 2009).

Skin disorders are usually the primary symptoms of HIV infection and its subsequent progression to AIDS. Hence, an estimated 90% of all people infected with HIV develop skin complications at one phase of the disease (Njoroge and Bussmann, 2007). South Africa accounts for a

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third of new HIV infections in Southern Africa and has the highest profile of the HIV pandemic globally, with an estimated 7.1 million people (18.9% of the population) living with HIV in 2016, and the North West province accounting for 17.7% (STATS SA, 2018; UNAIDS, 2017). Moreover, cases of skin and soft tissue infections caused by multi-drug resistant bacteria such as methicillin-resistant *Staphylococcus aureus* are a source of ever-increasing death toll (Kuehner et al., 2006). Additionally, fire-related skin conditions including burns were reported to be among the 15 leading causes of death among people less than 30 years of age and generally described as persistent and difficult to treat (WHO, 2012).

With a rise in skin infections, scarcity of dermatologists and high cost of consultations in South Africa, most rural people consult traditional health practitioners (THPs) for medical assistance (Caruthers, 2013). Due to the perceived ability of medicinal plants to alleviate skin conditions, medicinal plants have become highly sought (Greenwell and Rahman, 2015; Mebrahtu et al., 2016; Naidoo and Coopoosamy, 2011) and their usage is based on accumulated knowledge and expertise of the THPs acquired over time (Street et al., 2008). Furthermore, medicinal plants and associated products processed to treat skin infections have been described as possible novel strategy for combating multi-drug resistant pathogenic infections by elucidating biological compounds with alternate mechanisms of action (Quave et al., 2008).

In Southern Africa, the dependence on medicinal plants to treat dermatological infections and skincare has been reported (De Wet et al., 2013; Mabona and Van Vuuren, 2013). As highlighted by Mabona and Van Vuuren (2013), medicinal plants used for dermatological conditions in Southern Africa have not been given the attention they deserve, thereby creating a knowledge gap in the literature. For instance, documentation is still lacking in many areas including Ngaka Modiri Molema district municipality where no such studies have been conducted. As a result, this study was aimed at: (1) documenting the medicinal plants used to treat skin-related diseases; (2) documenting the indigenous knowledge used to treat skin-related diseases; and (3) analysing quantitative data using cultural importance index (CI), informed consensus factor (ICF) and use-value (UV).

2. Materials and methods

2.1. Study area

Ngaka Modiri Molema District Municipality is one of the four districts of the North West Province, South Africa (Fig. 1) and lies between latitude 26° South and Longitude 25, 8° east. It is bordered by the Republic of Botswana to the north, Dr. Ruth Segomotsi Mompati district municipality to the west, Dr. Kenneth Kaunda district municipality to the south, Bojanala Platinum district municipality to the east, and Waterberg district municipality (Limpopo province) to the northeast. The district has five local municipalities: Ditsobotla, Mahikeng Ramotshere-Moiloa, Ratlou and Tswaing, covering a total surface area of 28,206 km^2. The population consists of Black African (94%), White (4%), Coloured (4%) and Indians/Asians (0.6%). The main languages spoken are Setswana (82%), Afrikaans (5%), English (3%), Xhosa (3%), Sesotho (2%) and others (7%). The district has an estimated population of 889,108 (STATS SA, 2018). The main economic activities of the district are agriculture, mining, and tourism. The average annual rainfall is about 360 mm with rainfall mostly experienced in the summer months between October and April. The annual temperature ranges from 17 to 31 °C (62–88 ° F) in summer and 3–21 °C (37–70 °F) in winter.

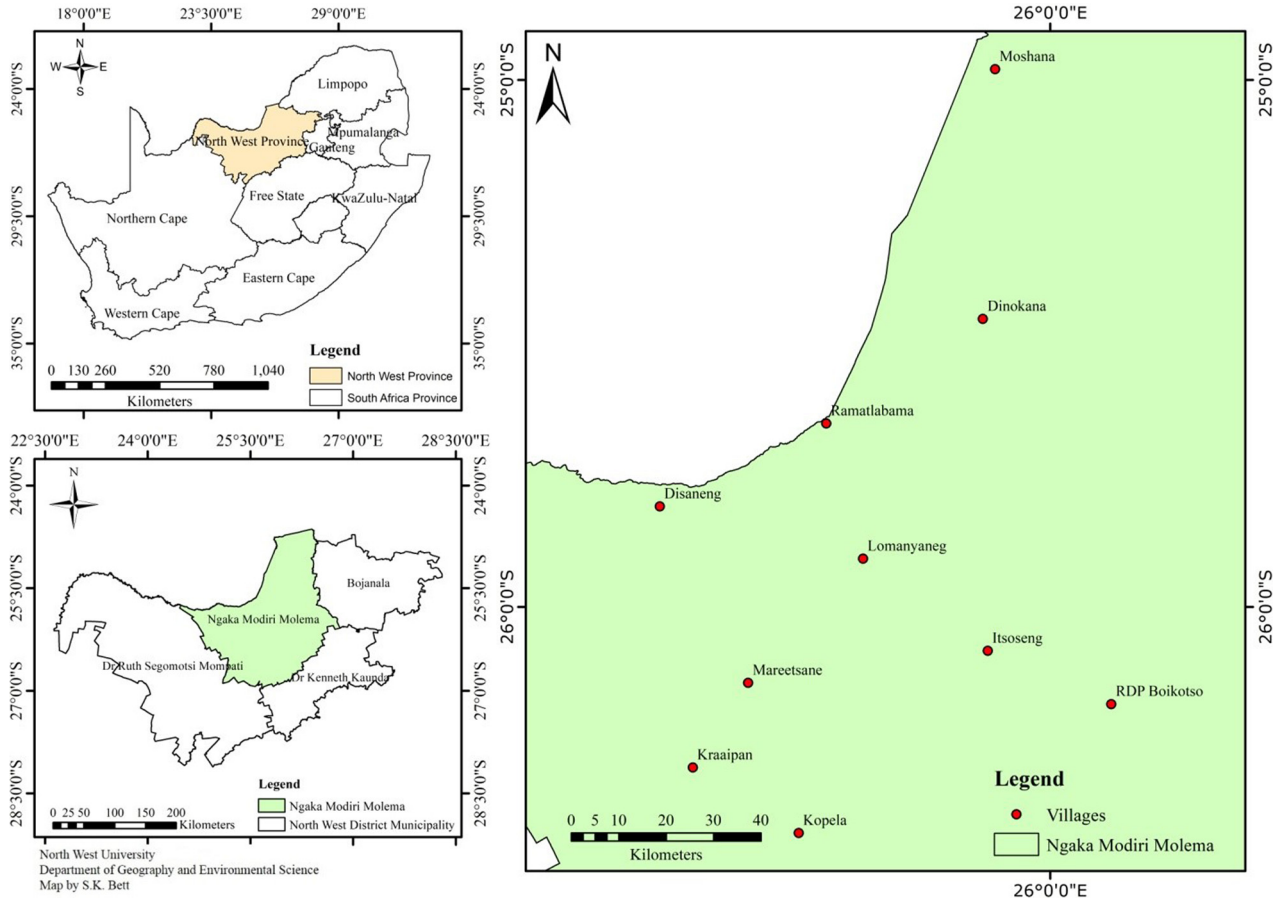

Fig. 1. Selected villages in Ngaka Modiri Molema district municipality, North West province, South Africa.

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2.2. Ethnobotanical survey

Ethnobotanical survey was conducted from September 2017 to May 2018 across 10 villages in the study area (Fig. 1). A total of 30 purposively sampled THPs were selected for the study, including men and women of different ages. The selection of villages was based on the following criteria: lack of modern health facilities with experienced medical personnel/dermatologist, distance from the main town or city, high rate of unemployment and poverty. The criterion for selecting a THP was based on his/her recognition by the Provincial Association of Traditional Healers as an expert on skin diseases. Prior to the interviews, written and verbal consents were obtained from all participants after a detailed explanation of the objectives was provided. Focused groups and individual interviews were administered in English and Setswana with the help of a translator (field assistant).

Semi-structured questionnaires designed to capture the local names of plants, parts used, methods of preparation, habit of the plant and types of skin disease or disorder treated, were administered to the participants. A colour picture guide extracted from literature titled "Common Skin Diseases in Africa: An Illustrated guide" (van Hees and Naafs, 2001) was used for identification of skin disorders. The data generated from individual interviews was cross-checked with other participants in the same/other villages (Abbasi et al., 2010). Data captured during focus group interviews were cross-checked with the participants. When two or more participants mentioned the same plant irrespective of the part used or preparation, the medicinal value was validated.

Ethical clearance (NWU-00468-18-A9) for the study was obtained from the ethics committee of the Faculty of Natural and Agricultural Sciences, North West University. The permit (number HQ 26/01/18–006 NW) for collecting the medicinal plants was issued by the North West Department of Rural, Environmental and Agricultural Development (READ).

2.3. Collection and identification of medicinal plants

Plants mentioned during the survey were collected during fieldwork with the assistance of the THPs. Voucher specimens were prepared and deposited at the national herbarium of South African National Biodiversity Institute (SANBI), Pretoria, South Africa. This allowed for the positive identification and confirmation of identities of the plants.

2.4. Data analysis

2.4.1. Qualitative analysis

Thematic analysis was used to interpret data on plant parts used, habit of plant, methods of preparation, administration and indigenous knowledge.

2.4.2. Quantitative analysis

Three quantitative parameters: use-value (UV), cultural importance index (CI) and informant consensus factor (ICF)were used to analyse the data.

2.5. Calculation of use-value

The UV of a species is a measure of the relative importance of how the plant is known locally. It ranks the plants according to the number of uses mentioned for a particular plant species and the number of participants who mentioned the use of the plant species. This was calculated using the formula below:

$UV = \sum \frac{Ui}{N}$ Where UV = use value, Ui = the number of uses mentioned per species by a participant and N = total number of participants taking part in the survey. When the number is high (closer to 1) it means the plant is used for many diseases by the healers and when it is low (closer to 0) it means the plant is used for few diseases (Gazzaneo et al., 2005).

2.6. Calculation of cultural importance index

The CI considers the spread of use (number of participants) for each species along with its versatility, which is a measure of the diversity of application of the plant species (Tardío and Pardo-de-Santayana, 2008). The index was calculated as the sum of all participants mentioning each species divided by the total number of participants taking part in the survey using the formula below:

$$\mathrm{CIi} = \sum_{u=u1}^{uNC} \sum_{i=i1}^{iN} \frac{\mathrm{URui}}{N}$$

2.7. Calculation of informant consensus factor

This value was calculated for the different categories of diseases/disorders to ascertain the degree of homogeneity of the knowledge among the participants in the study area with respect to the treatment of skin diseases and the use of plants per disease category (Heinrich et al., 1998). The ICF was calculated using the formula below:

$ICF = \frac{Nur-Nt}{Nur-1}$Where Nur = number of use reports for a particular disease category and Nt = number of plant taxa used per category by all participants in the survey. A high ICF (value nearer to 1) indicates that there is a high degree of agreement or shared knowledge between the participants on the medicinal uses of a particular species for treating a particular skin disease. Low ICF value (nearer to 0) indicates that the participants do not agree or do not share knowledge on the uses of specific plants used to treat a category of skin disease.

3. Results and discussion

3.1. Socio-demographic information of participants

The ages of the 30 purposively sampled participants ranged from 20 to 70 years. An equal proportion of males and females participated in the study, which indicates an even spread of knowledge of medicinal plant for skin disorders among men and women. Most (90%) of the THPs were not formally educated. Particularly, three of the THPs with a university degree had a formal record of their practice. In terms of years of experience, 53% of the THPs had practiced skin healing as a specialty for over 15 years while 13% had over 30 years of practice. Most (70%) of the THPs were self-employed as traders while others were domestic workers. Ten (six females and four males) of the participants were married, representing a third of the sample, while two-thirds were not married.

In this study, approximately 17% of the participants were less than 30 years of age, indicating that the traditional knowledge for treating skin-related diseases in the study area is limited (almost non-existent) among the young population. As a result, the need to sensitise the young population of the value of traditional knowledge is imperative. The limited knowledge among the youths is an indication that the knowledge may face a threat of extinction in the future, which may have negative impacts on the Setswana heritage because it is more in the hands of the elderly. This finding is in line with the notion that indigenous knowledge is declining among the younger generation in Africa (Asnake et al., 2016; Giday, 2018; Ianni et al., 2015). Traditional medicine practice serves as a source of employment and income generation for livelihood. The risk of losing most of the knowledge is very high given that 90% of the participants did not acquire tertiary education and may not do proper documentation. In the situation where they die without transmitting the knowledge to the next generation orally as the case has been, the knowledge is lost. There is a risk of losing the

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knowledge if all the elderly with such knowledge die without transferring the knowledge to the next generation. It is therefore of cultural and scientific importance that this knowledge is preserved. Failure to document will be endangering the cultural legacy of an ethnic group, especially when majority of the custodians are not formally educated.

The danger associated with failure to preserve valuable indigenous knowledge for present and future generations has been well-emphasised by several researchers (Asnake et al., 2016; Ianni et al., 2015; Mahwasane et al., 2013).

3.2. Diversity of medicinal plants used for skin-related disorders

In this study, 80 plants (used singly or in combination) distributed among 40 families and 61 genera were recorded as treatment for 43 different skin conditions (Table 1). Families with the most representative plant species were Asparagaceae and Asteraceae (seven species each), Solanaceae and Xanthorrhoeaceae (six plant species each). Euphorbiaceae and Malvaceae had four species each while other families had one to three species (Table 1). Asteraceae, Xanthorrhoeaceae, Solanaceae and Asparagaceae are often frequently cited as plant families used for the treatment of dermatological conditions (Afolayan et al., 2014; De Wet et al., 2013; Fred-Jaiyesimi et al., 2015; Grierson and Afolayan, 1999; Grierson et al., 2014; Otang et al., 2012). This study also brings to the fore the fact that these families are highly used in folklore across many ethnic groups in Africa.

In this study, some plant species were recorded for the first time for the treatment of skin-related diseases in South Africa. For example, *Asparagus laricinus* that has been used as anti-cancer (Mashele and Fuku, 2011) and for the treatment of umbilical and urine infections by most Setswana THPs, was cited for the treatment of four skin conditions (candidiasis, chicken pox, *infantile acropustulosi*, and syphilis). *Acrotome inflata* is used for the treatment of persistent cough and breast pain in Namibia (Leffers, 2003); but there are no previous recorded uses in South Africa for skin-related diseases. In this study, it was cited for the treatment of albinism, burns, chicken pox, fleabites, sores, rash and wounds. *Barleria macrostergia* is used for the treatment of chicken pox, boils and ringworm. Members of the genus *Barleria* have been reported for the treatment of toothache, swellings, piles, boils, fever, obesity, stiffness of limbs, urinary infection and enlargement of the scrotum in other African countries (Banerjee et al., 2012). No record of the traditional use for genus has been documented in South Africa. *Helichrysum* spp. have been reported for the treatment of enuresis in children, *Herpes simplex,* menstrual pains, respiratory problems, smallpox, urinary problems and wound dressing, (Arnold et al., 1988; Lourens et al., 2008; Mathekga and Meyer, 1998; Swanepoel, 1997). There has been no previously recorded use of *Helichrysum paronychioides*, recorded in South Africa. This is the first time the plant is recorded for treating skin conditions in South Africa. This huge number of plants identified as being used for the first time in traditional medicine is an indication of the rich Batswana folklore heritage. Furthermore, it is an indication that a huge percentage of the floral diversity of South Africa is still untapped and calls for more ethnobotanical surveys.

3.3. Growth forms and plant parts used

The four growth forms documented in the study were herbs (84%), shrubs (11%), trees (4%), and epiphytes (1%). The study area falls within the grassland biome which is characterised by grasses and shrubs and an absence of larger trees (Huntley, 1984). This suggests the reason why herbs and shrubs are the most observed growth forms. According to the participants, herbs are generally easy to handle and prepare. A similar pattern of herbs being the most common growth form of medicinal plants have been reported in other studies exploring botanicals used for skin-related conditions (Afolayan et al., 2014; Fongnzossie et al., 2017; Mahwasane et al., 2013).

Mabona and Van Vuuren (2013) noted in a review of Southern African plants for treating skin diseases that leaves are the most used parts in ethnomedicine. Surprisingly, in the current study, roots (31%) was the most commonly used plant parts followed by whole plants (26%) (Fig. 2). This observation present an unusual scenario considering the unsustainability and possible destruction of plant life resulting from the choices of the THPs in the area. Leaves (19%) was surprisingly the third choice while inflorescence, latex and seeds, accounting for less than 4%, were the least used parts for skin conditions in the study area. As highlighted by Mahwasane et al. (2013), roots were mostly used in treating various ailments in humans by the traditional healers of the Lwamondo area in the Limpopo province. This is possibly an indication of the similarity in traditional medicine practices among different ethnic groups in South Africa.

3.4. Methods of preparation and administration

Various methods of preparations including powder, paste ointment, lotion, poultice, plant juice, decoctions, concoctions or infusions have been recorded in different ethnobotanical surveys (Mabona and Van Vuuren, 2013; Rabe and Van Staden, 1997; Van Wyk et al., 2009; Watt and Breyer Brandwijk, 1962). In the current study, concoction (30%), which refers to the soaking of different plant parts in water for a couple of days before administration, was the most used method of preparation. Maceration (23%) and decoction (19%), which involve the boiling of different plant parts to extract active ingredient, were the most used methods of preparation while lotion (4%) was the least used method. Based on the responses from the THPs, there is no standardised measurement of the plant material used in any of the preparation methods. The materials were estimated based on the physical observation of the patient's condition. However, spoons, handfuls, pinches, lids of cold drink bottles (powdered material) and number of leaves were employed for the purpose of estimation. According to the participants, concoctions enhance healing through synergism.

Ethnobotanicals have recorded different methods of administration of ethnomedicine, which when grouped together may be either topical or oral, with topical being the most employed (Mabona and Van Vuuren, 2013; Rabe and Van Staden, 1997; Van Wyk et al., 2009). In the current study, the most common method was oral (47%), which was mostly by drinking and clyster, in the case of children; and infusion, followed by topical (31%) which was mostly in the form of bathing, sprinkling powder and poultice. Combinations of two administering modes were also reported; for example, bathing and drinking (3%), bathing and clyster (3%) and sprinkling powder and infusion (9%). The dominance of the oral method is in line with the findings from other studies that focused on floras used for treating skin diseases (Maroyi, 2013; Mgbeahuruike et al., 2019). The dominance of topical and oral modes has been observed in other studies (Afolayan et al., 2014; Bhat et al., 2014). Batswana healers believe that skin problems are mostly a manifestation of contamination from inside the body, hence they prefer to use oral means more in order for healing to begin from inside towards outside for complete eradication and restoration of health.

3.5. Use-value

The species with the highest UV (0.9) was *Hypoxis hemerocallidea,* locally known as “Tshuku-ya-poo”, which was used for treating 14 skin conditions; followed by *Helichrysum paronychiodes* (0.8), locally known as “Phate-ya-ngaka”, used to treat 13 conditions. *Elephantorrhiza elephantina* (0.7), locally known as “Mositsane”; and *Senecio longiflorus* (0.6), locally known as “Mosiama”, ranked third and fourth, respectively. The result shows that the healers have a wide understanding of the medicinal potential of these plants; hence they have the highest use report among the healers. The high UV of *Hypoxis hemerocallidea,*

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Table 1
Plants used by Batswana traditional health practitioners for treating skin-related diseases in Ngaka Modiri Molema District Municipality, South Africa.

Botanical name family voucher number	Local/Setswana name	HA	PU	Ethnobotanical use	UV	CI	CS
Acrotome inflata* Benth. **Lamiaceae 022	Mogato	H	RH	Albinism, burns, chickenpox, fleabites, sores, rash and wounds	0.36	0.23	LC
Agave Americana* (L) **Asparagaceae ja003	Garamboom	H	L	Eczema	0.06	0.06	LC
Albuca* sp. **Hyacinthaceae ja025	Wakgobaka-wa-seso	H	B	*Kaposi sarcoma*	0.16	0.13	LC
Allium cepa L. **Alliaceae 081**	Onion	H	B	Yaws	0.3	0.13	ND
Aloe greatheadii var. *davyana* (Schonland) Glen & D.S Hardy **Xanthorrhoeaceae ja034**	Kgopane	H	LJ	Baruli ulcer, boils, chickenpox, eczema, Steven Johnson syndrome	0.16	0.13	LC
Aloe turkanensis* Christian **Xanthorrhoeaceae ja080	Lekgala	H	LJ	Eczema	0.23	0.1	LC
Aloe vera (L) Burm.f. **Xanthorroeaceae ja006**	Legkala	H	LJ	Boils, chickenpox, *erythematodes*, rash, ringworm, sores	0.4	0.13	LC
Aptosinum elongatum Engl **Scrophulariaceae ja035**	Ditantanyane	H	WP	Chickenpox and yaws	0.1	0.06	NE
Asparagus exuvialis Burch **Asparagaceae ja036**	Tlhkabotshwaro	S	WP	Leprosy, impetigo, *condylomata acuminate,* and Madura foot	0.1	0.03	NE
Asparagus nodulosus* (Oberm) J.P. Lebrun & Stock **Asparagceae ja078	Radipolopolwane	H	R	Boils	0.03	0.03	LC
Asparagus suaveolens*. Burch **Asparagaceae ja046	Mothantanyane	S	L	Leprosy, impetigo, Madura foot	0.1	0.03	LC
Atemisia afra Jacq. ex Willd **Asteraceae ja013**	Legana	S	L	Chickenpox, rash	0.13	0.01	ND
Babiana hypogaea* Burch **Iridaceae ja077	Thuge	H	L	Burns	0.03	0.06	LC
Barleria macrostegia Nees **Acanthaceae a042**	Magata	H	R	Boils, burns chickenpox, athlete's foot	0.2	0.13	LC
Barleria sp. **Acanthaceae ja032**	Thotshana tonya	H	R	Albinism, burns, chickenpox, rash and wounds	0.26	0.1	LC
Rauvolfia caffra Sond **Apocynaceae MVS 017**	Quinine	T	La, L	Measle rash, athlete's foot	0.06	0.03	LC
Bulbine abyssinica A.Rich **Xanthorrhoeaceae ja017**	Kgomo ya badisa	H	L,R	Chickenpox	0.06	0.06	LC
Bulbine capitate Poelln **Xanthorrhoeaceae ja037**	Kgomo	H	L	Chickenpox in children	0.06	0.06	LC
Bulbine frutescens (L) Willd Xanthorrhoeaceae **ja038**	Makgabinyane	H	R	Boils, *Kaposi sarcoma*, chickenpox, Candidiasis, eczema	0.26	0.2	LC
Cadaba aphylla (Thunb) Wild **Capparaceae ja049**	Sekgalofatshe (male)	H	WP	Sores, rashes, common warts and yaws	0.26	0.06	LC
Cadaba aphylla (Thunb.) Wild **Capparaceae ja045**	Monnamontsho (female)	H	L,RS	Chickenpox, *Hermangioma, Kaposi sarcoma and malignant melanoma*	0.2	0.16	LC
Catharanthus roseus (L) G.Don **Apocynaceae ja007**	Dabula	S	L	Genital warts, syphilis	0.06	0.03	ND
Centella asiatic (L.) Urb **Apiaceae 088**	Setimamollo/ Pennywort	H	WP	Burns, genital warts and skin itch	0.1	0.1	ND
*Barleria***Acanthaceae ja022**	Thotshana	H	R	Albinism, burns, chickenpox, rash and wounds in children	0.26	0.01	LC
Dysphania ambrosioides (L.) Mosyakin & Clemants **Amaranthaceae JA008**	Hlahlabadimo	H	WP	*Kaposi sarcoma*	0.03	0.03	ND
Chenopodium multifidum*.L **Amaranthaceae ja011	Schalahalasamatlaka	H	WP	Eczema, sores and rash	0.17	0.04	LC
Combretumapiculatum* Sond. subsp *apiculatum* **Combretaceae ja024	Tsholakhudu / Kgosi ya di thlare	H	B	Chickenpox, *Kaposi sarcoma*, flea bites, incision, *Molluscum contagiosum*, *Malignant melanoma*, rash and sores	0.6	0.13	LC
Commicarpus pentandrus* (Burch) Heimerl **Nyctaginaceae JA020	Moetapele	H	WP	Burns, sores, warts and wounds	0.2	0.06	LC
Cullen tomentosum* (Thunb) *J.W.Grimes* **Poaceae ja021	Mojakubu	H	WP	Rash and sores	0.13	0.06	LC
Dianthus mooiensis* F.N Williams subsp. *kirkii* (Burtt Davys) SS *Hooper* **Caryophyllaceae ja050	Tlhokalatsela	H	R	Genital warts	0.03	0.03	LC
Dicoma anomala Sond **Asteraceae ja028**	Tlhonya	H	R	Albinism, boils, burns, flea bite, *Herpes zoster, condylomata acuminata*, impetigo, Kaposi sarcoma, rash, skin itch and sores	0.4	0.13	LC
Drimia altissima* (LF) Ker Gawl **Asparagaceae ja016	Thobega	H	L	Sores	0.03	0.03	LC
Drimia sanguinea* (Schinz) Jessop **Asparagaceae ja004	Sekaname	H	B	Candidiasis, common warts, *condylomata acuminate*, genital warts, syphilis and yaws	0.43	0.26	NT
Elephantorrhiza burchellii Benth (Burch) Skeels **Fabaceae ja015**	Mositsane	S	R	Chickenpox, *condylomata acuminata, squamus carsinoma, Malignant melanoma infantile acropustulosis,* Hermangioma, Keratosis, *Kaposi sarcoma*, pearl penile papules, genital warts, Madura foot, keratosis, and *Herpes simplex*	0.53	0.16	LC
Euclea divinorum Hiern **Ebenaceae MVS 012**	Mokwere	T	Ba	Skin lightener, rashes, eczema	0.10	0.03	LC
Eucomis autumnalis* (Mill). Chitt **Asparagaceae 068	Mathubadifhala	H	RH	*Acne vulgaris*, boils, chicken pox, *Herpes zoster* and sores	0.33	0.2	LC
Euphorbia inaeqilatera Sond. Var. inaequilatera*Euphorbiaceae ja055**		H	R	Burns, sores and rash	0.10	0.03	LC
Euphorbia prostrata* Aiton **Asparagaceae ja047	Letswetlane	H	RH	Candidiasis, syphilis, *infantile acropustulosi,* chickenpox	0.23	0.13	ND

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Table 1 (*continued*)

Botanical name family voucher number	Local/Setswana name	HA	PU	Ethnobotanical use	UV	CI	CS
Euphorbia serpen* Kunths **Euphorbiaceae 067	Lwetsane	H	L,R	Athlete's foot, ringworm	0.13	0.13	LC
Gompocarpus fruticosus* (L) Aiton.f. *sudsp.fruticosus* **Apocynaceae ja019	Moetimolo	H	WP	Burns, sores and rash	0.10	0.03	LC
Grewia flava* DC **Malvaceae ja030	Moretlwa	H	R	Pearl penile papules	0.03	0.03	LC
Grewia flavescens* Juss. **Malvaceae ja057	Motsotsojane	S	L	Candidiasis, common warts, sores	0.01	0.03	LC
Helichrysum nudifolium* (L). Less **Asteraceae 066	Imphepho	H	L	Genital warts	0.03	0.03	LC
Helichrysum paronychioides* DC. Humbert **Asteraceae ja037	Phate-ya-ngaka	H	WP	Boils, Candidiasis, eczema, *Kaposi sarcoma*, soils, rash, yaws, *Herpes zoster*, ringworm, *Kaposi sarcoma, condylomata acuminata*, eczema and pearl penile papules	0.8	0.4	LC
Helichrysum* sp. **Asteraceae ja051	Phate-ya-ngaka (female)	H	WP	Boils, Candidiasis	0.01	0.03	LC
Hermania depressa*N.E.BrMalvaceae ja029**	Selejane	H	WP	Sores	0.03	0.03	LC
Hilliardiella elaeagnoides (DC) Swelank & J.C.Manning **Asteraceae ja031**	Ntshikologa	H	R	Scabies, eczema	0.13	0.03	LC
Hypoxis hemerocallidea Fisch.C.A Mey & Ave **Hypoxidaceae ja053**	Tshupoo ya poo	H	B	*Acne vulgaris*, boils, *condylomat acuminate*, genital warts *infantile acrupostulosis, Herpes zoste*r, pimples rash, ringworm, sores, syphilis, wounds and yaws	0.9	0.4	LC
Ipomoea oblongata* E.Mey.ex Chiosy A. **Convolvulaceae ja026	Morebe / Mokatelo	H	R	Genital warts, leprosy and scabies	0.33	0.1	LC
Jatropha zeyheri Sond **Euphorbiaceae ja065**	**Seswagadi**	H	R	*Acne vulgaris*, albinism, boils, *Herpes zoste*r, genital warts, and yaws	0.33	0.2	LC
Kedrotis nana* var. *zeyheri* **Curcurbitaceae ja060	Mpitike	H	B	Eczema	0.06	0.06	LC
*Lantana angolensis Moldenke***Verbenaceae ja023**	Selaole	H	R	Ringworm			LC
Lippia javanica (Burm.f.) Spreng **Verbenaceae ja061**	Selaole /fever tea	H	WP	Incision, rashes, sores and common warts	0.26	0.06	LC
Lycium horridum Thunb **Solanaceae ja018**	Motlhalawadikonyana	H	WP	Kerotosis	0.03	0.03	LC
Malva neglecta Wallr. **Malvaceae ja010**	Tikamotse	H	WP	Albinism, bullous dermatosis, herpes simplex, sores and yaws	0.16	0.03	LC
Pelargonium lubridum (Andrews) Sweet **Geraniaceae ja062**	Thotamadi	H	R	*Acne vulgaris,* burns, eczema, pimples and yaws	0.2	0.16	LC
Peltophorum africanum* Sond **Leguminosae ja20	Mosetlha	H	R	Kaposi sarcoma and heat rash	0.03	0.03	LC
Phyllanthus maderaspatensis L. **Phyllanthaceae ja054**	Leestane	S	L	Ringworm, eczema	0.06	0.06	LC
Pouzolzia mixta* Solms **Urticaceae ja087	Moreba	H	R	Abscess, boils, eczema, *infantile acropustolosis*, and pearl penile papules	0.03	0.03	LC
Ricinus communis* L. *var communis* **Euphorbiaceae ja005	Mokhura	H	L	Abscess	0.03	0.03	LC
Rubia horrid* (Thunb.) Puff **Rubiaceae ja063	Madi-a-phalane	H	R	Albinism	0.03	0.03	LC
Sansevieria hyacinthoides (L) Druce **Asparagaceae ja052**	Mosekela tsebeng	H	R	Genital warts	0.06	0.06	LC
Sclerocarya birrea subsp. *multifoliolata* (Engl) **Anarcardiaceae ja064**	Morula	H	Ba	Genital warts	0.03	0.03	LC
Senecio longiflorus* (DC). Sch.Bip **Asteraceae ja071	Mosiama	H	WP	Athlete's foot, chicken pox, eczema, Kaposi sarcoma, molluscum contagiosum, rash syphilis and yaws	0.66	0.2	LC
Senna italica Mill subsp. *arachoides* Burch Lock **Leguminosae ja044**	Sebetebete	S	WP	Chickenpox	0.03	0.03	LC
Siphonochilus aethiopicus (Schweinf.) B.L.Burtt **Zingiberaceae ja072**	Serokolo	H	WP	Chickenpox	0.1	0.06	LC
Solanum catombelense Peyr **Solanaceae ja039**	Morolwana	H	WP	Chickenpox, fleabites, Kaposi sarcoma, rash and sores	0.23	0.1	LC
Solanum lichtensteiniisolanum* **Solanaceae ja040	Tolwane	H	WP	Burns	0.03	0.03	LC
Solanum lichtensteinii Willd **Solanaceae ja033**	Kgaba (young)	H	R	Scabies in children	0.03	0.03	LC
Solanum lichtensteinii Willd ***Solanaceae* ja029**	Kgaba (old)	H	R	Scabies and ring worm in adults	0.03	0.03	LC
Sorghum bicolour* (L) Moench **Poaceae ja074	Sorghum	H	Inf	Chickenpox	0.03	0.03	LC
Stapelia gigantea*N.E.Br **Apocynaceae ja073	Menoanoga	H	WP	*Kaposi sarcoma* and *molluscum contagiosum*	0.16	0.06	LC
Sutherlandia frutescent(L)R.Br. **Fabaceae ja083**	Lerumolamadi	H	R	*Acne vulgaris,* boils, rashes and yaws	0.4	0.23	LC
Tarchonanthus camphoratus* L. **Asteraceae ja084	Mohatlha wadikonyana	H	R	Albinism	0.03	0.03	LC
Tribulus terristris L **Zygophylaceae ja048**	Tshetlho	H	Se	Chickenpox, eczema and *Infantile acropustulosis*	0.1	0.1	LC
Tulbaghia violacea* Harv **Alliaceae ja009	Wild Garlic	H	WP	Eczema and *Herpes zoster*	0.3	0.13	LC
Viscum menyharthii Engl.& Schinz* **Santalaceae ja005	Lephakama	E	S	*Kaposi sarcoma*	0.06	0.06	LC

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Table 1 (*continued*)

Botanical name family voucher number	Local/Setswana name	HA	PU	Ethnobotanical use	UV	CI	CS
Withania somnifera) *(L) Dunal* **Solanaceae ja012**	Modikashope	S	WP,L,R	*Molluscum contagiosum*, rash, syphilis, creeping eruptions and *Herpes simplex*	0.3	0.23	LC
Zingiber officinale* Roscoe **Zingiberaceae ja069	Ginjer	H	RH	*Herpes zoster* and genital vitiligo	0.06	0.06	LC
Ziziphus zeyheriana sond **Rhamnaceae ja027**	Mokgalofatse	H	L	Condylomata acuminate, discoid lupus, erythematodes and Kaposi sarcoma	0.16	0.03	LC
Ziziphus mucronata Willd **Rhamnaceae Ja014**	Mokgalo/ Buffalo-thorn	T	S	Boils, eczema and ringworm	0.2	0.06	LC

Parts used: B = Bulb, Ba = Bark, INF = Inflorescence, L = Leaves, LJ = Leaf juice, R = Roots, RH = Rhizome, S = Stem, SB = Stem bark, Se = Seeds, Th = Thorns, WP = Whole plant.. (HA = Habit; PU = Part Used; UV = Used value; CI = Cultural Index; CS = Conservation status; VN = Voucher number).
Habits: E = Epiphyte, H = Herb, S = Shrub and T = Tree.
Conservation status: LC = Least concern, NE = Not evaluated, NT = Near Threaten, R = Rare, ND = No data.
* Plants possibly identified for the first time used for treating skin disease as no records were found based on current search.

Helichrysum paronychiodes and *Elephantorrhiza elephantina* indicates that the plants are very popular among THPs in the study area. *Hypoxis hemerocallidea* is widely used in sub-Saharan Africa by many cultural groups for treating various ailments including coughs, AIDS, influenza, headaches, septic sores, inflammation (Albrecht, 1995; Ncube et al., 2013). Other medicinal uses of the plant include for the treatment of vomiting, dizziness, insanity, bladder disorders, prostate problems, testicular tumours and urinary infections. Tonics prepared from the plant are also used as immune boosters (Albrecht, 1995; Pujol, 1990; Van Wyk et al., 2009; Watt and Breyer Brandwijk, 1962). The popularity of the plants with high UV in traditional medicine probably suggests the plants have a long history of use with high rate of perceived indigenous efficacy and safety, hence the diversity of uses for treating skin ailments.

3.6. Cultural importance index

The CI is a function of the diversity of uses of a particular species among people of an ethnic group (Albuquerque et al., 2005). As indicated in Table 1, the plants with the highest CI values were *Hypoxis hemerocallidea* (0.4), *Helichrysum paronychiodes* (0.4) and *Drimia sanguinea* (0.3). These aforementioned plants had the highest diversity of uses with respect to the treatment of skin-related diseases. *Hypoxis hemerocallidea* was cited by 40% of the participants sampled. About 68% of the plants had CI values of less than 0.1 indicating that the plants are not well-recognised; hence their low diversity of use, though it does not necessarily mean that they are not important. The indigenous knowledge regarding these plants may be facing extinction due to the less frequent use, and may risk not being transmitted to the next generation. On the other hand, a high CI value is an indication of the diversity of different uses culturally attached to the plant, which is a factor of how long the plant has been used in folklore and its accessibility (Abbasi et al., 2013; Bonet and Vallès, 2002).

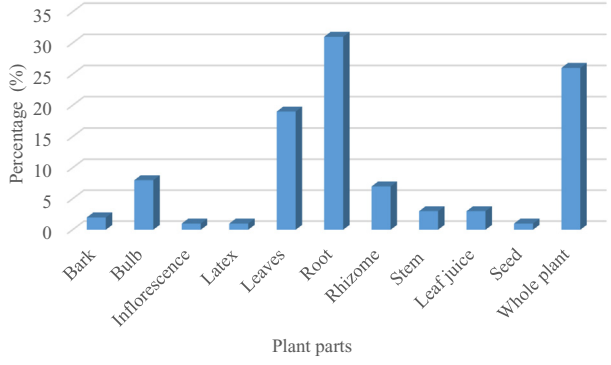

Fig. 2. Plant parts used for treating skin-related diseases by Batswana traditional health practitioners in Ngaka Modiri Molema district municipality, North West province, South Africa (n = 87).

3.7. Informant consensus factor

The diseases that were grouped into the miscellaneous category had the highest ICF value (0.6). It consisted of 112 citations, comprising 14 skin disorders with rashes as the most cited disorder, and a total of 40 plant species (50% of total plants) were used for diseases in this category (Table 2). The most cited plant in this category was *Hypoxis hemerocollidea*. There was a wide distribution of the plant taxa in this category. Additionally, the high ICF value indicates that there is an agreement among the THPs regarding the plant taxa used for treatment and possibly, a high prevalence of diseases in this category (Afolayan et al., 2014; Pandikumar et al., 2011). Viral infections, though ranked second, had the highest number of cited plant (51, which is 64% of total plants). The lowest ICF value was recorded for parasitic infections (0.001) indicating that there is no agreement or shared knowledge among the THPs on the plants used to treat skin diseases of a parasitic origin or additionally the plants are selected randomly. According to Gazzaneo et al. (2005), ICF values range from 0 to 1 with values closer to 0, meaning that there is a lesser degree of agreement among the THPs of the plants used to treat diseases in a particular category. Participants also reported that some of the plants used for diseases in this category, for example, *Solanum lichtensteinii,* locally known as "Kgaba," were not very common within the study area, which probably suggests why the THPs have little agreement about the plants used to treat diseases in the category. A similar scenario was reported by Heinrich et al. (2009).

3.8. Conservation status

Based on the SANBI Red List of South African plants, no plant species documented in this study were classified as rare. *Drimia sanguinea* is classified as near threatened (NT) while six other plant species are considered as data deficient (ND) (Table 1). In the current study, one plant is classified as not evaluated (NE) and the rest of the plants have the status of 'least concern'. This implies that the Batswana heritage concerning medicinal plants used for skin-related diseases is not yet threatened, which is a positive attribute to folklore. However, habitat loss, harvesting pressure from the wild and other anthropogenic stressors are continuously posing threats to the conservation of medicinal plants on a global scale (Grace, 2011; Moyo et al., 2015). In addition, there was no significant report of re-planting of the plants by the participants. For example, in Lesotho, *Elephantorrhiza elephantina* has been classified as data deficient in the Red data list due to overharvesting by traditional healers (Talukdar, 2002). Given the current trends in climate change and the high rate of dependence on medicinal plants, the plants with high UV values from the current study may face severe strains resulting from overharvesting of the populations in the wild. However, the risk of losing plants with low UV values (closer to 0) due to low diversity of use cannot be ignored. Additionally, the harvesting of roots and whole plant, as reported by the participants, is unsustainable and leading to the destruction of plant

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Table 2
Categories of skin diseases and associated informed consensus factors (ICFs).

No	Disease categories	No of use reports (Nur)	No of plant taxa (Nt)	ICF
1	Eczema infections (EI)	38	24	0.4
	i) Atopic eczema			
	ii) Pityriasis alba			
	iii) Infantile eczema			
	iv) Seborrhoic eczema			
	v) Lichen simplex			
	vi) Infective eczema			
	vii) Contact eczema			
2	Fungal/yeast infections (F1)	22	19	0.16
	i) Mycids			
	ii) Tinea corporis			
	iii) Tinea capitis			
	iv) Tinea unguium			
	v) Athlete's foot			
	vi) Pityriasis versicolor			
	vii) Candidiasis			
	viii) Mycetoma			
3	Bacterial infections (BI)	54	30	0.45
	i) Impetigo			
	ii) Folliculitis			
	iii) Erythrasma			
	iv) Secondary syphilis			
	v) Yaws			
	vi) Leprosy			
	vii) Buruli ulcer			
	viii) Cancrum oris			
4	Viral infections (VI)	95	51	0.46
	i) Pityriasis rosea			
	ii) Chickenpox			
	iii) Herpes zoster			
	iv) Herpes simplex			
	v) Karposi sarcoma			
	vi) Warts			
	vii) Molluscum contagiosum			
5	Parasitic infections (PI)	3	3	0.001
	i) Creeping eruptons			
	ii) Scabies			
	iii) Leishmaniasis			
	iv) Lymphatic filariasis			
	v) Oncocerciasis			
6	Auto-immune diseases (AID)	11	9	0.25
	i) Alopecia areata			
	ii) Bullous dermatosis			
	iii) Discoid lupus erythermatodes			
	iv) Lichen planus			
	v) Vitiligo			
7	Miscellaneous diseases (MD)	112	40	0.6
	i) Acne vulgaris			
	ii) Albinism			
	iii) Dermatosis papulose nigra			
	iv) Hemangioma			
	v) Infantile acropustulosis			
	vi) Keloids			
	vii) Malignant melanoma			
	Penile papules			
	viii) Psoriasis			
	ix) Urticaria			
	x) Heat rash			

life, the very asset on which the knowledge and treatment relies on and therefore has negative consequences for the future of Batswana folklore and conservation in general. This calls for the need to encourage research on alternative plant part and promote plant part substitution which is a conservation strategy recommended by Zschocke et al. (2000).

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4. Conclusion

Findings from the current study established that the Batswana people still depend largely on folk medicine useful for skin-related disorders. The study documented 80 medicinal plants used to treat skin diseases by Batswana traditional healers. These plants were used to treat 43 symptoms of skin diseases grouped into seven categories. The medical pharmacopoeia of the Batswana people is more in the hands of the elderly than the young generation, thereby posing a threat of future loss. Further investigations into their efficacy, safety, biological activities and phytochemical compounds present in these documented plants remain pertinent. Such stringent investigations may unravel novel compound(s) with pharmaceutical relevance in the treatment of skin disorders.

Authors' contributions

JAA conducted the field study, analysed the data and prepared the draft manuscript. PTN assisted with data collection during the fieldwork. NSK coordinated the knowledge holders (she being one of them) during interviews. WOM was involved in the conceptualization of the research and sourced for the fund. AOA and WOM supervised the project and edited the draft manuscript. All the authors approved the final manuscript for submission.

Conflict of interest

We do not have any conflict of interest concerning this study.

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