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Exotic plants used therapeutically by *Bapedi* traditional healers for respiratory infections and related symptoms in the Limpopo province, South Africa

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The present study examines the use of exotic plants by *Bapedi* healers (THs) as medicine for respiratory infections (RIs) and related symptoms (RLs). A sample of 240 THs practising in the Limpopo Province, South Africa was questioned using a semi-structured questionnaire, supplemented by personal observations. Thirty-eight plants comprising of 35 genera belonging to 26 botanical families, mainly the Solanaceae (5 spp.) and Poaceae (3 spp.), were documented. Herbs (44.7 %, n = 17) constituted the major habit followed by trees (42.1 %, n = 16). The most important plants according to use mention (UM) and fidelity level (FL) indexes were *Zingiber officinale* (UM = 240 and FL = 99.5 %, chronic cough), *Moringa oleifera* (UM = 210 and FL = 100 %, fatigue), *Datura stramonium* (UM = 202 and FL = 100 %, chest pain), *Jacaranda mimosifolia* (UM = 156 and FL 100 %, chronic cough) and *Schkuhria pinnata* (UM = 105 and FL = 94.5 %, painful eyes). These plants also yielded the highest use value (UV) index, but with *M. oleifera* (fatigue; UV = 0.87), followed by *D. stramonium* (chest pain; UV = 0.84), *J. mimosifolia* (chronic cough; UV = 0.65) and *S. pinnata* (asthma, fatigue and painful eyes; UV = 0.46) being the most appreciated. Overall, larger number of species recorded in our study illustrates the important role played by foreign plants as treatment of RIs and RLs in the *Bapedi* traditional healing sector.

Keywords: *Bapedi* healers, Exotic plants, Limpopo Province, Respiratory infections

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Respiratory infections remain an important public health problem, accounting for over 10 % of world's morbidity and mortality per year[1]. In most African countries including Zambia[2], Congo[3], Egypt[4] and Nigeria[5], as it is also the status *quo* in other developing countries, millions of people suffered from these infections, or die prematurely because of them. South Africa is not spared from the impact of such infections. According to Bradshaw *et al.*[6], respiratory infections (RIs) and related symptoms (RLs) contribute to both the higher proportion of all disability adjusted life years, and mortalities rates in this country. Studies showed the prevalent of these diseases in most African countries is mainly triggered by factors comprising unhealthy life style such as tobacco smoking and excessive alcohol consumption, and crowded environment[7-9]. In addition to these factors, incidents of the referred afflictions also result from a range of pathogenic bacteria and fungi[10]. Generally, free available drug regimens for treating RIs and RLs in government owned healthcare facilities across rural Africa are severely affected by multi-drug resistance[11,12]. This situation is often worsened by lack of modern healthcare facilities and associated professionals[13]. Thus, over 80 % of African patients consult locally accessible traditional healers (THs) to treat of various ailments particularly RIs and RLs[14].

Like many THs or lay people in different countries of the world including North America[15], Argentina[16], India[17], Brazil[18] and Bangladesh[19], African THs also take advantage of the diversity of alien or exotic[20,21] plant species available in their areas to heal and manage different human ailments. Medicinal applications of most of this species for infectious ailments are well supported by scientific studies[22,23]. Despite this, ethnobotanical enquiries describing the use of exotic taxa to treat RIs and RLs remain meagre. There is presently no comprehensive study focusing or reporting on the use of exotic plant species as

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medicine for these ailments in Africa and elsewhere. As it is the case in other provinces of South Africa, exotic plant species are widespread across Limpopo Province; in agricultural areas, home gardens and in the wild[24]. In South Africa generally, these species, especially those classed as weeds and invasive under the Conservation of Agricultural Resources Act (1983) (CARA) No. 43 of 1983 are considered problematic due to the dramatic impacts they have on natural environment, and concomitant implications for human welfare as well as their livelihoods. For instance, they invade natural vegetation usually adversely affecting native biodiversity and ecosystem functioning, or invade agricultural land, impacting on the growth as well as productivity of cultivated crops[25]. Therefore, are being eradicated indiscriminately by the government, without evaluating their economic importance and values on the local communities. This indiscriminate abolition is due to lack of data about the extent of their use and the importance to rural economies[23]. As part of an attempt to comprehend and document the medicinal use of exotic species by THs in the Limpopo Province, we present an inventory of those employed by *Bapedi* healers to treat RIs and RLs. South African healers are known to prescribe a considerable number of alien plants as medicines against respiratory infections[21,23]. We hope that the data gathered in the present study will contribute towards a better understanding of the importance of this species to primary healthcare in South Africa.

Materials and methods

Study area

This survey was carried out in the municipalities of Capricorn, Sekhukhune and Waterberg districts of the Limpopo Province, South Africa. From each municipality, five villages were selected as study sites. Generally, *Bapedi* are the predominant ethnic groups in the sampled districts and across Limpopo Province at large, constituting over 50 % of the total provincial population[26]. The studied districts have the highest level of poverty, with greater than 40 % of the population living below the national poverty line[26,27]. There are no health services (i.e., clinics and pharmacy) in most of the sampled villages. However, in few villages where a single healthcare facility exists, it is shared by more than one community. Therefore, most of the patients utilise cheaply available THs for the treatment of various ailments.

Ethnobotanical survey and data collection

Ethnobotanical explorations of exotic plants used for RIs and RLs were conducted from May 2017 to October 2017 with 240 conveniently (i.e., with the assistance of local traditional leaders and healers) selected THs who signed a consent form. Data was collected from each of these healers using a semi-structured questionnaire (administered in *Sepedi* linguistic), followed by field observation for specimen collection and observation on other field data. The questionnaire was designed to seek data on the vernacular names of each species (native and exotic) by *Bapedi* THs to treat RIs and RLs, used plant parts, methods of herbal preparation, administration and dosage. The interview session was followed by field excursions with each healer. During these trips, plants were initially identified by THs though their vernacular name/s, thus researchers collected voucher specimens and deposited them at the Larry Leach Herbarium (University of Limpopo), for botanical identification by an expert.

Exotic species

Distinction of alien plants from native ones followed analogous approached utilised in our previous survey[24]. For instance, a preliminary survey (unpublished data) on medicinal plant used by *Bapedi* THs for RIs and RLs recorded a total of 224 species. List of these species were compared with the various publications which focused on plant species declared by South African government as exotics. Hence, we were able to discrete exotic from native plant species.

Data analysis

The data pertinent to the exotic species used by *Bapedi* THs to heal RIs and RLs were organised and entered in to SPSS version 14.0, and were later analysed for descriptive statistical patterns such as percentages and frequencies.

Fidelity level (FL) and use mention (UM)

The most trusted and preferred healing plants employed by *Bapedi* THs for treating a specific ailment (RIs or RLs) was analysed following the method of Al-Quran[28]:

$$FL\ (\%) = \frac{NP}{N} \times 100$$

Where, *NP* was the number of THs who claim a use of a plant species to treat same RIs or RLs, and *N* was the total number of THs who mentioned the use of species as a medicine to treat any given RIs or RLs.

Fidelity value of or close to 100 % is taken as an indication of high intra-cultural consensus, which in turn illustrate a very high confidence amongst THs in the use of a particular species for treating specific disease[28]. The opposite of this can be said for lower FL. However, FL has some limitation as an analytical tool. For instance if a plant (A) has a low number of mentions (2–3) against a particular ailment, the FL can be high (100 %); in contrast a plant (B) with more mentions (15+) may have a lower FL (84 %). To evade this limitation, Andrade-Cetto[29] proposed the UM factor (defined as frequency of citation by all informants for a particular species as therapy for a specific disease). Therefore, resulting UM value obtained for each exotic species used by *Bapedi* THs for RIs or RLs were correlated with the FL to identify a species with high FL. Overall a total number of these healers (n = 15) questioned in each municipality was used as a minimum bench mark to establish high UM of an individual species.

Use value (UV)

The average number of plant species applications for each species (total use of each species) used by *Bapedi* THs as medicine for RIs and RLs was determined with the UV index as described by Phillips *et al.*[30]:

$$UV = \Sigma \frac{U}{N}$$

From these formulae, UV is the number of medicinal applications registered by THs for a particular species, *U* is the number of citations per species, and *N* is the total number of questioned THs. Generally, UV for a plant is high when there are corresponding broad therapeutic applications coupled with a relatively high use mentioned (UM) by participants[20] and *N* represent the total number of THs questioned in this study.

Results and discussion

Diversity of used exotic species

A total of 38 exotic plant species comprising of 35 genera belonging to 26 botanical families, mainly the Solanaceae (5 species) and Poaceae (3 species), were used by *Bapedi* THs practicing in Capricorn, Sekhukhune and Waterberg districts of the Limpopo Province (South Africa), as medicine to treat RIs and RLs. As far as our literature search went, our survey is the first systematic attempt in South Africa, Africa and elsewhere to comprehensively focus on the curative applications of non-indigenous plants for these conditions. *Bapedi* THs are known to use introduced species to heal various human ailments, and this was previously emphasised by studies of Semenya *et al.*[24,32]. The practices of utilising exotic plants to heal general human afflictions are also common amongst THs of other South African cultures such as Venda[21] and Xhosa[20]. Findings from our study therefore emphasises the significance of these vegetation as treatments of RIs and RLs in the *Bapedi* traditional healing sectors, and also provide first-hand information on this subject. We concur with Albuquerque *et al.*[33] who stated that the high medicinal usage of exotic species (similarly to our study), should be viewed as a strategy to diversify the stock of therapies, thus increasing the range of alternative medicines and ultimately reducing extensive exploitation of native flora used for similar purposes.

Although not explicitly focusing on the application of alien plants as therapies for RIs and RLs, the Solanaceae were also highly presented with higher number of exotic species in a study conducted by Semenya *et al.*[24] and Njoroge[31], thus indicating the versatility of taxa from this family as medicinal remedies. Generally, the predominant of Solanaceae and Poaceae in our survey might be attributed to both their accessibility and abundant, thus allowing THs to experiment with them as cure for RIs and RLs. Members of the remainder of families recorded in this survey received less attention from *Bapedi* THs as medicine for these afflictions.

Plant habit and source

The floristic composition of the 38 documented exotic plant species used by *Bapedi* THs for RIs and RLs was 44.7 % (n = 17) herbs, 42.1 % (n = 16) trees and 13.1 % (n = 5) shrubs. Njoroge *et al.*[31] found the supremacy of herbs, followed by shrubs and trees respectively, perhaps due to the fact that their study focused on the exotic plants used to heal general human ailments. Nevertheless, the degree of utilisation of these growth forms in our survey might be ascribed to their local availability and most importantly their value as natural resources apart from ethnomedince. Generally, the distinct preferences of alien herbaceous and woody (trees) plant species by *Bapedi* THs might also be accredited to the fact that they can replace themselves easily, and are accessible ubiquitously in various climatic conditions.

An overwhelming majority of exotic plant species used by *Bapedi* THs for RIs and RLs were sourced from home gardens (Table 1). With the exception of *Nymphaea Mexicana* (homegardens (9.1 %, n = 22)

Table 1 — Medicinal plants used by *Bapedi* traditional healers to treat respiratory infections and related symptoms in the Limpopo Province, South Africa

Botanical family	Species name &voucher number	Habit	Parts used	State of use	Aliment/s treated	Quantitative indexes		
						FC	FL (%)	UV
Amaryllidaceae	*Allium cepa* L. SSS06	Herb	Bulb	Fresh	Angina pain	1	50	0.01
					Tuberculosis	1	50	
Amaryllidaceae	*Allium sativum* L. SSS78	Herb	Bulb	Dried	Asthma	1	11.1	0.04
					Laboured breathing	1	11.1	
					Tuberculosis	6	77.7	
					Tuberculosis	1		
Anacardiaceae	*Mangifera indica* L. SSS100	Tree	Root	Fresh	Asthma	1	100	0.00
Anacardiaceae	**Schinus molle* L. SSS60	Tree	Leaf	Fresh	Asthma	1	1.4	0.29
					Fatigue	4	5.7	
					Fever	10	14.2	
					Laboured breathing	2	2.8	
					Sore throat	7	10	
					Tuberculosis	37	52.8	
					Chronic cough	7	11.4	
					Chronic cough	1		
				Dried	Pneumonia	1	1.4	
Apiaceae	*Daucus carota* L. SSS102	Herb	Tuber	Fresh	Painful eyes	1	100	0.00
Apocynaceae	*Schizoglossum nitidum* Schltr. SSS119	Herb	Root	Dried	Asthma	2	66.6	0.01
					Nasal congestion	1	33.3	
Asteraceae	*Pseudognaphalium luteoalbum* (L.) Hilliard &B.L.Burtt SSS118	Herb	Leaf	Dried	Chronic cough	3	60	0.02
					Fatigue	2	40	
Asteraceae	*Schkuhria pinnata* (Lam.) Kuntze ex Thell. SSS107	Herb	Whole plant	Fresh	Asthma	1	0.9	0.46
					Fatigue	5	4.5	
					Painful eyes	105	94.5	
Bignoniaceae	**Jacaranda mimosifolia* D.Don. SSS116	Tree	Root	Dried	Chronic cough	156	100	0.65
Cactaceae	**Opuntia ficus-indica* (L.) Mill. SSS109	Tree	Root	Dried	Asthma	1	100	0.01
					Chronic cough	1	100	
Cannabaceae	*Cannabis sativa* L. var. *indica* (Lam.) Wehmer SSS55	Herb	Leaf	Dried	Chronic cough	6	7.6	
					Fever	7	8.9	
					Headache	14	17.9	
					Sore throat	2	2.5	
					Tight chest	11	14.1	
					Tuberculosis	25	38.4	
				Fresh	Tuberculosis	4		
					Tuberculosis	1		
					Asthma	8	10.2	
Caricaceae	*Carica papaya* L. SSS510	Tree	Root	Dried	Chest pain	1	100	0.00
Euphorbiaceae	**Ricinus communis* L. var. *communis* SSS33	Shrub	Leaf	Fresh	Pneumonia	1	25	0.02
					Chronic cough	1	50	
					Chronic cough	1		
					Tuberculosis	1	25	
Fabaceae	**Senna didymobotrya* (Fresen.) H.S.Irwin & Barneby SSS50	Shrub	Root	Dried	Chronic cough	8	100	0.03
Meliaceae	**Melia azedarach* L. SSS68	Tree	Root	Dried	Tuberculosis	2	100	0.01
Moraceae	**Morus alba* L. var. *alba.* SSS816	Tree	Leaf	Dried	Chronic cough	2	100	0.01
Moringaceae	*Moringa oleifera* Sensu Exell & Mendon. SSS111	Tree	Leaf	Dried	Fatigue	210	100	0.87
Musaceae	*Musa sapientum* L. SSS311	Tree	Fruit scale	Dried	Chronic cough	1	50	0.01
			Root	Fresh	Painful eyes	1	50	

(*Contd.*)

Table 1 — Medicinal plants used by *Bapedi* traditional healers to treat respiratory infections and related symptoms in the Limpopo Province, South Africa (*Contd*.)

Botanical family	Species name &voucher number	Habit	Parts used	State of use	Aliment/s treated	Quantitative indexes		
						FC	FL (%)	UV
Myrtaceae	**Eucalyptus camaldulensis* Dehnh. SSS715	Tree	Bark	Dried	Asthma	1	1.3	0.31
					Sinusitis	1	1.3	
					Fever	34	45.9	
					Sore throat	1	1.3	
			Leaf	Fresh	Tuberculosis	23	31	
					Chronic cough	14	18.9	
Myrtaceae	**Psidium guajava* L. SSS523	Tree	Leaf	Fresh	Lack of appetite	1	100	0.00
Nymphaeaceae	*Nymphaea mexicana* Zucc. SSS113	Herb	Whole plant	Dried	Chronic cough	1	3.7	0.11
					Painful eyes	26	96.2	
Punicaceae	*Panica granatum* L. SSS77	Tree	Fruit scale	Fresh	Lack of appetite	1	66.6	0.01
					Lack of appetite	1		
					Asthma	1	33.3	
Papaveraceae	**Argemone ochroleuca* Sweet subsp. Ochroleuca SSS528.	Herb	Root	Dried	Tuberculosis	4	100	0.02
Poaceae	*Pennisetum glaucum* (L.) R.Br SSS46	Herb	Root	Dried	Tuberculosis	2	100	0.01
Poaceae	*Saccharum officinarum* L. SSS310	Herb	Root	Dried	Tuberculosis	2	100	0.01
Poaceae	*Zea mays* subsp. *mays* L. SSS38	Herb	Root	Dried	Asthma	1	33.3	0.01
					Chronic cough	1	33.3	
					Headache	1	33.3	
Portulacaceae	*Portulaca oleracea* L. SSS10	Herb	Root	Dried	Tuberculosis	2	100	0.01
Rosaceae	**Eriobotrya japonica* (Thunb.) Lindl. SSS800	Tree	Leaf	Fresh	Tuberculosis	4	100	0.02
Rosaceae	*Prunus persica* (L.) Batsch var. *persica* SSS900	Tree	Seed	Dried	Headache	1	33.3	0.01
			Root		Chronic cough	2	66.6	
Rutaceae	*Citrus limon* (L.) Burm.f. SSS808	Tree	Bark	Dried	Fever	45	93.7	0.2
			Seed		Angina pain	1	2	
			Fruit	Fresh	Tight chest	2	4.1	
Rutaceae	*Citrus sinensis* (L.) Osbeck SSS835	Tree	Fruit	Fresh	Chronic cough	1	50	0.01
			Leaf		Lack of appetite	1	50	
					Tuberculosis	1	14.2	
Solanaceae	*Capsicum annuum* L. var. *glabriusculum* (Dunal) Heiser & Pickersgil SSS2	Shrub	Root	Dried	Headache	2	100	0.01
Solanaceae	**Datura stramonium* L. SSS4	Herb	Seed	Dried	Chest pain	202	100	0.84
Solanaceae	**Datura ferox* L. SSS997	Herb	Whole plant	Fresh	Pneumonia	2	100	0.01
Solanaceae	*Nicotiana tabacum* L. SSS115	Shrub	Leaf	Dried	Headache	2	6.8	0.12
					Sinusitis	3	10.3	
					Rhinitis	24	82.7	
Solanaceae	**Solanum mauritianum* Scop. SSS112	Herb	Root	Dried	Headache	1	100	0.00
Verbenaceae	**Lantana camara* L.SSS5	Shrub	Root	Dried	Tuberculosis	1	100	0.00
Zingiberaceae	*Zingiber officinale* Roscoe. SSS306	Herb	Rhizome	Fresh	Chronic cough	3	99.5	1.00
					Chronic cough	237		
					Sore throat	1	0.4	

(*=CARA listed species)

and communal lands (2 %, n = 5), *Pennisetum glaucum* (communal lands (0.8 %, n = 2) and *Zingiber officinale* (*muthi* markets; shops selling healing plants and animal materials (100 %, n = 240), which were obtained by THs from the mentioned sources, the rest of plant species was harvested in the homegardens. Amongst these species, *Schkuhria pinnata* was the only one which grew naturally in the home gardens and thereafter maintained by all *Bapedi* THs as cultivated herb. The rest of the species found in the visited gardens were intentionally grown by the THs. Cultivation of the exotic plants by these THs was generally based on their efficacy as RIs and RLs cures, their diversity of uses (i.e., medicine and ornamentals amongst the other utilities), wider adaptability, faster growth rate and easy propagation with extremely limited water requirements.

Exotic species regulated by conservation of Agricultural resources act

Comparison of the alien plant species documented in the present survey with the list of those regulated under Conservation of Agricultural Resources Act (1983) (CARA) No. 43 of 1983 matched 15 taxa, of which 40 % (n = 6) namely *Argemone ochroleuca*, *Datura ferox*, *Datura stramonium*, *Lantana camara*, *Opuntia ficus-indica* and *Solanum mauritianum* are classified as weeds under category one of this Act. Therefore, their cultivation or propagation is prohibited, and the control of the population using chemical, mechanical or physical techniques, and or combination of these techniques is high recommended. Despite this, our study revealed that the above-listed species are actively cultivated by THs in home gardens, and they will continue to do so because the species are an important aspect of their medicinal systems. This is especially true for *D. stramonium* which its seeds were implicated as chest pain therapy by an overwhelming majority (84.1 %, n = 202) of THs. Traditional application of this troublesome alien weed for pain is supported by scientific study[34]. Therefore, further inquiry in to the probability of producing pain therapies from *D. stramonium* seeds should be a subject of future study, as this have a great potential to aid in controlling the species, especially since the taxa reproduce reproductively via seed dispersal. The application of *D. ferox* as prescribed by *Bapedi* THs is supported by Jamdhade *et al*.[35], who reported its efficacy against various respiratory pathogens namely *Bacillus cereus* and *Staphylococcuis aureus*. Likewise use of *L. camara* for prevalence ailment like TB[22] and *O. ficus-indica* as chronic cough therapy[36], is also supported by scientific studies. We therefore, recommend that the future amendment of CARA listed taxa should cater for the THs and other poor South Africans who relies on the aforesaid species as source therapies for RIs and RLs.

The above can also be said for with another 40 % (n = 6) of species encompassing *Eriobotrya japonica*, *Jacaranda mimosifolia*, *Melia azedarach*, *Morus alba*, *Ricinus communis* and *Senna didymobotrya*. These taxa are listed as invaders under category 3 of CARA, thus their propagation is highly prohibited. However, the fact that such taxa they provide multiple benefits (i.e., medicines and ornamentals, among the others) than native species, will continue to encourage their propagation by interviewed THs. The same is true for multi-used *Psidium guajava* and *Eucalyptus camaldulensis* which appears in category two of CARA, meaning they have potential to become invasive, but because they both have economic and commercial benefits, they are allowed only in demarcated areas under controlled conditions.

Fidelity level (FL) and use value (UV)

The most important exotic species used by *Bapedi* THs for RIs and RLs according to FL index were *Z. officinale* (UM =240 and F L= 99.5 %, chronic cough), *M. oleifera* (UM = 210 and FL = 100 %, fatigue), *D. stramonium* (UM = 202 and FL = 100 %, chest pain), *J. mimosifolia* (UM = 156 and FL 100 %, chronic cough) and *S. pinnata* (UM = 105 and FL = 94.5 %, painful eyes), *C. limon* (UM = 45 and FL = 93.7 %, fever), respectively. Many of the mentioned plants including *D. stramonium*[34], *Z. officinale*[37]and *J. mimosifolia*[38] have already been screened for their biological activity against various micro-organisms known to cause the stated ailments and found to contain secondary metabolites that are biologically active, which might explain their higher FL in this study. In addition, *C. limon*[39], *Z. officinale*[40] and *M. oleifera*[41] are repeatedly reported in ethnobotanical literature as being used medicinally by indigenous people, thus suggesting that they are harmless as herbal remedies. Analysis of the recorded exotic plants with regards to UV was also executed. Accordingly, the plants which yielded the highest values were *M. oleifera* (fatigue; UV = 0.87), *D. stramonium* (chest pain; UV = 0.84),

J. mimosifolia (chronic cough; UV = 0.65), *S. pinnata* (asthma, fatigue and painful eyes; UV = 0.46), *C. sativa* (asthma, chronic cough, fever, headache, sore throat, tight chest and TB; UV = 0.33), *E. camaldulensis* (asthma, fever, sinusitis and sore throat; UV=0.31) and *S. molle* (asthma, chronic cough, fatigue, fever, laboured breathing, pneumonia, sore throat and TB; UV = 0.29), respectively. According to Silva *et al*.[42] the species with the highest use values, similar to the aforesaid are actually or potentially important to the rural population, particularly THs. The extent of utilisation of such species in our study is attributed either to their use in the treatment of one or more investigated afflictions by higher number of THs, which suggests that medicinal knowledge about them as RIs and RLs are highly appreciated and greatly distributed amongst *Bapedi* THs.

Used plant parts, methods of herbal preparation, administration and dosage

Parts of the plants most used by *Bapedi* THs for remedy preparation were root (38 %, n = 17) and leaf (25 %, n = 11). Indigenous people in central Zimbabwe also prefer exotic roots and leaves for herbal medicines preparartions[43]. Other parts namely fruit (9.1 %, n = 4), seed and whole plant (6.8 %, n = 3, for each), bark and bulb (4.5v %, n = 2, for each), as well as tuber and rhizome (2.2 %, n = 1, for each) were less frequently used by traditional healers in the present study. Five species; *C. limon*, *Citrus sinensis*, *E. camaldulensis*, *Musa sapientum* and *Prunus persica* were harvested by THs for more than one part.

A larger number (57.8 %, n = 22) of used harvested species were processed in dry form, 28.9 % (n = 11) while still fresh, and relatively few (13.1 %, n = 5) namely *C. sativa*, *C. limon*, *E. camaldulensis*, *M. sapientum* and *S. molle* in both dry and fresh states. Sixty-two recipes (16 multi and 46 mono) were recorded in this study. Most of these recipes were prepared via boiling (51.6 %, n = 32), pounding (33.8 %, n = 21), maceration (9.6 %, n = 6), burning (3.2 %, n = 2) and chewing (1.6 %, n = 1), respectively. These are the common techniques of making remedies from exotics species by THs of other cultures in South Africa[21,24]. The most popular way of administering prepared recipes in this study was oral (62.9 %, n = 39), followed by the nasal (25.8 %, n = 16), and lastly topical (11.2 %, n = 7).

Conclusion

Our study showed that exotic plant species plays an important role in the *Bapedi* THs traditional healing sector as remedies for RIs and RLs. Overall, we share similar sentiments with Albuquerque *et al*. who stated that the incorporation of alien plants in to local traditional medicine should not only be considered in terms of cultural erosion, but also as a strategy to diversify the stock of therapeutic plant species. This will subsequently increase the range of alternative medicines and ultimately contributing towards the reduction of the overuse of native wild plants. The effectiveness and widespread use of CARA listed species by *Bapedi* THs has the potential to provide alternative control measures while supplying the much needed plants for healing purposes. However, for this to be effective the local nature conservators should educate the THs on the permitted and restricted activities of using species regulated by this act.

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