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Full Length Research Paper

Putative medicinal properties of plants from the Kavango region, Namibia

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Namibia has over 4,334 different plant taxa. Although, some of these plants may potentially be used as herbal medicines, there is limited knowledge about their efficacy and safety. This is partly due to the fact that screening of plants for pharmacological activity and characterization of their active chemical compounds is expensive. In order to circumscribe this problem, this paper presents data on the putative medicinal properties of plants surveyed in the Kavango region, Namibia. The data were mined from electronic search engines. The search results showed that 48 plant species from 22 families were known to treat several diseases including malaria, diarrhea, sexually transmitted infections and tuberculosis. Data from this study will be used by community forestry officers to educate the local people about the possibility of using indigenous plants for medicinal purposes.

Key words: Namibia, medicinal plants, reverse bioprospecting, green bio-economy.

INTRODUCTION

Namibia is a semi-arid country with a population of 2.3 million people spread over an area of 823,145 square kilometres (Ministry of Health and Social Services and Macro International Inc., 2008; Wardell-Johnson, 2000). It is the most arid country south of the Sahara; 16% of the country being covered by the desert (Wardell-Johnson, 2000). Giess (1998) divided the vegetation of Namibia into three main groups: deserts (16% of the country), savannas (64%) and woodlands (20%). He outlined 15 main vegetation types, namely: five deserts, eight savannas and two woodland types. The *mopane* savanna, which mainly consists of *Colophospermum mopane*, occupies the north-western part of the country inland from the northern Namib vegetation type. Overall, plant life in Namibia comprises 4,269 taxa which include species, sub-species and varieties (Craven, 1999). Earlier, Maggs et al. (1998) documented at least 4,334 vascular plant taxa which included 61 indigenous species of ferns in 19 genera and 12 families. Among the monocots, there were 968 indigenous species in 129 genera and 33 families, with the Poaceae (422 species) being the dominant family (Maggs et al., 1998). They found that the eudicots and other non-monocotyledonous flowering plants comprised approximately 3,010 indigenous species scattered over 730 genera and 124 families with the Asteraceae (385), Fabaceae (377), and Aizoaceae (177) being the dominant families. This rich plant biodiversity provides an important foundation for human survival and development in Namibia (Wardell-Johnson, 2000).

Thus, although Namibia is a diamondiferous country, biodiversity and indigenous plants in particular, are now perceived to be the country's 'green diamonds' (Chinsembu, 2009). For instance, Namibia is the world's largest supplier of the Devil's claw, estimated at over 1000 metric tons in 2002 (Mwandemele et al., 2006), and accounting for almost 95% of global trade (INP Bulletin, 2011). In 2009, over 401,728 kg of selected indigenous plant products (Devil's claw, *Hoodia*, Kalahari melon seed oil, Marula oil, *Ximenia* oil and *Commiphora* resin) calculated at 22 million Namibian dollars (about US$ 3 million) were exported out of Namibia (INP Bulletin, 2011). It goes without saying that self-reliant plant

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Abbreviations: ABS, Access and benefit sharing; **THMPD,** traditional herbal medicinal products directive; **IK,** indigenous knowledge; **IP,** intellectual property; **LDC,** livestock development centre; **HIV/ AIDS,** human immunodeficiency virus; acquired immune deficiency syndrome.

gatherers and vendors are part of the supply chain and beneficiaries from Namibia's green bio-economy. Consequently, the Namibian government instituted the National Biodiversity Programme (1994), the Indigenous Plants Task Team (2000), and the Interim Bioprospecting Committee (2007); all these structures deal with matters related to indigenous plants (Shikongo, 2011). An Access and Benefit Sharing (ABS) bill has been finalized (Shikongo, 2011), but its operationalization remains a Herculean task; more especially the mechanisms to dispense monetary benefits such as royalties. These efforts signify the fact that trade in indigenous plants forms a hidden bio-economy that supports the livelihoods of many rural households (Reihling, 2008; Byers, 1997).

On the other hand, all herbal products marketed in the European union are required to have a traditional-use registration based on the Traditional Herbal Medicinal Products Directive (THMPD) adopted in 2004 (INP Bulletin, 2011). The purpose of the THMPD is to create consumer safety or assurance and help weed out products of questionable quality or unfounded pharmacological claims (INP Bulletin, 2011). Be that as it may, scientific validation of medicinal plants is an expensive and arduous process in Southern Africa, including Namibia (Chinsembu, 2009), and it is quite difficult to estimate the quantum of cost-benefits for a bioprospecting and plant medicinal screening project. Moreover, the classical route to screen and validate indigenous plants may take as many as 15 years (Chinsembu, 2009). Indigenous knowledge (IK), coupled with a history of safe use and ethnopharmacological efficacy, present a faster approach to discover new plant-based drug agents (Kaya, 2009). This new approach is now called reverse pharmacology (Chinsembu, 2009). However, while Namibian IK holders can provide invaluable data for reverse pharmacology, they tend to withhold vital ethnobotanical information that can lead to the commercialization of ethno medicinal plant products because there are no economic benefits (from drug companies) that ensue from sharing their IK and plant genetic resources (Chinsembu, 2009; Du Plessis, 2007; Craven and Sullivan, 2002). Therefore, ever since plants such as the Devil's claw and *Hoodia cactus* entered the speculative marketplace of bio-capital, Namibians have become alive to the various issues surrounding the scientific validation and commercialization of indigenous medicinal plant products.

Speaking at a symposium on the Devil's claw in 2001,Namibia's first President, H.E. Sam Nujoma, said: "I believe that while scientific research is necessary to improve the way in which our natural resources are exploited...our people must not be completely disowned...of resources that they have possessed for generations. It will be a sad day when the medicinal formulas of Devil's claw are patented by big pharmaceutical companies and thereby become depleted and unavailable to the natural owners of the resource" (Wickham, 2009). Still, such statements have not prevented the biopiracy of IK and plant natural resources from Namibia. Although Apartheid was abolished in 1990, the country's indigenous people have not benefited from the lucrative biotrade in the Devil's claw, whose sales in Germany rocketed to 30 million Euros as of 2001 (Stewart and Cole, 2005). A purified extract from the Devil's claw was patented by Finkelberg, a leading Germany company (Stewart and Cole, 2005), and as President SamNujoma had feared, Namibian IK holders were neither addressed through patent negotiations nor did they benefit from the large commercial success of the drug in Germany where it turned into the third most frequently used natural drug of all (Reihling, 2008). A 50 gram extract of Devil's claw in tablet form fetched 25 Euros in 2007 (Reihling, 2008) but Namibian gatherers were paid 30 to 40 cents per kilogram of dried tubers (Wegener, 2000).

This story of the Devil's claw demonstrates that Namibians have had little benefit from bioprospecting and commercialization of their medicinal plants. It is within this prism of economic dispossession that the entry point for research into traditional medicines in Namibia is informed by a multiplicity of moral and economic perspectives (Chinsembu, 2009). In short, reliance on IK holders to provide critical leads for drug discovery meets an intellectual property (IP) thicket shrouded in secrecy and suspicions. To circumvent this IP thicket, as well as to avoid lack of access to early-stage capital for bioprospecting and rapid screening of ethno medicinal plant materials, we pursued leads from available literature to pin-point putative medicinal properties of selected plants in Namibia. Therefore, the aim of this paper was to mine data pertaining to the medicinal properties of plants found in the central Kavango region, Namibia. We refer to our approach as reverse bioprospecting.

MATERIALS AND METHODS

We obtained a list of known tree species recorded during a survey conducted between April-May 1999 for the Kavango region (Burke, 2000; GRN, 2000). There were 146 tree species recorded during the survey. The trees were part of the central Kavango woodlands near the Mile 46 Livestock Development Centre (LDC) (Figure 1). Briefly, this area has broad-leafed, deciduous woodlands that vary according to topography and the nature of the soils that support them; thus the vegetation is described as 'mosaics' of various small units (El Obeid and Mendelsohn, 2001). The vegetation map of the study area is shown in Figure 2. Briefly, there were three general vege*tation types:*(a) fairly tall woodlands such as the *Burkea*-Teak woodlands, *Burkea* woodland and shrub lands and woodlands of the northern sand plains; (b) vegetation types associated with drainage systems such as floodplains, riverine forests and the Omatako drainage and riverine forests along the river near Andara and Bagani; and (c) two vegetation types with many pans, namely the Camelthorn-Silver *Terminalia* shrubland mosaic and Shrub lands of the southern panveld (El Obeid and Mendelsohn, 2001). We mined data related to the medicinal properties of the plants in the search engines Pub Med Central, the United States of America

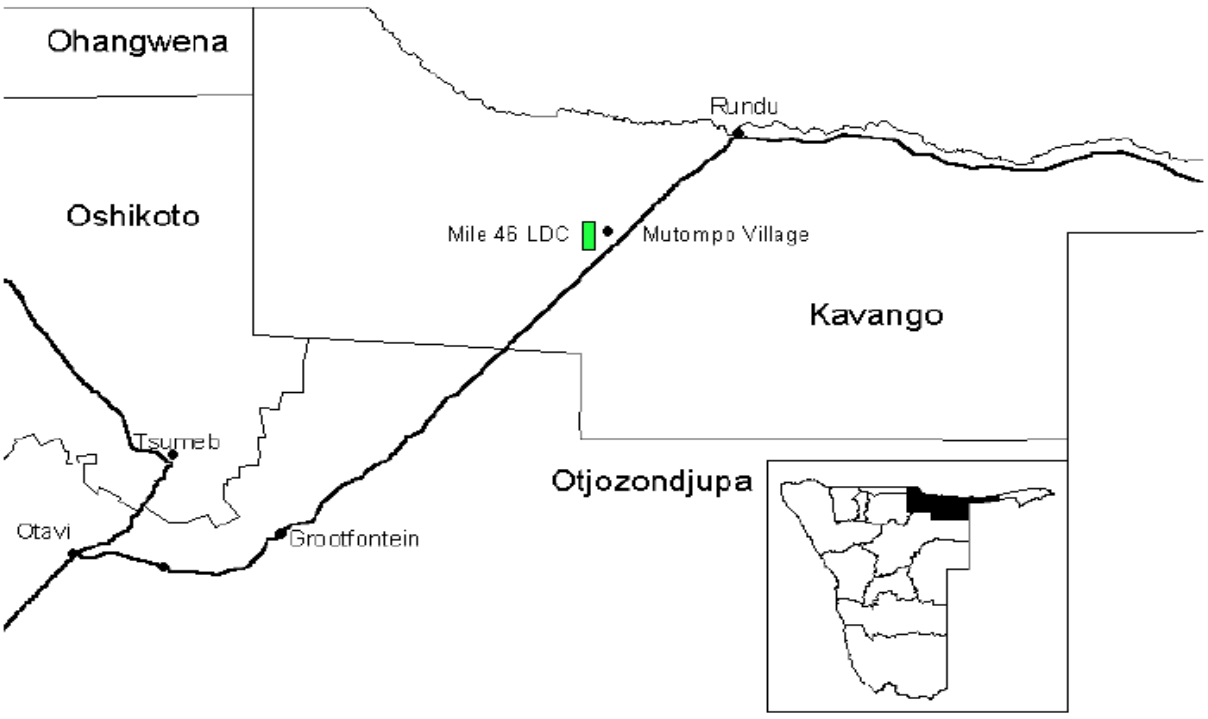

Figure 1. A map of Namibia showing Kavango region (Strohbach and Strohbach, 2004).

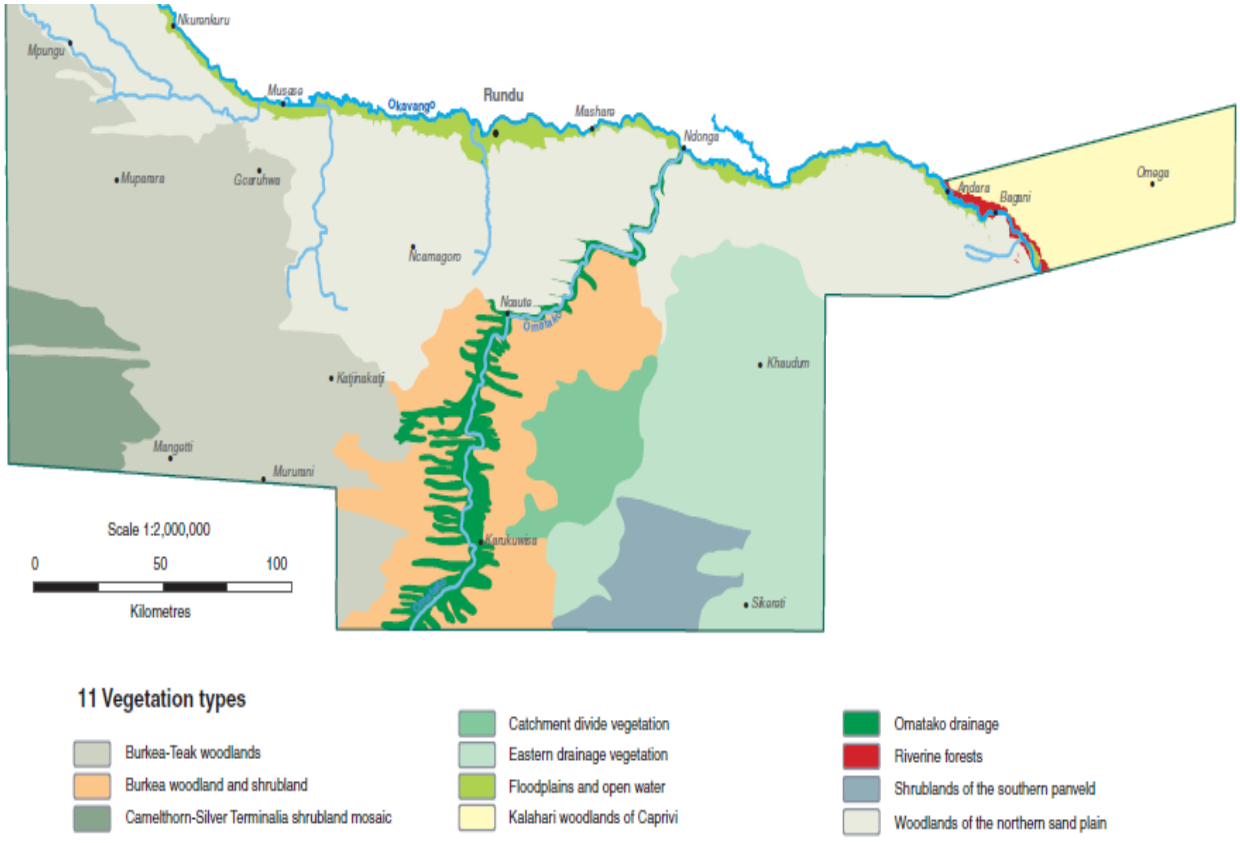

Figure 2. Vegetation map of the Kavango region (El Obeid and Mendelsohn, 2001).

National Library of Medicine's digital archive of biomedical and life sciences journal literature, Google scholar, Biomed Central and Yahoo scholar by keying in the scientific name of each plant in these search engines. During the literature search which lasted 6 months, we reviewed "primary" journal publications which reports on the medicinal use of each of the plants in the search. We considered only-peer reviewed journal articles written in English language (excluding journal abstracts and conference abstracts), from all over the world. The search documented the plant families, plant species, common names, plant parts used, medical conditions that were treated, method of application and the journal publication.

RESULTS

The study revealed 48 plants from 22 families with medicinal uses which are used to treat over 50 different disease conditions (Table 1). The diseases which are commonly treated with medicinal plants were malaria (23%), diarrhea (20%) and tuberculosis (7%) (Figure 3). Most of the plants came from the following families: Combretaceae (19%) Ebanaceae (12%), Mimosaceae (12%) and Fabaceae (8%) (Figure 4). The common parts of the plant used as medicine were leaves (36%), bark (32%), roots (24%), whole plants (4%), fruits and seeds (2%) (Figure 5). Furthermore, the study assessed the different modes of application of these plants and found that drinking (53%) was the most common mode of application followed by rubbing (22%), steaming (18%) and oral wash (7%). Drinking was commonly used for diseases caused by internal parasites and steaming was mainly used to treat fever-related symptoms, while rubbing was used for diseases caused by external parasites or diseases which show external physical symptoms like wounds and sores. Diseases which affect the mouth such oral candidiasis and tooth-ache were usually treated by chewing plant parts.

DISCUSSION

Namibia is the second most sparsely populated country in the world. Therefore, rural people walk long distances in order to access health facilities. For this and other reasons, many rural communities still depend on indigenous medicinal plants to treat various ailments (Chinsembu, 2009). Despite the abundance of medicinal plants, knowledge of medicinal plant usage is rarely shared outside of the family. Further, knowledge of traditional medicines is heavily guarded by traditional healers who also charge exorbitant fees for their services. In this paper, we have made a modest attempt to showcase the potential of medicinal properties of plants found in the Kavango region, Namibia. Although the local communities may already have knowledge of these medicinal plants, our intention is to avail the data presented in this paper to community forestry officers so that they in turn share this knowledge with the local people. Obviously, this will present a new dimension to the use of ethno medicines among the Kavango people. We expect that the community forestry officers will identify the plants and advise the local people on how to harvest and process the plants as ethnomedicines for various common diseases such as diarrhea, flu, dysentery, coughing, wounds, malaria, sexually transmitted infections, stomachache, anemia, pneumonia and infertility. Sharing the knowledge of medicinal properties of plants will be important as the local people will not be compelled to seek the services of traditional healers.

The most important limitation with this approach is that there is no information pertaining to correct dosages for patients. Data about prescriptions of ethnomedicines are seldom in the literature; hence caution should be taken as people may become ill if some of the cures are administered without knowing their recommended quantities. The question of dosages may not be critical as local people may already have prior knowledge of medicinal properties of these plants. Such knowledge varies according to local people's age, experience and training. Undoubtedly, there will be people in the community that know about the medicinal properties of the plants found in this literature search. Having said that, we strongly recommend against drug companies using local people as guinea pigs during efforts to validate and commercialize wild medicinal plants. This is a very serious bioethical concern.

The survey revealed different plant species and plant parts used to treat several diseases. These results present an enormous potential and variety of choice for the use of local plants to treat diseases. Other than the Caprivi region, the Kavango region has one of the highest infection rates of malaria in Namibia. The study revealed a large repertoire of plant species (23%) which can potentially be used as anti-plasmodial agents; this may help expand the current arsenal of natural remedies against malaria. Of all the plant parts, leaves were the most commonly used. Again, this is an interesting result because harvesting of leaves, rather than barks and roots, could be less damaging thus ensuring sustainable harvesting and long-term survival of the medicinal plants. Yet, the local communities should be alerted to the potential dangers of over-harvesting of medicinal plants, as well as the need to establish nurseries to grow such plants.

Since the medicinal properties of the plants are well documented in the literature, their usage by local people will easily meet the requirements for safety and product efficacy. The export of these plants may also satisfy the regulatory requirements of the European Union. It will further preserve the niche markets and increase the incomes of exporters. As it was earlier noted, any data that help to demonstrate the chemical characteristics of indigenous plants are useful because they tremendously improve international certification and acceptance of secondary products especially where the producer and

Table 1. Putative medicinal properties of plants from the Kavango region of Namibia.

Family and scientific name	Common name	Plant part used	Medical condition treated	Method of application	References
Anacardiaceae					
Sclerocaryabirrea	Marula tree	Roots	Candidiasis	Rubbing	Runyoro et al. (2006)
		Leaves,	Nervous discomfort of feet	Rubbing	Chinsembu and Hedimbi (2010)
		Roots	Diarrhoea	Drinking	Otieno et al. (2008)
			Bilharziasis	Steaming, drinking	
Bignoniaceae					
Kigelia africana	Sausage tree	Fruits	Colds	Steaming, drinking	Sonibare and Gbile (2008)
		Bark	Flu Herpes simplex	Rubbing	Chinsembu and Hedimbi (2010)
Burseraceae					
Commiphora africana	African myrrh	Roots	Swollen pancreas	Drinking	Otieno et al. (2008)
					Chinsembu and Hedimbi (2010)
Caesalpiniaceae					
Bauhinia variegata L.	Orchid tree	Bark	Piles	Drinking	Jain et al. (1991)
			Dysentery	Steaming	
			Leprosy	Rubbing	
Caesalpiniaceae					
Piliostigma thonningii	Camel's foot	Bark	Blood pressure and cough	Drinking	Kareru et al. (2007)
			Wounds, jaundice and abdominal	Drinking, steaming	Njayou et al. (2008)
		Leaves	pain		
Capparaceae					
Boscia salicifolia Oliv.	Willow-leaved	Leaves	Anti-candida	Oral wash	Runyoro et al. (2006)
Boscia angustifolia A. Rich	shepherd's tree				
	Rough-leaved	Root	Gastric ulcer	Drinking	Togola et al. (2008)
	shepherds tree				
Combretaceae					
Combretum glutinosum	-	Leaves	Anti-malaria and diarrhoea	Steaming,	Titanji et al. (2008)
Combretum latialatum	-	Leaves	Anti-malari and diarrhoea	Drinking	Titanji et al. (2008)
Combretum micranthum	-	Leaves	Anti-malaria and diarrhoea	Drinking	Kisangau et al. (2007)
Combretum platysterum	-				Kisangau et al. (2007)
Combretum spinesis.	Bushwilow	Leaves	Anti-malaria and diarrhoea	Drinking	Chinsembu and Hedimbi (2010)
Combretumcollinum Sound.	Rooibos	Leaves	Chronic diarrhea,		Chinsembu and Hedimbi (2010)
Combretum apiculatum		Leaves	Tuberculosis and sterility	Drinking	Chinsembu and Hedimbi (2010)
Combretum elaeagnoides	Oleaster	Bark			

Table 1. Contd.

Terminalia mollis Laws	bushwillow	Bark	Tuberculosis and Diarrhoea	Drinking	
Terminalia sericea	Kudu Bush	Bark	Tuberculosis and Diarrhoea	Drinking	
	Silver cluster-leaf	Root	Cryptococcal meningitis	Drinking	
			Tuberculosis and diarrhoea	Drinking	
Cyperaceae					
Cyperus rotundus	Nut grass	Whole plant	Cooling	Steaming	Lans (2007)
Ebanaceae					
Diospyros mespiliformis	Jackal Berry	Bark and Leaves	Anti-plasmodial	Drinking	Kantamreddi and Wright (2008)
Diospyros melanoxylon		Leaves and bark			Muazu and Kaita (2008)
Diospyros peregrina	African Ebony	Leaves and bark	Anti-plasmodial	Drinking	
	Indian persimmon	Leaves and bark			Kantamreddi and Wright (2008)
Diospyros sylvatica	Nepal Ebony	Seeds	Anti-plasmodial	Steaming	Nanyingi et al. (2008)
Diospyros tomentosa	-	Roots	Anti-plasmodial		Mothana et al. (2009)
Euclea divinorum Hiern	Diamond-leaved euclea	Roots	Malaria, fevers and venereal diseases	Drinking oral wash,	Chinsembu and Hedimbi (2010)
			Oral care, tooth ache, fungal diseases, sores and wounds and abscesses	Chewing rubbing	
Euphorbiaceae					
Antidesma venosum Tul.	Tassel berry	Roots	Tuberculosis, chronic diarrhoea,	Drinking	Kareru et al. (2007)
		Roots			Kisangau et al. (2007)
Phyllanthus reticulates	Potato plant	Leaves	Herpes simplex	Rubbing	Chinsembu and Hedimbi (2010)
Fabaceae					
Bauhinia cumanensis	Monkey step	Bark	Gall stones	Drinking	Runyoro et al. (2006)
Bauhinia excise	-	Leaves			Runyoro et al. (2006)
	Weeping wattle		Anti-Candida	Drinking, oral wash	Chinsembu and Hedimbi (2010)
Dichrostachys cinerea (L.) Wight and Arn	-	Leaves		Rubbing	Bizimenyera et al. (2007)
Peltophorum africanum	African Wattle	Bark	Wounds, colic (acute pains), Joint and back pain, Ascites, Abdominal disorders, diarrhoea, dysentery, infertility and depression		
		Roots		Drinking	

Table 1. Contd.

Gramineae					
Andropogon schoenanthus	Fever grass	Leaves	Anti-malaria	Steaming,	Randrianarivelojosia et al. (2003)
Andropogon nardus L.	Citronella Grass	Leaves	Anti-malaria	Drinking	Randrianarivelojosia et al.(2003)
Leguminosae					
Bauhinia semibifida Roxb.	Daup-daup	Roots	General weakness	Steaming	Samuel et al. (2010)
Mimosaceae					
Albizia amara (Roxb.) Boiv.	Bitter albizia	Leaves	Stomach pains	Drinking	Kareru et al. (2008)
Albizia anthelmintica	Worm-cure albizia	Bark	Malaria	Drinking	Kareru et al. (2008)
Brong.					
Acacia hockii De Willd.	Shittim wood				Chinsembu and Hedimbi (2010)
Acacia erioloba		Bark	Herpes zoster	Rubbing	Kisangau et al. (2007)
Acacia erubescens Welv. Ex Olive.	Camelthorn				
Acacia nigrescens	Blue thorn		Herpes zoster	Rubbing	Chinsembu and Hedimbi (2010)
	Knob thorn		Herpes zoster	Rubbing	
			Herpes zoster	Rubbing	
Moraceae					
Ficus sycomorus	Bush fig	Bark, leaves,	Coughing,	Drinking	Ahmadu et al.(2007)
		bark	digestion problems and	Drinking	Ibrahim et al. (2008)
			anaemia	Drinking	Victor 2006
Myrtaceae					
Syzygium guineense	Water pear	Bark	Chronic diarrhoea	Drinking, steaming	Bekalo et al. (2009)
Olacaceae					
Ximenia Americana	Tallow wood	Bark	Tonsillitis,	Drinking	Teklehaymanot and Giday (2007)
		Leaves	throat infection,	Drinking	Kareru et al. (2007)
		Bark	malaria, dysmenorrhoea,	Drinking	Kissangau et al. (2007)
		Roots	gonorrhoea and skin rashes	Drinking	Chinsembu and Hedimbi (2010)
				Rubbing	
Papilionaceae					
Baphia nitida	Camwood	Roots and bark	Ulcer boils and dressing	Rubbing	Kayode (2006)
Poaceae					
Cymbopogon citratus	Fever grass	Leaves	Anti-malaria	Drinking	Titanji et al. (2008)
Cynodon dactylon Pers.		Roots	Liver disorder	Drinking	Kumar and Jain (1998)
	Bermuda grass	Whole plant	Wounds	Rubbing	Muthu et al. (2006)
			Cooling	Steaming	

Table 1. Contd.

Rhamnaceae					
Ziziphus mucronata	Buffalo Thorn	Roots	Sterility	Drinking	Otieno et al. (2008)
Tiliaceae					
Grewia bicolor	Bastard brandy bush	Whole plant	Chronicdiarrhoea	Drinking, steaming	Kisangau et al. (2007)
Verbenaceae					
Clerodendrum myricoides (Hoschst.) Vatke.	Blue cat's whiskers	Leaves Roots	Pneumonia, gastrointestinal, lumbago and venereal diseases	Drinking Drinking, steaming	Kareru et al. (2008) Nanyingi et al. (2008)

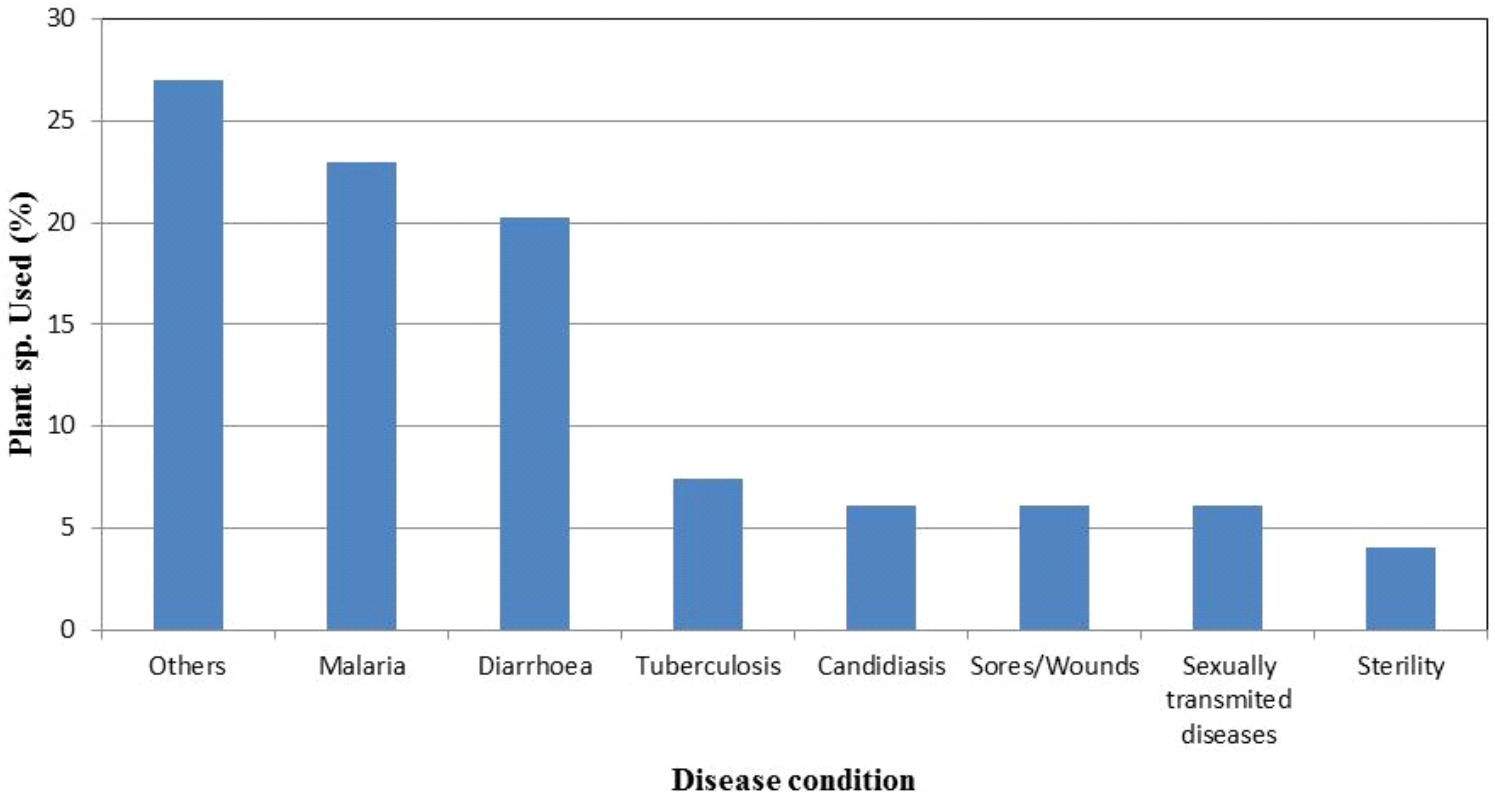

Figure 3. Percentage use of plants to treat different disease conditions.

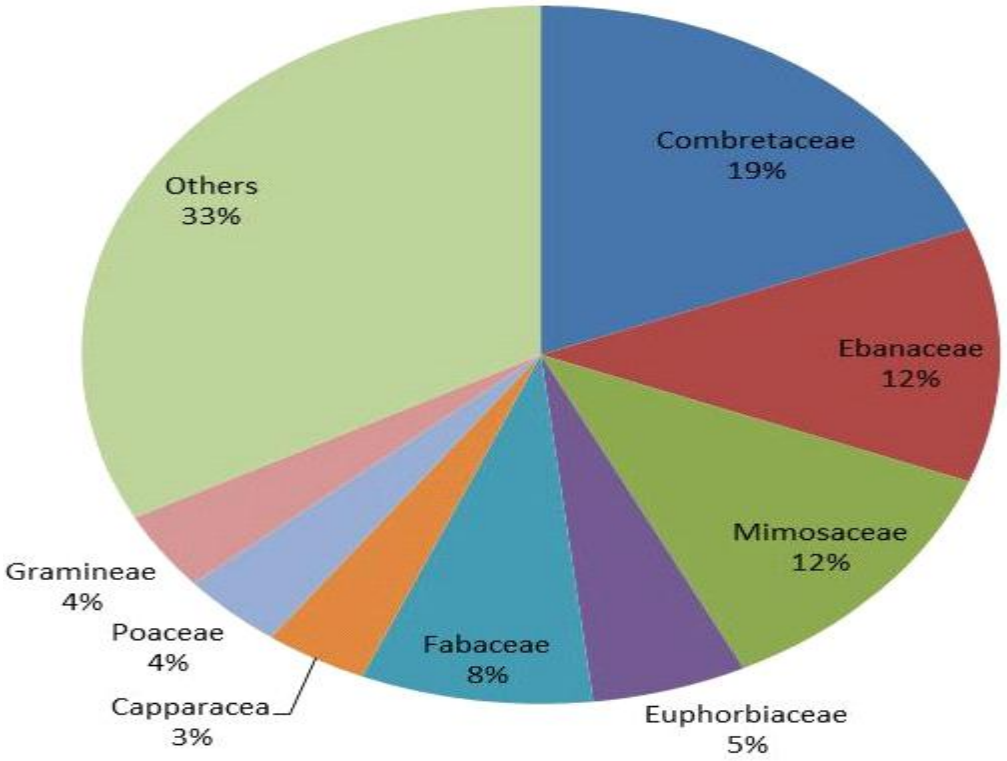

Figure 4. Percentage use of plants from different families.

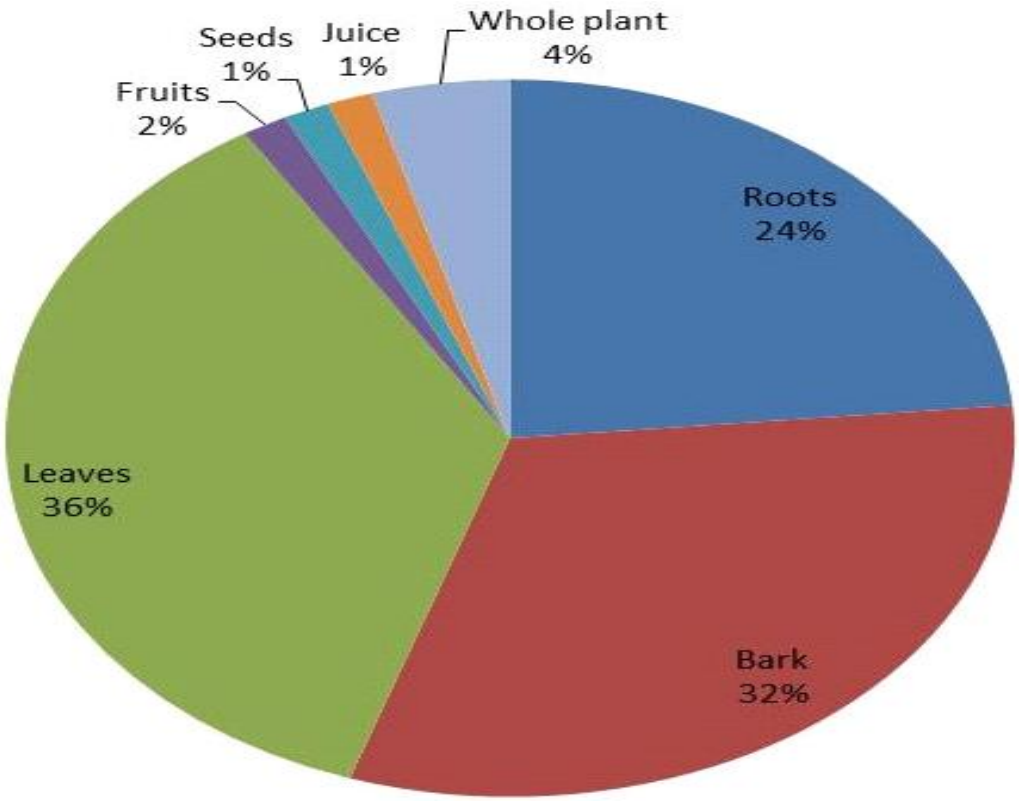

Figure 5. Percentage of plant parts used for medicinal application.

consumer are not in direct contact (INP Bulletin, 2011). The methodology illustrated in this study helps to narrow the screening process and shorten the period of scientific validation of medicinal plants in Namibia. Furthermore, our work presents a major point of departure because whereas local communities always suspect scientists of 'stealing' their knowledge of ethno medicinal plants, our approach shows that scientists can also be vital sources of knowledge of medicinal plants. The idea is to mine data on medicinal plants, in order to communicate new knowledge that may not yet be known by the local people. Sharing of new knowledge will hopefully build a climate of mutual trust among the various stakeholders including scientists and users of traditional medicines.

This will also lay the foundations for future cooperative research and set in motion discussions on the draft ABS bill especially regarding the issues of transparency, integrity, IP rights and benefit sharing. Understandably, benefits shall not only be channeled to local communities but will also be premised on the sustainable conservation or use of indigenous medicinal plants. At the same time, scientists will need to carefully stress the fact that their research may not lead to economic benefits. We believe that this approach will unlock the unknown medicinal potential of Namibian plants, enrich the local pharmacopeia, and quicken the process of local drug development. The idea is to share knowledge of putative medicinal properties of plants with the communities in the Kavango region of Namibia. In this way, communities living closer to putative medicinal plants may benefit from what is known to work elsewhere, without re-inventing the wheel, thus ensuring quicker technology transfer and the right to share into the benefits of medicinal plant knowledge accrued in the global literature.

Conclusion

The study revealed 48 plants from 22 families which has a potential as ethnomedicines for different disease conditions in Kavango region, Namibia. These plants treated conditions such as herpes zoster, diarrhoea, malaria, coughing, tuberculosis and meningitis. Further research is needed to isolate the plants' active chemical compounds, in addition to deciphering their dosages and modes of action.

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