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Erectile dysfunction: Definition and materia medica of Bapedi traditional healers in Limpopo province, South Africa

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Erectile dysfunction (ED) is a neurovascular event modulated by various factors impacting on the physiological functioning of the penile tissue. Interest in therapeutic substances of plant origin, used to treat ED, has progressively increased in the last decades. This ethnobotanical study on Bapedi aphrodisiacs was undertaken during 2010/2011 to document the floral diversity, species utilization, extract preparation and administration. The emphasis was on the customs of traditional healers residing in 17 municipalities, in three districts in the Limpopo province of South Africa. Data was obtained, from 34 healers, using a semi-structured questionnaire. According to these traditional healers, ED entails the inability to sustain an erection during coitus as well as a decreased libido. Findings indicated the use of 12 species, 10 of them with new documentations. Among these species, *Zanthoxylum humile* was the most frequently used species, and only *Osyris lanceolata* and *Securidaca longepedunculata* were previously recorded in the treatment of ED. There was a definite selection for underground parts. Preparation was uncomplicated; with cooking and pounding of the preferred methods. Administration was mostly attained via oral administration; however, the vehicle for administration varied. This manuscript validated the application of two species as aphrodisiacs. It is concluded that the major contribution is the 10 species that have not been documented earlier.

Key words: Bapedi, aphrodisiacs, erectile dysfunction, Limpopo province, *Zanthoxylum humile*.

INTRODUCTION

The dependence on aphrodisiacs by cultures such as the Chinese, Romans and Greeks, to enhance sexual performance, has been demonstrated for millennia (Elferink, 2000). Guirguis (1998), quite eloquently stated that “the erect penis has always been a symbol of power, virility and fertility”. It is therefore not surprising that in the presence of observed sexual enhancing properties, and the lack of scientific support, the use of such “love drugs”

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(Drewes et al., 2003) remain in high demand.

These drugs are almost exclusively used to enhance male sexual performance, more specifically the ability to perform optimally during coitus. Worldwide, approximately 152 million males suffer from erectile dysfunction (ED) (McKinlay, 2000). ED is broadly defined as the persistent inability to attain and maintain an erection sufficient to permit satisfactory sexual performance (Lue et al., 2004). Drewes et al. (2003) noted that the introduction of phosphodiesterase type 5 inhibitors ($PDE5_i$), such as the designer drug VIAGRA® (Pfizer, 235 East 42nd Street, NY 10017) captivated the public's imagination. It also sparked a reassessment of older natural products for possible value in the treatment of ED, as well as the search for novel natural products to compete effectively against such synthetic drugs. The pursuit for more cost-effective herbal alternatives to compete against designer drugs is of the utmost importance as it will grant those with socio-economic constraints, access to treatment. Efficacy of these herbal substitutes depends on their potential to alter phosphodiesterase activity in the penile tissue.

Phosphodiesterases are a class of enzymes with the capability to cleave the phosphodiester bond in either cyclic adenosine monophosphate (cAMP) or cyclic guanosine monophosphate (cGMP), to yield 5'-cyclic nucleotides. They are therefore responsible for the cellular regulation of cAMP and cGMP levels (Omori and Kotera, 2007). The human genome encode 21 PDE genes; categorised into 11 families based on their protein sequence, structure, substrate specificity, enzymatic properties, tissue distribution, and sensitivity to selective inhibitors (Kotera et al., 2005). Of interest in the treatment of ED is PDE5, a highly specific cGMP enzyme. It is predominantly distributed in the smooth muscles located in the blood vessels and corpora cavernosa of the penis. This enzyme forms part of a cascade of mechanisms, where its inhibition leads to the accumulation of cGMP (Drewes et al., 2003). Therefore, any therapeutic intervention, from either natural products or designer drugs, targeting cGMP-binding will promote the cellular elevation of cGMP. These elevated levels induce a low Ca^{2+} state, which supports muscle relaxation (Williams and Melman, 2012). The resultant relaxation of the trabecular smooth muscle causes vasodilation, which increases blood flow into the corpora cavernosa via the pudendal artery. Consequently, the penis becomes engorged with blood and becomes erect (Andersson and Wagner, 1995); a purely hemodynamic event.

Regardless of the advances in modern medicine, traditional medicine is still the mainstay of primary health care for many people (Meyer et al., 2008); where herbal remedies are used to treat various diseases and disorders, including ED. In South Africa, a number of *in vitro* studies on species used to treat ED have been conducted. Drewes et al. (2002) evaluated pyrano-isoflavones isolated from *Eriosema kraussianum*, a species often used by the Zulu, in KwaZulu-Natal, to treat ED. Rakuambo et al. (2006) and Meyer et al. (2008) concentrated on species used by the Vha-Venda, residing in the Limpopo province.

The latter two studies predominantly focussed on *Securidaca longepedunculata*, and concluded that extracts showed potential as a therapeutic lead. In contrast to this, the Bapedi, the most dominant ethnic group in the Limpopo province (Monning, 1967) has received no attention with regard to their herbal remedies used to treat ED. It is well documented that male sexual performance and prowess is influenced by a multitude of factors. Amongst these factors, social and cultural norms play an important role in male sexual behaviour and performance; highlighting the fact that sexual performance is well correlated with self-esteem (Silberschmidt, 2001; Ahmed and Bhugra, 2007). The question thus remains whether the traditional definition of ED, among the Bapedi, is in line with its clinical definition. This study will also address to what extent they depend on herbal remedies to alleviate the symptoms of ED. Therefore, this study was conducted to investigate the species diversity, plant parts used, and specific preparation and administration of extracts used by this group to treat ED.

METHODOLOGY

Study area and study population

The study area is situated in the Limpopo province, in the far North of South Africa (Figure 1). Data was collected from three districts (Capricorn, Sekhukhune and Waterberg) covering 17 local municipalities (Table 1). These districts were selected due to their sizeable population of Bapedi; a cultural group that resides primarily in the central, Southern and Western parts of the Limpopo province. A total of 34 traditional healers (2 per local municipality) were selected from the listed local municipalities (Table 1).

Survey

This study was conducted from July 2010 to February 2011. Traditional healers were identified by convenience sampling, that is, with the assistance of colleagues and recommendations from villagers. Prior informed consent was obtained, and a semi-structured questionnaire was used to obtain information regarding the diversity of species used, plant parts used, as well as how these remedies were prepared and administered. Traditional healers were interviewed individually, in the confines of their consultation rooms.
The primary researcher accompanied traditional healers to the collection sites to confirm the identity of species and to collect samples. At the Larry Leach Herbarium (UNIN) these samples were taxonomically identified and voucher numbers allocated.

RESULTS

Among the participants, there was broad consensus regarding the definition of ED. According to them, ED is

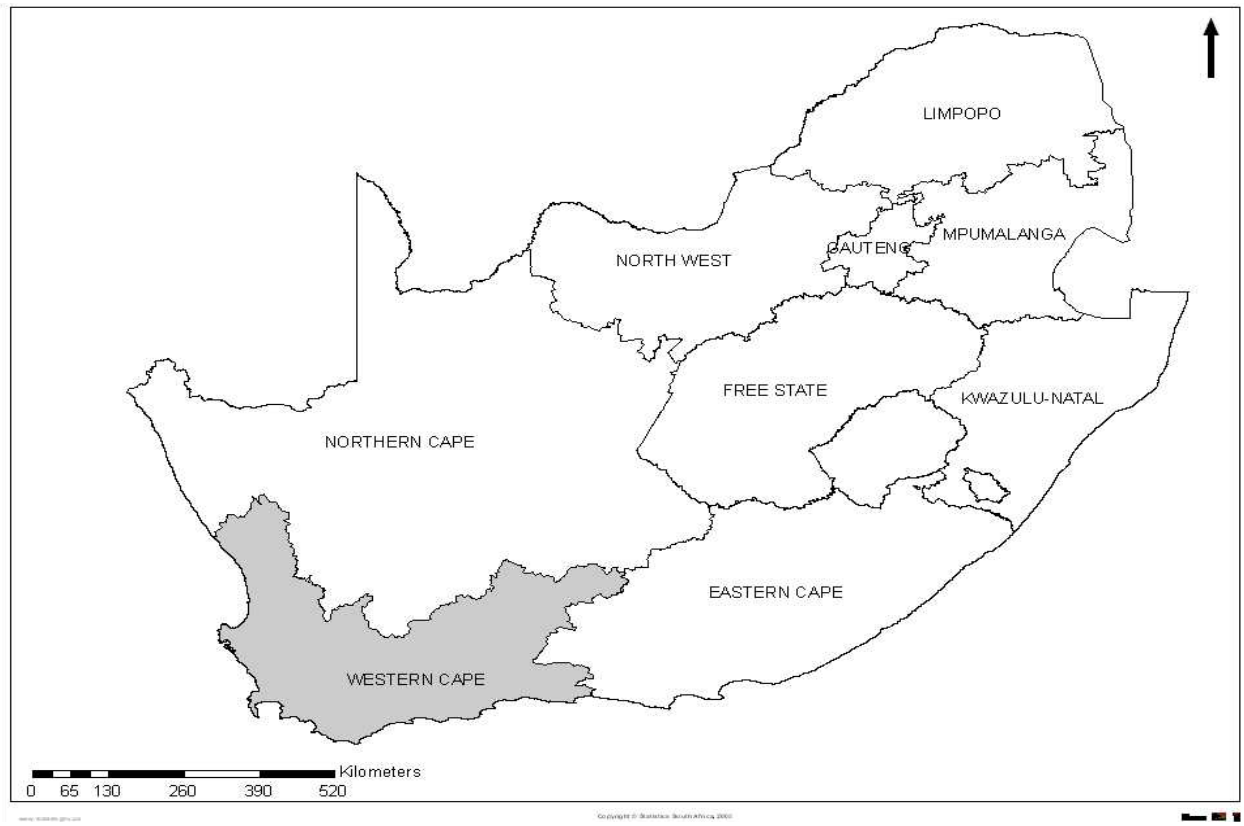

Figure 1. Map depicting the study area (Limpopo Province, South Africa), excluding the districts.
Source: http://geoinfo.statssa.gov.za

Table 1. Districts and local municipalities included in this study.

Capricorn district	Sekhukhune district	Waterberg district
Aganang	Elias Motsoaledi	Bela Bela
Blouberg	Fetakgomo	Lephalale
Lepelle-Nkumpi	Groblersdal	Modimolle
Molemole	Makhuduthamaga	Mogalakwena
Polokwane	Marble Hall	Mookgophong
-	Tubatse	Thabazimbi

an inability to complete coitus due to a gradual loss of tumescence and a decreased libido. This study recorded 12 plant species (12 families), which was used by the interviewees in the treatment of ED (Table 2). Only three species, *Hypoxis obtusa* (2), *Ozoroa sphaerocarpa* (2) and *Zanthoxylum humile* (6) were used more than once. Majority of the species featured as single extracts, and just three multi extracts were noted; with *Z. humile*, the most prominent species (67%) among the multi extract preparations.

Traditional healers from 12 (71%) of the 17 municipalities indicated that they treated ED (Table 3). There was a definite selection for underground parts, with only two occasions where the bark (*O. sphaerocarpa*), and the entire plant (*Myrothamnus flabellifolius*) were used. Most of the traditional healers preferred to use pounded material (65%), which was then either dissolved in a cup of hot water or mixed with soft porridge prior to oral consumption. In the Tubatse and Marble Hall municipalities (Sekhukune district), the pounded material was consumed with Mageu, a locally well-known non-dairy, non-alcoholic energy beverage prepared from *Zea mays* L. In the Fetakgomo municipality, pounded material was added to a cup of warm water and administered rectally, using a bulb syringe. The oral administration procedure was consistent throughout; one tin cup (± 340

Table 2. Diversity and usage frequency of species employed in the treatment of erectile dysfunction.

Scientific name and family	Frequency	
	Single extract	Multi extract with
Ammocharis coranica (Ker Gawl.) Herb. Amaryllidaceae	1	-
Artemesia annua L. Asteraceae	1	-
Asclepias fruticosa L. Apocynaceae	1	-
Carica papaya L. Caricaceae	1	-
Eucomis pallidiflora Baker Hyacinthaceae	0	*Hypoxis obtusa*
Hypoxis obtusa Burch. ex Ker Gawl. Hypoxidaceae	1	-
Myrothamnus flabellifolius Welw. Myrothamnaceae	1	*Zanthoxylum humile*
Osyris lanceolata Hochst. & Steud. Santalaceae	1	-
Ozoroa sphaerocarpa R.Fern. & A. Fern. Anacardiaceae	2	-
Prunus persica (L.) Batsch var. *persica* Rosaceae	1	-
Securidaca longepedunculata Fresen. var. *longepedunculata* Polygalaceae	0	*Zanthoxylum humile*
Zanthoxylum humile (E.A.Bruce) P.G.Waterman Rutaceae	4	-

ml) consumed three times per day for a period of one week.

Slightly more than a third (35%, n=5) cooked their plant material. Most of them (n=4) using a cooking time of 20 min; followed by a single healer favouring 10 min.

DISCUSSION

Ethnopharmacology follows a utilitarian approach focussing on the experimental investigation and validation of species with potential medicinal value (Balick and Cox, 1996). According to Etkin and Elisabetsky (2005), the broad perspective is to contextualize ecology and address the perception of plants; their utilization, pharmacology and physiology in human communities. Currently, the human-plant interface, incorporating the pharmacological basis of plant constituent interactions, compliments this view. An important indicator regarding the medicinal value of the species, preceding the utilitarian investigation into its medicinal significance, relates to their traditional application. The South African floral diversity makes it virtually impossible to test the bio-active profile of all species, hence the trend to follow-up on traditional usage.

The clinical definition of ED focus on the inability to attain an erection or when it is attained, to last long enough to successfully complete coitus. Among the Bapedi traditional healers, these concepts were well understood and applied in their practices. Their symptomatic diagnosis include: (i) a lack of sexual desire, which can easily represent an inability to attain an erection and (ii) an inability to have coitus for an extended time. In the latter, even with the consideration that “extended time” is difficult to pin point, it is evident that the male partner either reaches orgasm too soon or that he becomes flaccid before reaching an orgasm.

The fact that not all traditional healers use herbal remedies to treat ED was unexpected. Within the socio-cultural confines, where virility and sexual prowess is highly valued, a possible explanation might be that males feel incapacitated, and therefore only a limited number of those affected consult, leading to an underutilisation of traditional healers.

This study found that Bapedi traditional healers used 12 species to treat ED. A number of these species, or at best some genera from the current study, are known for medicinal uses other than for the treatment of ED. Among the Swazi people (Swaziland), bark from *Amorpha fruticosa* is used to treat asthma (Amusan et al., 2007). The Vha-Venda use *O. lanceolata* to treat sexually transmitted diseases (STDs) and infertility (Mulaudzi et al., 2011). Prozesky et al. (2001) indicated the use of *Ozoroa* species (*Ozoroa engleri* R.A. Fernandes) in the treatment of STDs. However, after a comprehensive literature search, this study was unable to find information regarding the use of the following species in the treatment of ED; *Ammocharis coranica*, *A. fruticosa*, *Artemisia annua*, *Carica papaya*, *Eucomis pallidiflora*, *Holospora obtusa*, *M. flabellifolius*, *O. sphaerocarpa*, *Prunus persica* var. *persica* and *Z. humile*. To the best of our knowledge, this is a first report describing their species-specific use in the treatment of impotence. However, a recent study (Van Andel et al., 2012) did indicate the use of the genus *Zanthoxylum* as an aphrodisiac. A number of these species had limited use among the healers interviewed, as most of them were used in a single municipality (Table 2). This seemingly insignificant application of a species should be approached with caution, as it cannot be discarded in the light of its perceived limited usefulness. As a matter of fact to comprehend the value of such a species, it is important to understand that thousands of people reside in those municipalities and many of them might be using

Table 3. District and municipality distribution of species used to treat erectile dysfunction; including extract preparation and administration.

District	Municipality	Species and part used	Preparation	Administration
Capricorn	Aganang	*Carica papaya* (root) *Prunus persica* (root)	Pounded material	Five teaspoons of material taken with soft porridge.
	Blouberg	*Securidaca longependuculata* (root) and *Zanthoxylem humile* (root)	Pounded material	Five teaspoons of material, from each species, taken with soft porridge.
	Lepelle-Nkumpi	*Myrothamnus flabellifolius* (root) and *Zanthoxylem humile* (root)	Pounded material	Five teaspoons in a cup of warm water.
		Osyris lanceolata (root)	A piece of root cooked for 20 min	-
	Molemole	*Zanthoxylem humile* (root)	Pounded	Five teaspoons in a cup of warm water.
Sekhukhune	Fetakgomo	*Eucomis pallidiflora* (bulb) and *Hypoxis obtusa* (tuber)	Pounded	Equal amounts added to one cup of warm water and taken rectally with a bulb syringe.
		Zanthoxylem humile (root)		Pounded material taken with soft porridge.
	Makhuduthamaga	*Ozoroa sphaerocarpa* (bark)	Pounded	Pounded material taken with soft porridge.
	Marble Hall	*Myrothamnus flabellifolius* (entire plant)	Pounded	Five teaspoons of material in a bowl of Mageu.
		Hypoxis obtusa (tuber)	A piece of tuber is cooked for 20 min	-
	Tubatse	*Zanthoxylem humile* (root)	Pounded	Four teaspoons in a cup of Mageu.
Waterberg	Bela Bela	*Ammocharis coranica* (fleshy tuber)	A piece of tuber is cooked for 10 min	-
	Lephalale	*1. Asclepias fruticosa* (root)	A piece of root is cooked for 20 min	-
	Modimolle	*1. Zanthoxylem humile* (root)	Pounded	Five teaspoons of material taken with soft porridge.
	Mogalakwena	*1. Artemesia annua* (root) *2. Ozoroa sphaerocarpa* (root)	In both cases a piece of root is cooked for 20 min	-

these aphrodisiacs to improve their sexual performance. Therefore, comparing the value of a medicinal species to the number of healers using it, this might be a short-sighted and sub-optimal approach.

In this study, only a few number of the species had scientific support for their use as sexual performance enhancers. In the case of *S. longepedunculata*, species-specific proof was found of its possible value in the treatment of impotence. Two studies investigated this species and concluded that it active compounds causes smooth muscle relaxation in the corpora cavernosum (Meyer et al., 2008; Rakuambo et al., 2006). Rakuambo et al. (2006) reported its use among the Vha-Venda as a general remedy to treat various disorders, including ED. However, its use by the Bapedi is not as extensive and is restricted to the Blouberg municipality (Capricorn district), a geographical area in close proximity to Venda, which might explain this specific usage pattern. *In vitro* studies by Rakuambo et al. (2006) and Meyer et al. (2008) confirm the potential of this species in the treatment of ED, subsequently validating its use by the Bapedi and Vha-Venda.

Evidence supporting the use of *O. lanceolata* by South African ethnic groups to treat ED, could not be located. However, this cannot be considered a first description, as Muthee et al. (2011) indicated its use to treat ED in Kenya.

The sexual performance enhancing properties of two other more frequently used species, *Z. humile* and *H. obtusa* could not be validated, but other species from these genera had reported pharmacological value in the treatment of ED. This is a first report of *Z. humile* being used to treat ED; however, roots of *Z. capense* are used by the Zulu to treat ED (Corrigan et al., 2011). This observation reflects positively on the potential value of *Z. humile* in the treatment of ED. Furthermore, combining this species with *S. longepedunculata* in the Blouberg municipality, highlights the fact that ethnic groups, such as the Bapedi and Vha-Venda, residing in close proximity to one another, often employ similar species or combinations, as distribution and availability of species are relevant predictors of usage. This is significant when it is considered that *Z. humile* has a very limited distribution (Germishuizen and Meyer, 2003).

The report by Drewes et al. (2008) shed light on the use of *Hypoxis* species, however, within the context of their study, it can be accepted that specific reference was made to the use of *H. hemerocallidea*, and not *H. obtusa*. Therefore, this study seems to be a first species-specific report of the therapeutic application of *H. obtusa* in the treatment of ED.

In this study ED was almost exclusively treated using underground parts such as bulbs, tubers and roots. The most feasible explanation for this is the cultural belief that the underground parts, due to their close contact with the soil, contain the highest concentration of bio-active compounds. The nearly exclusive use of *O. sphaerocarpa* bark, instead of the expected use of its root, needs further investigation. Rankoana (2000), however, reported that the bark of this species is used by the Bapedi to treat gall-sickness among cattle. Thus it would seem that among the Bapedi there is a propensity for the use of bark from this species. The exclusive use of *Ozoroa* (*O. engleri*) bark is also reported by Mabogo (1990) for the Vha-Venda, where it is used as a remedy for STDs.

When herbal remedies are used, the dosage form, as well as the method of preparation and administration is very important (Steenkamp, 2003), as it will determine bio-availability. This availability is dependent on geographical distribution patterns (Van Wyk and Albrecht, 2008), which supports findings from this study where no trends of consistency within and among municipalities was recorded. Arnold and Gulumian (1984) reported that the Vha-Venda prefer to prepare a decoction of the plant part in the form of a soft porridge. Similarly, evidence of this practice was noted among Bapedi traditional healers who mixed pounded plant material with soft porridge. In some cases, Mageu was used to substitute the soft porridge. The use of Mageu in only two of the municipalities, coincidentally from the same district, is a custom that is currently difficult to explain as this beverage is provincially readily available. It is therefore, reasonable to argue that the use of Mageu, is not necessarily based on its availability, but rather on its other advantages. Its unique sour taste can easily mask the taste of plant material, and similar to the use of soft porridge it can delay the absorption of bio-active compounds in the digestive tract, thereby prolonging the bio-availability of compounds. With the exception of the multi-extract preparation involving *E. pallidiflora* and *H. obtusa,* which is administered as an enema, all other administrations in this study were done orally.

A thorough literature search could not reflect on the presence of PDE inhibitors in majority of species being used by Bapedi to treat ED. However, *S. longepedunculata* has been linked to smooth muscle relaxation. Meyer et al. (2008) noted that an isolated xanthone from this species stimulated smooth muscle relaxation in the corpus cavernosa in a frequency dependent manner. Vasodilation of blood vessels results in engorgement of the corpus cavernosa, leading to an erection.

Although not species-specific, the genus *Zanthoxylum* was noted to exhibit cAMP PDEI activity (Borges et al., 2005). The unique Bapedi custom to combine *S. longepedunculata* and *Z. humile* allude to a possible synergistic action between these two species. This warrants further investigation.

Results from this study confirm that, among the Bapedi, plant resources are widely used to treat ED. The absence of a definite usage pattern, excluding *Z. humile*, among the municipalities and districts reveals that the Bapedi does not have a universal species used to treat impotence. The relative, yet not overwhelming, consistent use of *Z. humile* warrants further investigation. Similarly, 10 new species records have been disclosed, and can be important leading to the discovery of natural products with PDE5 activity, and thus the ability to compete effectively against designer drugs.

This study has a number of invariant limitations. These include: (i) sample size and (ii) data collection was limited to three of the five districts, even though these districts represent the vast majority of Bapedi in the Limpopo province, South Africa.

In conclusion, certainty exists regarding the degree to which the Bapedi definition of ED corresponds to its clinical definition. A wide range of species and applications are employed to treat this debilitating male reproductive disorder.

Conflict of Interest

Authors declare no conflict of interest.

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