

Kniphofia crassifolia Baker: A Critically Endangered medicinal plant used in the Soutpansberg, Vhembe Biosphere Reserve, Limpopo Province, South Africa

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Abstract

Literature studies suggest the possibilities that *Kniphofia crassifolia* might have gone extinct in some areas across the Limpopo Province, South Africa. However, the species is still extant in the Soutpansburg area of the Limpopo Province. Traditional healers within the region have been using *K. crassifolia* as phytomedicine for various male reproductive related ailments for ages. The present study was, therefore, aimed at documenting phytomedicinal uses of *K. crassifolia* by the traditional healers for treating male reproductive related ailments across the Soutpansberg area of the Vhembe Biosphere Reserve in Limpopo Province, South Africa. Data about phytomedicinal uses of the target plant species were collected using triangulation research methods, including interviewing 123 traditional healers using semi-structured questionnaires. The total of four phytomedicinal uses associated with *K. crassifolia* were recorded, including being utilized as a cure for orchitis (34.1%), hydrocele (infants and adult) (24.4%), varicocele (24.4%) and erectile dysfunctionality (17.1%). Three of the four recorded ailments were firstly recorded in the present study and they have never been reported elsewhere. To the best of our knowledge, no study has articulated the phytomedicinal uses of *K. crassifolia* before, in South Africa and elsewhere. Although traditional collection of phytomedicinal materials involved conservation cautions, this study argued that over-harvesting of *K. crassifolia* could exert its extinction pressure. So far, there is no evidence of published literature about active biological compounds that the target plant species may possess. Therefore, further studies on phytochemical and pharmacological evaluation of *K. crassifolia* need to be done.

Keywords: Phytomedicinal species, *Kniphofia crassifolia*, Male-reproductive related ailments, Soutpansberg, Traditional healers, Vhembe Biosphere Reserve.

INTRODUCTION

Plant species are considered an essential source of both traditional and synthetic medicines [1]. The history of using plant species as phytomedicines has existed since time immemorial [2–8]. Phytomedicines have been the fundamental source of drug discovery and synthesis since human civilization [9]. More than 80% of the global population use phytomedicines for preventing and combating assorted ailments [10–12]. Underprivileged people, especially in the third world countries consider the use of phytomedicines as an alternative to access an affordable primary health care system [13]. Nowadays, phytomedicines are considered to be a fundamental therapeutic agent [14]. The therapeutic dominance of phytomedicines was enhanced due to their reliability in combating assorted ailments, inability to cause side-effects and cost-effectiveness [15]. It is evident that phytomedicines play a significant role in treating a range of various communicable and non-communicable diseases, including reproductive related ailments in male patients across the remote areas of South Africa [16]. It is evident that most of the patients, within some remote areas in Southern African region, particularly males diagnosed with symptoms of reproductive related infections, heavily depends on phytomedicine prepared by traditional healers for their therapeutics [17]. Prasad *et al.* [18], articulated that indigenous communities in remote areas worldwide

have been using phytomedicines for handling, combating and preventing reproductive related infections for ages, whereas, Semenya *et al.* [19], argued that the variety of reproductive related ailments, including those that infects males only, are better treated using phytomedicines. Literature studies show that rural communities across the globe still use phytomedicines, prescribed by traditional healers for therapeutic against an assortment of reproductive ailments, including male related diseases [20–22]. The majority of male patients across South Africa, especially those having symptoms of reproductive related infections, usually consults traditional healers for therapeutics [23].

Traditional knowledge about phytomedicinal collections includes conservation cautions [24], however, commercialization of this precious knowledge could enhance the livelihood, with confined existence of highly demanded plant species [25]. Thus, according to Tsobou *et al.* [26], deforestation, environmental degradation and over-grazing are known to threaten the phytomedicinal diversity across the African continent, whereas, Ramarumo *et al.* [27], stated that over-harvesting, habitat destruction and development of human settlement triggers the rate of phytomedicinal species extinction across South Africa. Some of the phytomedicinal used species are threatened with the chance to go extinct [28], including *Kniphofia crassifolia* Baker. *Kniphofia crassifolia* is a

monocotyledonous plant belonging to genus *Kniphofia* Moench (Asphodelaceae family) [29]. Genus *Kniphofia* contains 71 species and it has an African-Malagasy with sixty-eight species found in mainland Africa, two in Madagascar and the remaining one in Yemen [30]. A total of 48 species within this genus are endemic to southern Africa including *K. crassifolia* [29–30]. *Kniphofia crassifolia* is known to have a small distribution range restricted to the Limpopo highlands of Limpopo Province, South Africa [31–32]. Raimondo *et al.* [33], assessed the conservation status of *K. crassifolia* using the Red List Categories and Criteria, version 3.1 of the IUCN and categorized it as Critical Endangered plant species. The literature studies suggest the possibilities that *K. crassifolia* might have gone extinct in some areas across the Limpopo Province [32,34]. However, *K. crassifolia* is still extant in the Soutpansberg Region of the Vhembe Biosphere Reserve, in Limpopo Province, South Africa. Traditional healers across the Soutpansberg area in the Vhembe Biosphere Reserve have been using *K. crassifolia* parts as phytomedicines for various male reproductive related ailments. However, much of this important knowledge is rooted within the elderly people. Furthermore, this wealth of knowledge is only transmitted orally from generation to generation and it has never been documented before. The present study was, therefore, aimed at documenting the phytomedicinal uses of *K. crassifolia* by the traditional healers for treating male reproductive related ailments across the Soutpansberg area of the Vhembe Biosphere Reserve in the Limpopo Province, South Africa. This study is not only significant for the preservation of traditional health knowledge within the studied sites, but it could also aid with the provision of baseline data needed for evaluating phytochemical and pharmacological properties of *K. crassifolia* which might lead to certain drugs discovery and synthesis.

MATERIALS AND METHODS

Study areas

The study was conducted in 22 remote villages across the Soutpansberg-East area, Vhembe Biosphere Reserve, Limpopo Province, South Africa (Fig. 1 and Table 1). The study sites incorporate the combined total surface area of roughly 83.17 km², with the population size of about 70 914 people living within the area [35] and its elevation ranges from 800 to 1900 meters above the sea level. More than 97.24% of dwellers within the studied areas are the Vhavenda ethnic population group who also speaks Tshivenda as their innate language [35]. The study site, therefore, incorporates 9 villages in the eastern part of the Makhado Local Municipality and 13 villages within the western region of the Thulamela Local Municipality (Fig. 1 and Table 1). The economic status of the studied sites is of poor economic reform, with many dwellers practicing subsistence farming [36]. Therefore, the majority of participants across the study areas depend upon government grants and herbal healings, with an estimated monthly income range from 120 to 240 US \$ (Fig. 2). Generally, the vegetation cover of the studied sites is classified as Soutpansberg Mountain Bushveld with some

few patches of the Afromantane Forest (Thathe Vondo Holy Forest and Makwile Rain Forest), and some grasslands patches within [37]. The region is climatically described by its precipitations and temperatures, averaged from 300 mm in cold-dry winter (April until September) and 820 mm during warm-wet summer seasons (October until March) [38], whereas, the average annual temperature range from a minimal of 20°C (winter season) and the maximum being 30°C (summer season) [39]. The geological and topographic features of the area incorporate Wylies Poort geological formation of the Soutpansberg Group, Bushveld Igneas complexity, Limpopo Belt Archaean Cratons, Karoo systems and the Kalahari Cratons [40–41].

Sampling methods

Having conducted various ethnobotanical studies in the Soutpansberg area before, information about phytomedicinal uses of *K. crassifolia* for the treatment of male reproductive related ailments was firstly gathered by chance, from 13 randomly sampled specialist traditional healers. Since it was difficult to recruit more traditional healers who shared the same knowledge of specialization, an Exponential Non-Discriminative Snowball sampling method was then employed. An Exponential Non-Discriminative Snowball is defined as a research sampling method in which all participants are afforded an opportunity to suggest potential recruits whom they share similar knowledge of specialization with [42]. The snowball sampling method was essential and holistically used in the present study for accessing the dispersed and scant group of traditional healers [43–44], who shared the same knowledge of specialization, particularly, traditional knowledge about male reproductive health care.

Data about the phytomedicinal uses of *K. crassifolia* in the treatment of male-reproductive related ailments was gathered over a period of four months in 2019 (March until June 2019). A total number of 123 specialist traditional healers were recruited and interviewed individually, using semi-structured questionnaires. Therefore, all the interviews were conducted in Tshivenda language, better understood by all the healers and also to ensure confidence among the recruits, since it is generally understood that traditional healers are reserved when it comes to, publicly sharing their medicinal knowledge [45]. To intensify the authenticity and precision of the given answers during the interviews, same questionnaires were administered to all the study recruits at the individual level. Among the recruited healers, there were 89 males (72.4%) and 34 females (27.6%), aged from 41 to 93 years old (Fig. 2). Prior to the commencement of the sampling survey, aim of this study was clearly explained to all the recruits during the pilot survey and therefore, specialist traditional healers who were willing to take part in the present study, signed the informed consent letter endorsed by the University of Fort Hare's Research Ethics Committee (Reference no. MAR031SRAM01). In the informed consent letter, all recruits were assured that their participation in the present study remains voluntary, their information will be utilized for research purpose only and

they are allowed to quit participating at any time they wish to do so, and there will be no consequences for their acquittals.

Specimen collection and data analysis

Gathered information was then supplemented by a guided field excursion-survey together with the respective recruits who knows well the target plant species and its location for identification and specimen collection purpose. Prior to the commencement of a field excursion-survey with the traditional healers, a permit (Reference number: ZA/LP/92932) for the voucher specimen collection was issued by the Limpopo Department of Economic Development, Environment and Tourism (LEDET). During the field excursion-survey, traditional healers identified the target plant species using its vernacular name "Lurumbulathundelo or Lurumbulavhunna" (Personal communication with the traditional healers). Sample specimen was then collected, prepared, assigned the voucher code number (RAMLJ 028) and deposited in Botany Herbarium of the University of Venda for further taxonomic examination.

Data analysis was performed using descriptive statistical tool endorsed by Ramarumo *et al.* [45]. Therefore, this includes frequency of occurrence and fidelity level percentage (FL%). Fidelity level (%), was determined using the formula: $[FL (\%) = N_p / N \times 100]$ adopted, from Umair *et al.* [46] and Al-Qura'n [47]. Therefore, since all the traditional healers have mentioned the phytomedicinal uses of *K. crassifolia*, then N_p represent the number of traditional healers who mentioned the certain uses of the plant species, whereas, N , delineates the total number ($n=123$) of traditional healers who mentioned all uses of the plant species.

RESULTS AND DISCUSSION

Table 2 describes the phytomedicinal uses of *K. crassifolia* by the traditional healers for treating male reproductive related ailments within the studied sites. The results of this study revealed that traditional healers within the studied region have been using *K. crassifolia* as the main phytomedicine for assorted male reproductive related infections, including treating orchitis (34.1%), hydrocele (infants and adult) (24.4%), varicocele (24.4%) and erectile dysfunctionality (17.1%) (Table 2). Although, this

study lacks the evaluation of *K. crassifolia*'s pharmacodynamics, the multiple usage of the plant species by the traditional healers across the studied region proves its pharmacological abilities, reliabilities and potential [48–50]. Traditional healers seemed to be combining *K. crassifolia* with other herbal remedies for treating erectile dysfunctionality (Table 2). This demonstrates their pharmacodynamics skill, understanding and wealth of knowledge possessed among them. Nejatbakhsh *et al.* [51], argued that ailments such as erectile dysfunctionality, lack of sexual desire and deficient sperm counts, are better treated using combined herbal remedies, whereas, Mncwangia *et al.* [52], stated that the preparation of any herbal medicine using raw materials of either combined individuals of species or parts, involves knowledge and understanding of their chemical compositions. According to Wang *et al.* [53], the combination of herbal remedies increased with an increase on its therapeutic efficacy and pharmacological activities. The traditional healers of the studied region articulated that, mostly the therapeutic mechanism used for the administration of *K. crassifolia* to patients, is done orally and through bloodstream injection (Table 2). Moreover, oral administration of herbal medicines is considered common practice to many countries worldwide [54–56]. Literature studies suggested that phytomedicines for varying ailments differs in terms of preparation techniques, parts used and mechanisms of administration [57–60]. However, the results in the present study do not concur with the literature, since there is consistent with regards to the preparation techniques of the therapeutic recipe and administration mechanisms used by local healers against hydrocele and varicocele ailments (Table 2). Traditional healers stated that, usually phytomedicines for ailments with similar symptoms are similarly prepared and administered (personal communication with the traditional healers). Thus, it has been argued that ailments such as hydrocele and varicocele shares some similar symptoms and therefore, the visible symptoms among these ailments includes, swelling of the penis and testicles [61–63]. Therefore, this could possibly be caused due to poor blood supply into the penis and testicles through the blocked veins [64].

Table 1: Surveyed villages' coordinates of location

Makhado Local Municipality				
Surveyed villages	Latitudes		Longitudes	
	From	To	From	To
Ha-Maelula village	– 22° 57' 1.709" S	– 22° 59' 28.504" S	30° 6' 47.574" E	30° 8' 42.842" E
Mapate village	–22° 58' 40.832" S	–22° 58' 51.168" S	30° 20' 51.81" E	30° 20' 9.306" E
Matshavhawe village	– 22° 58' 20.316" S	– 22° 59' 8.581" S	30° 5' 37.021" E	30° 6' 59.327" E
Muruṅwa village	–22° 58' 26.555" S	– 22° 59' 11.558" S	30° 9' 25.595" E	30° 10' 11.211" E
Phadzima village	– 22° 56' 7.055" S	– 22° 57' 2.423" S	30° 10' 22.09" E	30° 11' 57.678" E
Tshakhuma village	– 23° 2' 15.41" S	– 23° 2' 46.291" S	30° 17' 20.115" E	30° 18' 35.46" E
Tshedza village	–22° 58' 6.193" S	– 22° 58' 30.878" S	30° 10' 36.004" E	30° 11' 39.857"E
Tshiṅavha village	– 22° 57' 39.834" S	– 22° 57' 42.181" S	30° 10' 55.92" E	30° 12' 23.813" E
Vuvha village	– 22° 59' 25.386" S	– 22° 59' 40.733" S	30° 11' 26.368" E	30° 12' 54.223" E

Thulamela Local Municipality				
Surveyed villages	Latitudes		Longitudes	
	From	To	From	To
Dopeni village	-22° 54' 59.054" S	-22° 55' 44.598" S	30° 11' 52.594" E	30° 12' 42.029" E
Fondwe village	-22° 54' 53.536" S	-22° 55' 45.368" S	30° 15' 37.404" E	30° 16' 40.076" E
Mandala village	-22° 54' 53.366" S	-22° 55' 5.488" S	30° 13' 46.178" E	30° 15' 19.166" E
Maranzhe village	-22° 55' 12.306" S	-22° 55' 44.407" S	30° 21' 50.85" E	30° 22' 59.016" E
Mukumbani village	-22° 54' 1.256" S	-22° 54' 3.676" S	30° 24' 14.004" E	30° 25' 23.008" E
Mulume village	-22° 51' 27.774" S	-22° 51' 38.304" S	30° 19' 20.402" E	30° 19' 31.591" E
Phiphidi village	-22° 57' 18.144" S	-22° 57' 22.306" S	30° 22' 43.496" E	30° 24' 55.558" E
Shanzha village	-22° 55' 56.73" S	-22° 56' 22.6" S	30° 11' 40.171" E	30° 12' 59.504" E
Tshidzivhe village	-22° 51' 4.727" S	-22° 51' 28.314" S	30° 23' 31.469" E	30° 23' 54.239" E
Tshiheni village	-22° 52' 37.978" S	-22° 52' 55.718" S	30° 15' 10.875" E	30° 16' 20.085" E
Tshikombani village	-22° 52' 55.412" S	-22° 53' 1.126" S	30° 13' 40.972" E	30° 14' 44.62" E
Tshikunda village	-22° 56' 5.359" S	-22° 56' 43.829" S	30° 22' 51.254" E	30° 23' 26.386" E
Tshilungwi village	-22° 50' 51.842" S	-22° 50' 52.937" S	30° 20' 57.364" E	30° 21' 26.308" E

Table 2: Phytomedicinal uses of *K. crassifolia* [Keys: FL (%), Fidelity level percentage; +, Cited in the literature before; -, Not cited in the literature before]

Cured ailments	Part used	Preparation modes	Modes of administration and dosage	FL (%) (n=123)	Citations
Orchitis	Rhizome	A decoction of either fresh or dried rhizome	A cup of decoction is taken orally three-times per day for a period of two months	34.1	-
Hydrocele (Infant and adults)	Rhizome and flowers	Dried chopped pieces of rhizome and flowers are grounded separately. Powders are mixed together to become one and then mixed with the urine of either horse or donkey	Tiny cuts are made around the swollen scrotum using a razor-blade to make blood come-out. Then the medication is administered into the blood stream through the bleeding scrotum once per week, for a period of six weeks	24.4	-
Varicocele	Rhizome and flowers	Dried chopped pieces of rhizome and flowers are grounded separately. Powders are mixed together to become one and then mixed with the urine of either horse or donkey	Tiny cuts are made around the swollen scrotum using a razor-blade to make blood come-out. Then the medication is administered into the blood stream through the bleeding scrotum once per week, for a period of six weeks	24.4	-
Erectile dysfunctionality	Whole plant	A decoction of fresh parts is boiled together with the rhizome of <i>Elephantorrhiza elephantina</i> (Burch.) Skeels, tuber of <i>Hypoxis hemerocallidea</i> Fisch., C.A.Mey. & Avé-Lall., <i>Rhoicissus tridentate</i> (L.f.) Wild & R.B.Drumm., fresh chopped unripe fruits of <i>Kigelia africana</i> (Lam.) Benth. and either fresh root of <i>Securidaca longependunculata</i> Fresen. var. <i>longependunculata</i> or <i>Polygala virgata</i> Thunb. var. <i>decora</i> (Sond.) Harv.	A cup of decoction is taken orally once per day (in the evening), for a period of 28 days.	17.1	+ (65-67)

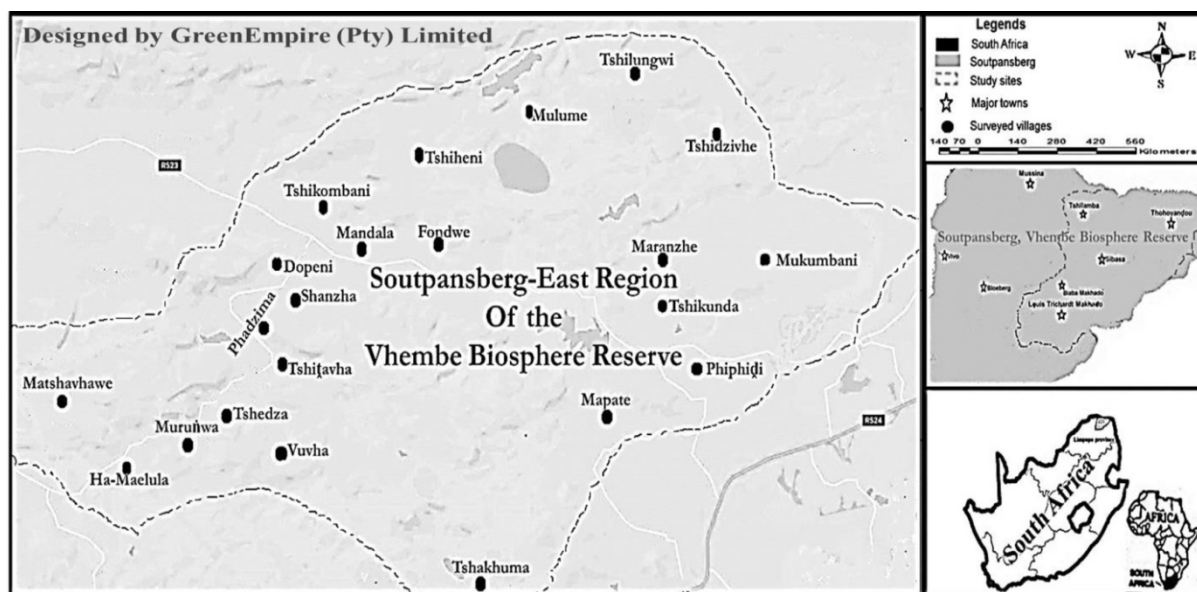


Figure 1: Locality map of the study areas

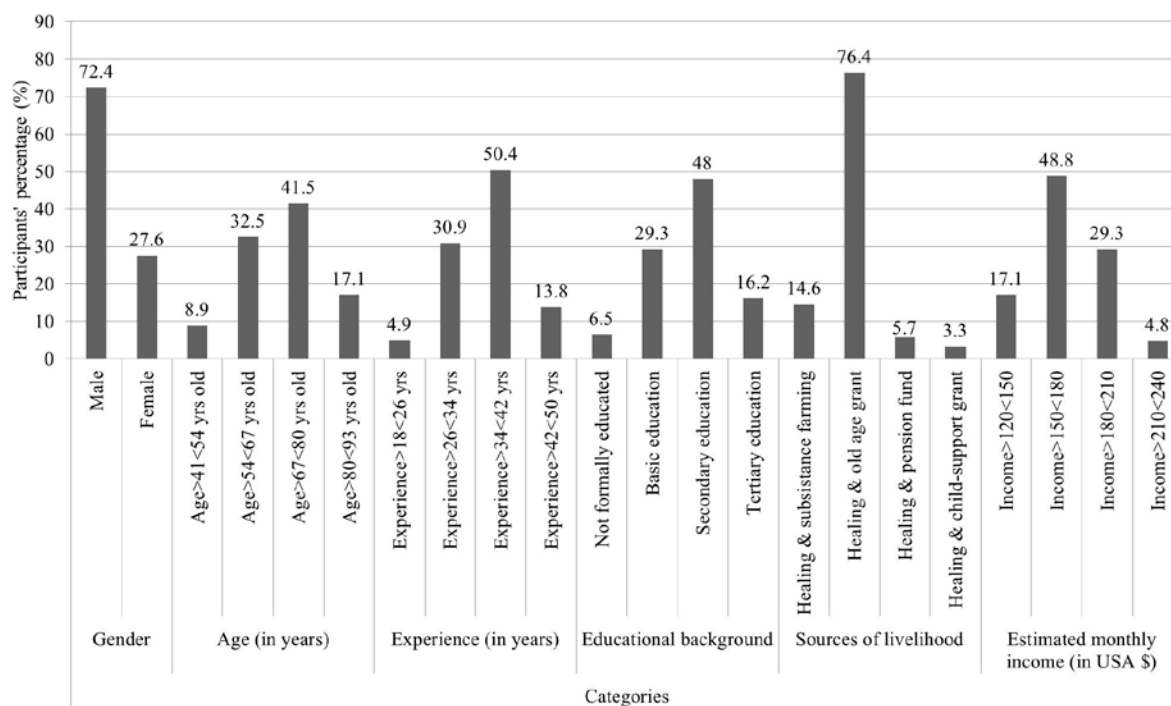


Figure 2: Participants' demographic details

CONCLUSIONS

Traditional healers across the studied sites considered phytomedicinal uses of *K. crassifolia* as part of their inherent socio-cultural and socio-ecological transformation. From the best of our knowledge, the phytomedicinal uses of *K. crassifolia* were firstly reported in the present study and therefore, no study of this nature has been done before elsewhere. Four reproductive related infections associated with males were recorded in the present study. There is no evidence of available data about phytochemical and pharmacological activities of the target plant species. Therefore, further studies on phytochemical and pharmacological evaluation of *K. crassifolia* need to

be done. Although traditional collection of phytomedicinal materials by traditional healers involved conservation cautions, this study argued that over-harvesting of *K. crassifolia* could exert its extinction pressure. Moreover, *K. crassifolia* is a Critical Endangered plant species with the possibilities to become extinct, therefore, less has been done regarding its population structure. The current study, therefore, calls for an evaluation of its population structure in the entire Limpopo Province.

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