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The impact of traditional medicine use and trade on *Euphorbia bupleurifolia* populations

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ABSTRACT

Euphorbia bupleurifolia is a slow-growing dwarf succulent used for its medicinal properties by the Zulu and Xhosa people of South Africa. The latex reportedly cures several skin ailments, and it has been observed in traditional medicine (*muthi*) markets in KwaZulu-Natal and the Eastern Cape. To assess the impact of traditional medicine use and trade on *E. bupleurifolia* and gain insight into its demand and availability, surveys were conducted with traditional health practitioners (THPs) and traders in the KwaZulu-Natal, Eastern Cape, and Gauteng provinces using semi-structured questionnaires. These took place between November 2018 and January 2019. According to the participants (n = 23), an estimated 1721 *E. bupleurifolia* plants were harvested in a year for medicinal use. Approximately 6 % of participants harvested strictly for trade at *muthi* markets. Only 25 % of participants claimed to have noted a decline in wild populations, while 44 % believe the species is still abundant in the wild. However, only four *E. bupleurifolia* plants were encountered at a street market in King Williams Town (Eastern Cape province) while conducting surveys, suggesting that it has indeed become harder to find and hence scarcer in the wild. Common names of 10 other plant species which can be used as alternatives for *E. bupleurifolia* in healing were supplied by THPs, with *uchithibhunga* (*Rhoicissus* spp.) the most frequently cited. The high demand and noted declines in *E. bupleurifolia* in field surveys signifies the need for increased efforts directed at educating stakeholders on sustainable harvesting practices and promoting artificial propagation.

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1. Introduction

Despite the accessibility of western medicine in South Africa, 72 % of the black community still consult with traditional health practitioners (THPs) and use prescribed herbal preparations (Williams et al., 2013; Mothibe and Sibanda, 2019). The use of traditional medicine is still prevalent in many other parts of Africa as well, with many rural communities in Zimbabwe (Maroyi, 2013; Mudonhi et al., 2021), Eswatini (Amusan et al., 2002, 2007), Lesotho (Letsela et al., 2003) and Tanzania (Luoga et al., 2000) still heavily reliant on self-medicating using medicinal plants. South Africans consume more than 70 000 t of traditional medicine (*muthi*) annually, which is comprised of a very large number of plant species (Botha et al. 2001; Williams et al. 2001; Williams et al., 2013). These are traded through an extensive indigenous trade network involving street markets and *muthi* shops throughout South Africa, particularly KwaZulu-Natal (Mander, 1998; Ndawonde et al., 2007), Eastern Cape (Cocks, 1997; Dold and Cocks, 2002), Gauteng (Williams et al., 1997; Williams, 2003), Mpumalanga (Botha et al., 2001), Limpopo (Moeng and Potgieter, 2011; Rasethe et al., 2019) and to a lesser extent the Northern Cape (Monakisi, 2007). Trading in medicinal plants provides a valuable income source for many South African households (Rasethe et al., 2019). Affordability, accessibility, unemployment, and the high cultural value placed on traditional medicines have resulted in the commercial exploitation of economically important medicinal plants by commercial harvesters to obtain income (Cunningham, 1988 in Williams et al., 2000; Mofokeng et al., 2022). This has resulted in overharvesting and in certain instances near extinction of some valued indigenous species, posing a serious threat to biodiversity (Williams et al., 2000; Street and Prinsloo, 2012; Van Wyk and Prinsloo, 2018; Seile et al., 2022). The sustainability of the *muthi* trade is of great concern as much of the material supplied is obtained directly from the wild (Williams et al., 2013; Cousins and Witkowski, 2012, 2017).

Euphorbia bupleurifolia Jacquin. (Euphorbiaceae), largely known as *inkamamasane* (isiZulu) and *insema* (isiXhosa), is a slow-growing, long-lived dwarf succulent endemic to the Eastern Cape and KwaZulu-Natal provinces of South Africa (Manning, 2001; Raimondo et al., 2009; Victor et al., 2016). The genus *Euphorbia* has 172 species

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found in southern Africa, 135 of which are succulent (Bruyns, 2022). Thirty-five *Euphorbia* species have been identified as having medicinal properties, with treatment of gastrointestinal diseases, skin ailments, and infections among the cited medicinal uses (Mavundza et al., 2022). The uses of certain *Euphorbia* species by the Bapedi (Semenya and Maroyi, 2018), Zulu (Sobiecki, 2002; Corrigan et al., 2011) and Xhosa (Dold and Cocks, 2002; Bisi-Johnson et al., 2010; Rankoana, 2012) people of South Africa have been widely documented in literature. The latex from *E. bupleurifolia*, applied topically, has been reported to treat cancerous sores, cracked skin on the feet, swelling of the lower limbs and many other skin diseases (Schwartz and LaFon, 1984; Hutchings, 1996). The latex from this species is also used to induce vomiting and as a laxative (Smith, 1895). While *Euphorbia* species are widely known for their medicinal properties globally, relatively little research efforts have been directed at assessing the medicinal trade in this genus, particularly the succulent euphorbias.

Euphorbia bupleurifolia is harvested extensively in the western parts of its range to supply the traditional medicine trade, which is considered to be unsustainable (Victor et al., 2016). However, until recently (April 2024) it was still classified as Least Concern due to the perception that it was still common and widespread (Victor et al., 2016). Many plant species traded at *muthi* markets were already showing signs of unsustainable harvesting in the late 1990s (Mander, 1998). For example, numerous species of bulbs displayed in the markets were becoming progressively smaller in diameter, strongly suggesting that the larger individuals had already been removed from the populations, and that only smaller ones remained in the wild (Williams et al., 2007a). Similar trends could be occurring with smaller succulent species, such as *E. bupleurifolia*. A recent study suggested that *E. bupleurifolia* may have been eradicated from over 70 % of its historical range (Mhlongo et al., 2023). Although this decline could be attributed to various factors, particularly harvest to supply international trade (Mhlongo, 2020), the negative impacts of traditional medicine use and trade on this species should not be underestimated.

The use and trade of plants has become part of the formal and informal entrepreneurial sectors of the South African economy and is no longer restricted to just THPs (Dold and Cocks, 2002; Van Wyk et al., 2009). However, estimating quantities of any species traded in traditional medicine markets remains a huge challenge due to a lack of records in informal markets and the often-illicit nature of this trade (Botha et al., 2004). This study aimed to assess the impact of traditional medicine use and trade on *E. bupleurifolia* by conducting surveys with stakeholders involved in the traditional medicine trade across the Eastern Cape, KwaZulu-Natal, and Gauteng provinces of South Africa. The targeted stakeholders included traditional health practitioners (THPs), such as diviners (*izangoma*) and herbalists (*izinyanga*), as well as traders operating in herbal shops and *muthi* markets. The objectives of the study were to gain insight into the medicinal trade in *E. bupleurifolia* through (1) identifying the reasons stated by participants for harvesting this species, (2) quantifying yearly offtake of this species from wild populations, (3) identifying source areas from which plants are harvested, (4) investigating the harvesting techniques employed by harvesters, (5) assessing the demand and availability in *muthi* markets, (6) confirming the plant parts of *E. bupleurifolia* used in traditional medicine and (7) investigating the use of alternative plant species in traditional medicine.

2. Methods

2.1. Study locations

Interview surveys were conducted in ten municipalities in the Eastern Cape, KwaZulu-Natal, and Gauteng provinces using semi-structured questionnaires. These included the Nelson Mandela Bay Metropolitan Municipality (Uitenhage), Makana Local Municipality (Grahamstown), Buffalo City Metropolitan Municipality (East London, King William's Town), Enoch Mgijima Local Municipality (Queenstown), King Sabata Dalindyebo Local Municipality (Mthatha), eThekwini Municipality (Durban), Msunduzi Local Municipality (Pietermaritzburg), uMshwathi Local Municipality (Dalton), City of Johannesburg Metropolitan Municipality (Johannesburg) and City of Tshwane Metropolitan Municipality (Tshwane) (Fig. 1). Most of these areas were selected due to their proximity to historically recorded populations of *E. bupleurifolia* (Mhlongo et al., 2023; Fig. 1b). The harvest of wild plants to supply the *muthi* trade is a norm amongst dwellers in townships and informal settlements (Petersen, 2014). Thus, larger informal *muthi* markets such as Warwick (Durban), Ezimbuzini (Isiphingo), Mthatha, Faraday (Johannesburg) and Kwa-MaiMai (Johannesburg) were also targeted (Mander, 1998; Williams, 2003; Raimondo et al., 2016; Mbongwa, 2018). *Muthi* shops in the Eastern Cape, KwaZulu-Natal, Johannesburg central business district and Pretoria's Marabastad were also assessed as previous studies by Williams et al. (2001) and Cocks (1997) indicated that large quantities of plants with medicinal properties were sold in these shops. The surveys were conducted from November 2018 – January 2019. Only four *E. bupleurifolia* plants were observed for sale during the three months in which the interviews were conducted, near a taxi rank in King William's Town (Eastern Cape Province) (Fig. 2a). Trade in *E. bupleurifolia* for traditional medicine purposes has been ongoing for many years in this area (Fig. 2b; Dold and Cocks (2001)).

2.1.1. Selection of participants

Traditional health practitioners were identified through information provided by local community members. The term "traditional health practitioner" (THP) is used to identify a group of individuals, including prophets (*abathandazi*), diviners (*izangoma)* and herbalists (*izinyanga*), who perform sacred rituals as a crucial part of their cultural-spiritual medicine practice in which ancestors act as mediators between the healer and a higher power (Washington, 2010; Mokgobi, 2014; Coals et al., 2022). Diviners are "called" by their ancestors and undergo initiation (*ukuthwasa*) and extensive training, where they are guided on how to diagnose and treat illnesses through appropriate medication by their ancestors (Mlisa, 2009). Herbalists, unlike diviners, undergo much less training and do not communicate with ancestors directly for guidance when treating patients but rather rely on the guidance of other skilled THPs, a familial elder (usually male) and dreams and visions on how to prescribe *muthi* (Washington, 2010; Davids et al., 2014; Coals et al., 2022). Prophets are typically known to use blessed water, anointed oil, laying of hands, prayer etc., for healing (Rinne, 2001; van der Torren, 2015; Shilubane, 2019). Similar to Coals et al. (2022), we only interviewed diviners and herbalists, collectively referred to herein as THPs, as they are known to utilize wildlife products. In each area, people were approached at random and asked about THPs operating within the area. The THP's house was then visited, the scope of the project was briefly outlined to them, and permission to conduct interviews was requested. Only THPs who had knowledge of *E. bupleurifolia* were interviewed, similarly with the street traders and *muthi* shop owners. There were potential participants who declined to be interviewed (approximately 30 people), particularly at large busy markets such as Warwick *muthi* market, where all the people approached refused to participate. They in any case claimed not to know the species.

2.1.2. Questionnaire

Information on the traditional uses of *E. bupleurifolia*, including harvest sites, quantities harvested annually, harvesting practices, pricing, as well as demand and availability for traditional purposes was collected and the overall sustainability of use was assessed (Appendix A1). Information was collected by interviewing 23 stakeholders involved in the trade of traditional medicine, which included

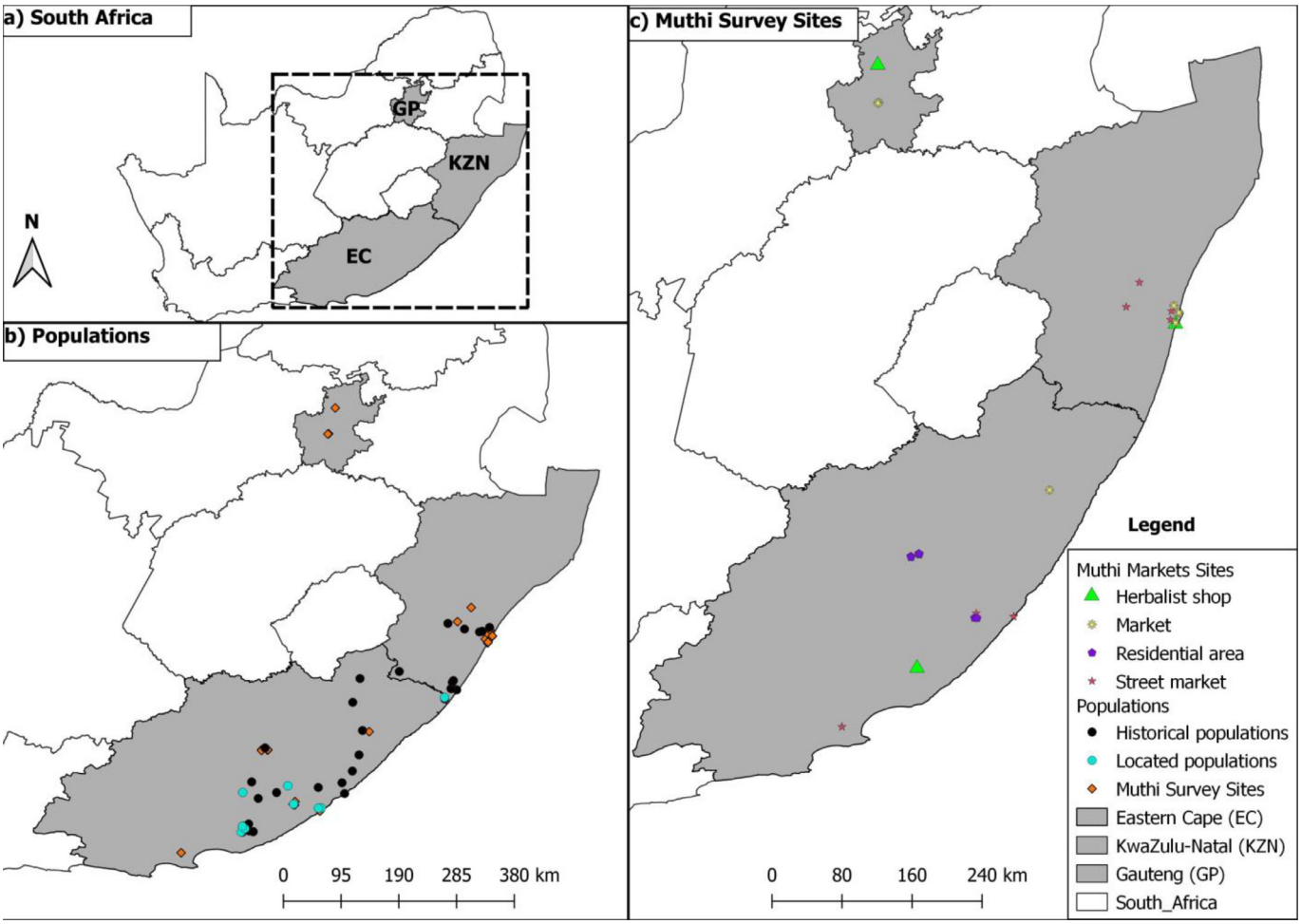

Fig. 1. Map showing historical locations of *Euphorbia bupleurifolia* populations (Eastern Cape and KwaZulu-Natal) and the study areas in the Eastern Cape, KwaZulu-Natal and Gauteng provinces where stakeholders were interviewed.

diviners (56.5 % of participants), herbalists (21.7 % of participants), and traders (21.7 % of participants) (Table 1). For many of the questions, not all the participants provided answers, and hence the number of responses (out of 23) is provided in parentheses for each section.

3. Results

3.1. *Harvesting practices and impacts on populations of* Euphorbia bupleurifolia

Sixteen of the 23 participants were actively involved in the harvest of *E. bupleurifolia*, 50 % of whom indicated that they harvest *E. bupleurifolia* either for their own use and/or to treat patients, while a further 31 % said they also harvest to sell to other THPs/traders in addition to the first two responses. Six percent of the harvesters harvest for the sole purpose of selling to diviners and herbalists (Fig. 3).

Participants were asked to provide an account of the number of *E. bupleurifolia* plants they had seen at each of their harvest sites over a one-year period (December 2017 – November 2018). Approximately 35 % of participants (35.3 %) estimated that there were 100+ plants at their collection sites, while a further 29.4 % thought that there were 50+ plants and three participants said that there were less than 50 plants where they harvest (Fig. 4). Only two harvesters claimed to harvest at sites with more than 500 plants. Furthermore, when asked how many plants they had collected within the same time period, five participants (31.25 %) had collected between 11 and 20 plants, while four (25 %) had collected up to 10 plants (Fig. 4). Three individuals (19 %) claimed to have harvested 100 or more plants each (Fig. 5). Two of these individuals harvest to sell to other THPs and traders. It is estimated that altogether the interviewed harvesters had collected 1721 plants (averaging 132±291(SD) each) (Fig. 5). Forty-four percent of the harvesters stated that the number of plants at their harvest sites were increasing, 25 % said that numbers had not changed, 25 % thought that the plants were decreasing while 6 % did not know.

Eighty-eight percent of the participants (n = 16) indicated that their understanding of sustainable harvesting practices is to only harvest what is needed. One harvester described how they first check the number of plants at the site before harvesting a sensible amount, while another indicated that they harvest everything they can find. To ensure sustainability, 69 % of the participants indicated that they have multiple harvest sites for *E. bupleurifolia* while the remaining 31 % harvest at only one site. Of those with multiple harvest sites, 45.4 % speculated that plants were increasing at their harvest sites.

3.2. *Traditional use and trade of* Euphorbia bupleurifolia

Most of the participants (78 %) (n = 18) stated that the entire plant is used in the treatment of patients, while the remaining



Fig. 2. *Euphorbia bupleurifolia* plants traded in street markets in King William's Town, in the Eastern Cape province, in (a) 2018 and (b) 2003 (circled). Photograph (b) courtesy of Tony Dold.

22 % indicated that the roots are used. One of the participants qualified that latex from any part of the plant can still be used if the root is unavailable. One participant added that sometimes stem cuttings are used.

The estimated average selling price for *E. bupleurifolia* was R15±6 at the time of the surveys (n = 19). Most of the participants (79 %) indicated that the price of the plant is not dependent on plant size, nor is it dependent on the season (according to 84 % of the participants).

Table 1
Demographic information of the traditional health practitioner (THPs) and traders interviewed (n = 23).

		Traditional Health Practitioners		Traders
		Diviners	Herbalists	
Number		13	5	5
Age class	20–29	1	1	1
	30–39	1	2	0
	40–49	5	2	0
	50–59	1	0	3
	60+	5	0	1
Education level	No formal schooling	1	1	0
	Foundation phase	1	0	1
	Intermediate phase	1	0	2
	Senior phase	3	0	0
	FET band (Grade 10 – 12)	5	4	1
	Tertiary level	1	0	0
	Not provided	1	0	1
Gender	Male	8	5	0
	Female	5	5	0
Ethnicity	Xhosa	12	3	1
	Zulu	1	1	4
	Khoisan	0	1	0
Market type	Does not trade	8	1	0
	Muthi shop	2	0	0
	Street market	3	3	0
	Muthi market	0	1	5

Fifty-six percent of the participants (n = 18) indicated that they would be willing to use cultivated plant material for healing while 44 % indicated their unwillingness, citing reduced efficacy.

Sixty-seven percent of the stakeholders interviewed (n = 18) stated that they were aware of the laws relating to harvesting, transporting, and selling of medicinal plants.

Uchithibhunga (*Rhoicissus* spp.) was mentioned three times as an alternative plant for treating the same ailments as *E. bupleurifolia*, while all other substitute plant species, such as *itshongwe, ithangazane*, and *ubhelabhela* etc. were each mentioned only once. All mentioned species and their corresponding scientific names are included in Appendix A2. Most of the species provided as alternatives are Least Concern, fast-growing species, as opposed to *E. bupleurifolia* which is slow-growing and has recently been evaluated as Critically Endangered under criterion A, based on population size reduction (Mhlongo and Pfab, 2024). Thirty-nine percent of the participants did not suggest alternative plant species that could be used instead of *E. bupleurifolia*, stating that they were either unaware of alternatives, were not allowed to divulge such information or relied on the guidance of the spirit and these plants would therefore differ.

4. Discussion

The *E. bupleurifolia* plants utilized by the participants in this study were all wild sourced, highlighting the primary problem with the traditional medicine trade, which is the unregulated harvesting of wild specimens. Populations of other species prevalent in this trade are also rapidly declining and some of these species are now on the verge

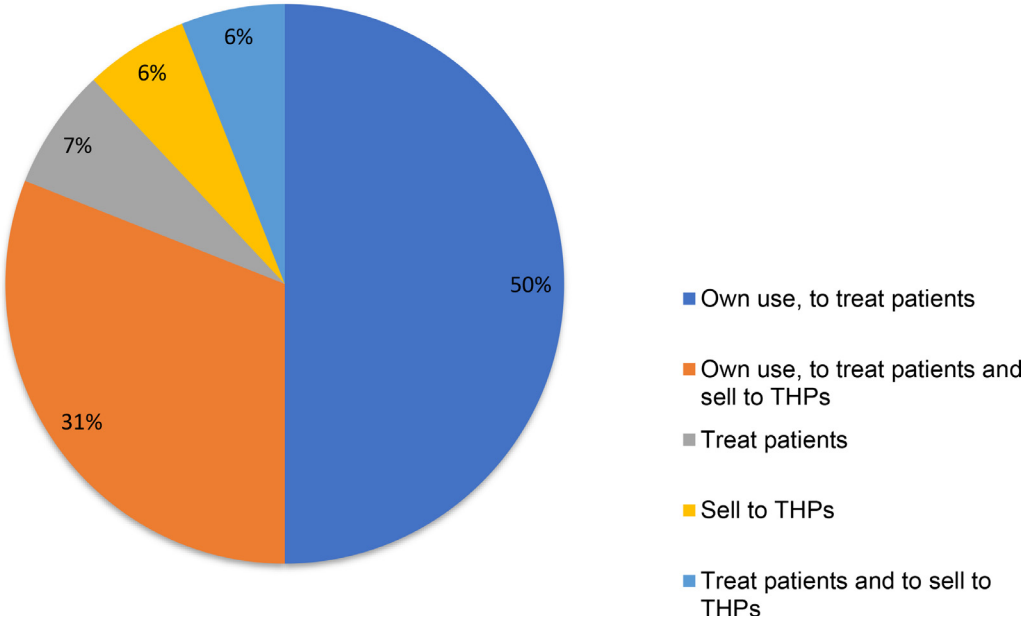

Fig. 3. The reasons stated by participants as to why they harvest *Euphorbia bupleurifolia* (n = 16).

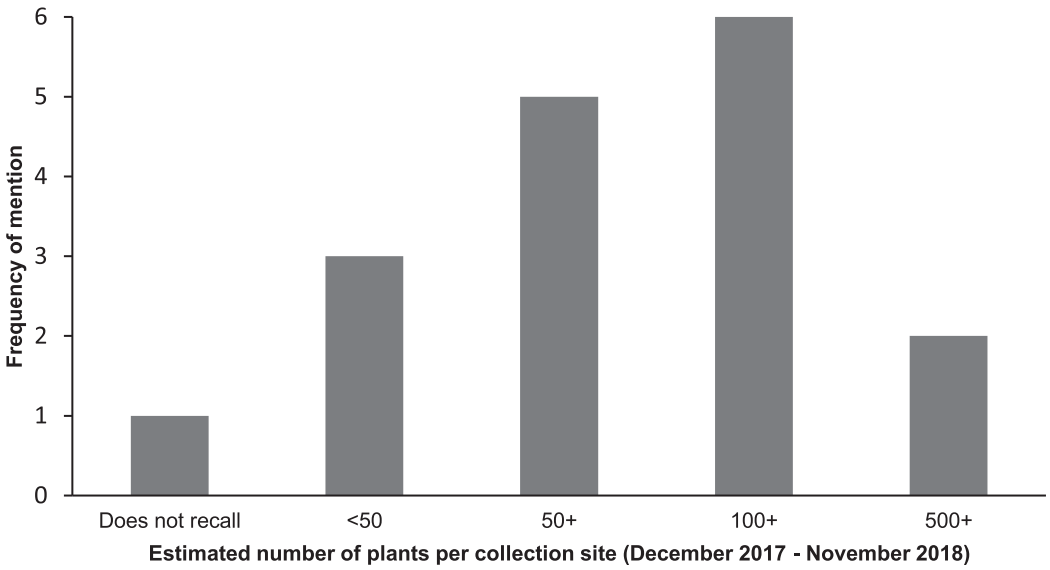

Fig. 4. Frequency of mention of the estimated number of *Euphorbia bupleurifolia* plants present at the harvest sites of participants (n = 16, one participant provided two different estimates for their different sites).

of extinction (Rasethe et al., 2019). *Euphorbia bupleurifolia* has undoubtedly experienced a drastic decline in recent years, and now may only occur in mostly small populations in less than 30 % of its historical range (Mhlongo et al., 2023). The previous Red List assessment for *E. bupleurifolia* cautioned that the harvesting of this species for medicinal purposes may be unsustainable (Victor et al., 2016). This study corroborates those concerns.

4.1. Quantities harvested, population trends and sustainability

The demand for many popular plants used for traditional medicine has exceeded supply as far back as the 1990s (Mander, 1998), and likely even earlier. The large offtake mentioned by the participants in this study is likely to be unsustainable and will have deleterious effects on *E. bupleurifolia* populations, increasing the species' risk of extinction. Traditionally, harvesting of medicinal plant species was the domain of trained THPs who followed strict customary regulations regarding plant collecting times and quantities to be harvested (Williams et al., 2000; Ngqobe, 1993 in Dzerefos and Witkowski, 2001). However, the commercialization of traditional health care has resulted in many untrained commercial harvesters with no other source of income, collecting plants from the wild to meet the urban demand (Williams et al., 2000). Large numbers of *E. bupleurifolia* individuals were harvested by a few participants (>100 plants each) in this study; while this would be expected from commercial traders, it was surprisingly diviners (2) and a herbalist who made these claims. Customary regulations and controls are no longer effective in alleviating the decline of medicinal plant populations as these customs are no longer prevalent or are intentionally disregarded (Mbongwa, 2018). This gradual cultural shift worsens the pressure on wild plant

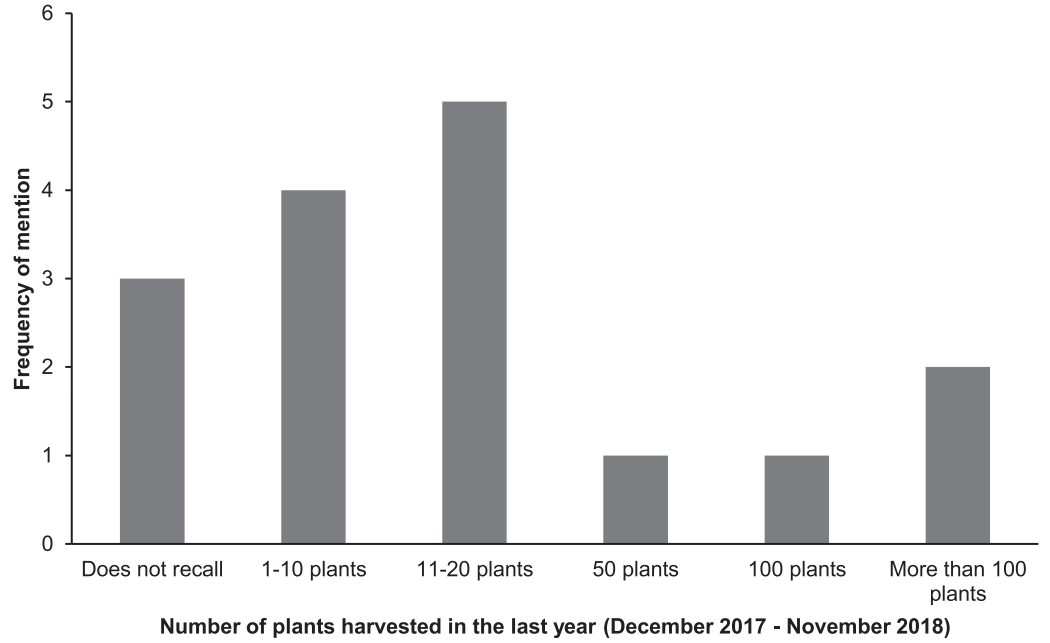

Fig. 5. Frequency of mention of the estimated number of *Euphorbia bupleurifolia* plants harvested by participants over a one-year period (n = 16).

populations (Mbongwa, 2018). This was demonstrated in this study by the participation of certain THPs in the commercial *muthi* trade, with destructive consequences.

In Botha (1998), THPs mentioned how sustainable harvesting practices were incorporated into training programmes during initiation. Initiates were encouraged to harvest only small amounts and to avoid repeated harvesting in the same area (Botha, 1998). This provided plants with an opportunity to regenerate between collection periods and promoted sustainability (Tshisikhawe, 2002). In this study, sustainable use approaches such as harvesting only the required amount and having multiple harvest sites were mentioned by participants. While these would ensure some form of sustainability, provided that the multiple sites are not visited by many harvesters, their effectiveness is difficult to ascertain as populations are currently not being monitored (Rasethe, 2017).

Another indicator of this species' increased scarcity in the wild is the low number of *E. bupleurifolia* plants encountered in the *muthi* trade during the three months of interview surveys. Traditional medicine trade in *E. bupleurifolia* in King William's Town has been documented as far back as 2001 (Dold and Cocks, 2001), showing that trade in this species for traditional medicine is not a recent occurrence and populations may only now be showing signs of unsustainable harvest. Mander (1998) found that many medicinal species were already showing signs of unsustainable use in the late 1990s, with sizes of plants decreasing, distances to harvesting sources increasing, supply becoming increasingly irregular and the unavailability of some species in certain markets. This could also explain why all the traders in the biggest traditional medicine market in KwaZulu-Natal (Warwick market in Durban) stated that they did not know the study species, though Professor Neil Crouch from the South African National Biodiversity Institute confirmed that *E. bupleurifolia* does occasionally appear in Durban *muthi* markets (pers. comm, 2017). It is possible that this species has declined to such an extent that people in KwaZulu-Natal have either not seen it for many years, or not seen it at all for the younger generation. On the other hand, some of the traders claiming not to know this species might have been using evasion tactics. Mbongwa (2018) revealed that traders at *muthi* markets have become reluctant to participate in research studies as they felt exploited by researchers who take their indigenous knowledge but do not compensate them accordingly nor acknowledge their contributions in their reports.

Some of the participants who harvest *E. bupleurifolia* stated that numbers were increasing at their harvesting sites. However, considering the life history and the latest population data based on field surveys of all known *E. bupleurifolia* locations (Mhlongo et al., 2023), along with its recent IUCN Red List status of Critically Endangered (Mhlongo and Pfab, 2024), this assertion is inconsistent with other lines of evidence. Researchers have noted that responses to survey questions may be distorted by the desire to seem helpful and the fear of legal repercussions (Baumeister and Vohs, 2007; Krumpal, 2013). Participants may have been fearful that confirming that wild populations were indeed declining might result in laws being implemented which would prohibit them from harvesting, as has been done with *Encephalartos* species. It is, however, still possible that some of these participants may truly be unaware of the possible declines, especially if they irregularly visit their harvesting sites. Participants who have multiple harvest sites may also not notice a decline because they may not be regularly visiting each site and may therefore view the population to either be stable or increasing. This perception has the potential to impair conservation efforts as these medicinal plants will continue being exploited. While it may be challenging to persuade commercial harvesters to adopt sustainable harvesting practices, there is a potential to motivate this behaviour amongst THPs who understand the healing and cultural significance of these plants.

4.2. Euphorbia bupleurifolia *plant parts used in traditional medicine and the adoption of alternative fast-growing plant species*

Roots, bulbs, and whole plants are most commonly traded in KwaZulu-Natal and Gauteng traditional medicine markets (Mander, 1998; Williams, 2003), and similarly for this species. The entire *E. bupleurifolia* plant is used for production of traditional medicine, with the latex as the primary substance used in healing. The harvesting technique used in gathering *E. bupleurifolia* is therefore destructive as the entire plant must be dug out, which would have contributed significantly to the decline in the wild. Several studies have explored the use of vegetative renewable plant parts such as leaves, twigs, and fruits for a few South African medicinal species (Zschocke et al., 2000; Horn et al., 2001; Lewu et al., 2006; Katerere and Eloff, 2008; Shai et al., 2009; Moyo et al., 2013). These could serve as useful alternatives to less sustainable medicinal products, such as bark, bulbs, and roots.

Another viable solution towards the conservation of highly threatened slow-growing medicinal plant species like *E. bupleurifolia* is the use of more common, fast-growing substitute plants. The reduced availability in popular medicinal plants has seen many THPs gravitate towards the use of substitute plants (Mander, 1998; Fennell et al., 2004). Ten alternative medicinal plant species were suggested by the interviewed stakeholders that could be used to treat the same ailments as those treated by *E. bupleurifolia*. The plant names were given in indigenous languages (isiZulu/isiXhosa), which might raise issues of ambiguity on the actual identity of the species. Most of the identified substitute species are classified as Least Concern in the IUCN Red List (Appendix A2). Indeed, most South African medicinal plants are listed as Least Concern (Williams et al., 2013), which was also the previous status of *E. bupleurifolia*. Victor and Keith (2004) introduced the concept of an "Orange List" as an early warning system to highlight the need for conservation monitoring and intervention for many Least Concern species. This list included taxa that were still abundant but had been flagged as "declining", such as plant species sought after for medicinal purposes (Victor and Keith, 2004). Williams et al. (2013) found that of the 36 medicinal plant species flagged as "declining", 33 were being traded as medicinal species. This demonstrates the devastating impacts this trade has had on "common" plant species.

4.3. Pricing

Market prices of medicinal plants do not reflect the high-perceived value and demand associated with them and unit prices are often low, with a few exceptions (Botha et al., 2007). Williams et al. (2007b) found scarcity and seasonal availability to be amongst the factors influencing market values. Size was also listed as the main determinant of price (Botha et al., 2007). However, neither size nor seasonal availability influenced the pricing of *E. bupleurifolia* in this study. Rasethe et al. (2019) found that the prices of medicinal plants traded in informal traditional medicine markets in the Limpopo Province ranged from R8.50 to R30 per kg. In Eastern Cape traditional medicine markets, prices of the 10 most commonly traded species ranged between R11 and R68 per kg (Dold and Cocks, 2002), though these prices may now be outdated. The low prices paid to commercial harvesters force them to increase harvesting to generate a reasonable income (Cunningham, 1993; Monakisi, 2007). The low selling price of *E. bupleurifolia* (R15±6 per plant) may encourage gatherers to source entire populations to increase profits. This is likely to have had detrimental impacts on wild populations, thereby corroborating recent findings in Mhlongo et al. (2023). If medicinal plant species continue being sold at unprofitable/low prices, wild populations will continue being harvested to meet demand until stocks eventually run out (Botha et al., 2007).

4.4. Willingness to use cultivated plant material

The cultivation of medicinal plants can alleviate harvesting pressures on wild populations of species while providing economic opportunities for poor communities (Schippmann et al., 2002). A large percentage of the participants in this study stated that they would be willing to use cultivated plant material. Various initiatives were undertaken in the past to relieve pressure on wild medicinal plants. These initiatives focused on cultivating species commonly used in the trade. These include the Silverglen Medicinal Plant Nursery (Berkes, 1999), Umthanti Africulture Project (Macaskill, 2010), SANParks' Medicinal Plant Nursery Project in the Makuya district (South African National Parks Annual Report, 2005) and Mtubatuba Female Traditional Healers Association medicinal plant project sponsored by CSIR (Ndawonde, 2015). However, the slow-growing nature of *E. bupleurifolia* (annual growth rate of 0.55±8.37 cm^2 (Mhlongo et al., 2023)) may pose challenges for cultivation.

To be effective as alternatives to wild-collected plants, cultivated plants need to be produced in bulk and at a low cost. This is necessary because cultivation must compete with commercial harvesters who have no input costs (Cunningham, 1993). If purchasing cultivated medicinal plants is too costly for a large portion of the market, then harvesting of wild populations will continue until species become extinct (Botha, 2001). There is also a widely held perception that wild-collected plants are more potent than cultivated ones (Mander, 1998; Heywood, 1999; Williams, 2003), which was certainly supported by just less than half the participants in this study. Schippmann et al. (2002) showed that the medicinal properties found in plants are attributed to the presence of secondary metabolites in plants that have grown under conditions of stress and competition, which would otherwise not be expressed under cultivation. However, despite the perceived lower potency of cultivated plants, there has been a general acceptance by THPs of cultivated material as a viable alternative (Cunningham, 1993). Dold and Cocks (2002) found that 82 % of THPs and 69 % of patients would welcome the use of cultivated plants for medicinal purposes in the Eastern Cape. Furthermore, many medicinal plants are used in combination with each other for healing purposes and the inclusion of just one wild collected plant in this mixture would counter any potential decline in power (Williams, 2003). A better understanding of the belief systems held by consumers and how those could be incorporated into the cultivation of medicinal plants would increase healers' acceptance of cultivated plant material, which might ultimately promote their conservation (Mbongwa et al., 2021).

4.5. Knowledge of the laws regulating trade in medicinal plant species

In South Africa, a variety of legislative laws pertaining to the conservation of indigenous plants exist, but enforcement remains a challenge (Botha et al., 2004). Government legislation has been largely ineffective in managing the traditional medicine trade (Cunningham, 1993). The listing of *E. bupleurifolia* as a species that is threatened or in need of protection in terms of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) is imminent, and activities such as collecting, cutting, picking parts of, uprooting or exporting of wild plants of this species will soon be regulated through permits. *Euphorbia bupleurifolia* is additionally protected by provincial conservation legislation. In the present study, 67 % of the participants had some knowledge on the laws that regulate the harvesting, transport and selling of medicinal plants. Although these participants were aware that they required a permit for the harvesting of medicinal plants, none of them possessed one. Rasethe (2017) uncovered that THPs often confuse the cards issued by the Traditional Healers' Association (THA) as permits enabling them to harvest any medicinal plant species, suggesting that THPs and their relevant associations may not be well informed about relevant legislation. Consequently, those harvesting *E. bupleurifolia* may not be aware that by harvesting this species they are contravening provincial and national environmental laws. Williams (2003) reported how a flawed permitting system, which granted THP organisations the right to issue permits to their members, proved disastrous and led to abuse of the permitting system. This flawed system may have resulted in the unsustainable harvesting of many medicinal plant species as it granted permission to an undisclosed number of THPs to harvest medicinal plants. This may have contributed to the extirpation of many of the KwaZulu-Natal populations of *E. bupleurifolia* (Mhlongo et al., 2023) and may explain why this species is no longer common in local traditional medicine markets in this province.

To prevent further extinctions and aid the recovery of threatened, slow-growing medicinal plant species such as *E. bupleurifolia*, large-scale cultivation, the use of alternative fast-growing species, and plant part substitution should be adopted. Since it is the latex in *E. bupleurifolia* that contains the active ingredient used in healing, THPs could be encouraged to harvest leaves, which is less detrimental to the species' survival. More experimental work may be necessary to test the practicality of this practice. Awareness through information sharing with THPs and their associations on plant part substitution viability should follow based on the success of those experiments. Furthermore, educational programs focusing on sustainable natural resource use and relevant legislation should ensure that all stakeholders (e.g., THPs, traders, consumers, and compliance officers) are well-versed in the laws governing medicinal plant species and should not strictly target specific groups (e.g. THPs only).

5. Conclusion

Despite encountering only four *E. bupleurifolia* plants in the local *muthi* trade during the period of this study, the information gathered from the 23 participants showed that harvesting of this species is severe, with an estimated 1721 plants harvested in just one year. This large annual offtake, coupled with other harvesting events such as harvesting for the specialist succulent trade, is likely to have already had detrimental impacts on wild populations of *E. bupluerifolia,* with many of the historically reported populations possibly now extinct, especially in the province of KwaZulu-Natal where no populations could be located (Mhlongo et al., 2023). The findings from this study show that trade in *E. bupleurifolia* for medicinal uses is presently unsustainable, and that the current environmental legislation has done very little to remedy this situation. There is an urgent need for an alternative supply of medicinal plant material as wild populations of *E. bupleurifolia* have been severely impacted by harvest. This situation is compounded by the harvesting of wild plants to supply international horticultural markets (Mhlongo, 2020). THPs should be encouraged to use alternative plant parts and substitute slow-growing species like *E. bupleurifolia* with faster-growing, more abundant species to prevent the extinction of valuable medicinal species. Medicinal plant nurseries should also be established in local communities to provide relief to wild populations, although the slow-growing nature of this species might pose a challenge to cultivation. Efforts should be focused at regulating the medicinal species trade through the development of strategies that promote sustainable use of natural resources in accordance with conservation requirements.

Appendix A. Supplementary data. Supplementary data associated with this article will be provided as a separate attachment.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

N.N. Mhlongo: Writing – original draft. **M.F. Pfab:** Writing – original draft. **E.T.F. Witkowski:** Writing – original draft.

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Supplementary materials

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