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Medicinal plants: An invaluable, dwindling resource in sub-Saharan Africa

Q1 Mack Moyo, Adeyemi O. Aremu, Johannes Van Staden [1]

Q2 *Research Centre for Plant Growth and Development, School of Life Sciences, University of KwaZulu-Natal, Pietermaritzburg, Private Bag X01, Scottsville 3209, South Africa*

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ABSTRACT

Ethnopharmacological relevance: The use of plant species for different therapeutic/medicinal purposes is well-entrenched in sub-Saharan Africa.
Aim of the review: To provide a critical and updated review of the enormous medicinal plant heritage in sub-Sahara Africa with regards to the abundance, importance, conservation status and potential means to help sustain their availability for future generations.
Methods: A comprehensive literature search involving different online databases, books and thesis were conducted in order to obtain, collate and synthesize available information on various fundamental aspects pertaining to African medicinal plants.
Results: African biodiversity hotspots are endowed with a high level of endemic species with a significant portion possessing medicinal value. Apart from the extensive ethnobotanical uses of medicinal plants found in Africa, scientific validation of their biological potential such as antimicrobial, antioxidant, anti-inflammatory, anti-diabetic properties have been recognized. Together with the demand arising from their biological efficacies, other anthropogenic factors are exerting conservation strains of the wild population of these medicinal plants. Even though researchers have acknowledged the importance and value of conserving these medicinal plants, several challenges have hampered these efforts on the Continent as a whole.
Conclusions: The rich flora occurring in sub-Saharan Africa suggests enormous potential for discovery of new chemical entity with therapeutic value. However, concerted efforts focused on documenting the conservation status of African medicinal plants are pertinent. Application of different biotechnological techniques is needed to sustain these valuable botanical entities, especially to meet increasing pharmaceutical demand. Most importantly, increased public enlightenment and awareness may help eradicate the prejudice against cultivation of medicinal plants.

1. Introduction

Despite the unavailability of supporting empirical data (Quiroz et al., 2014), the statement that '80% of the continent's population depends on herbal medicine for their primary health care' (Dold and Cocks, 2002; Fomogne-Fodjo et al., 2014; Ibrahim et al., 2014; Jäger et al., 1996; Jusu and Sanchez, 2013c; McMillen, 2012; Mulholland, 2005; Olorunnisola et al., 2015; Orwa et al., 2008; WHO, 2002; Yemele et al., 2015; York et al., 2011) has almost become synonymous with African ethnobotanical and ethnopharmacological literature. Based on this statistic, the rationale for many ethnopharmacological studies has been that a large proportion of the African population depends on medicinal plants for their primary health care needs (van Andel et al., 2012). According to Pouliot (2011), researchers and policymakers still rely on outdated estimates because recent quantitative data on the use of medicinal plants do not exist. Notwithstanding, it is undeniable that medicinal plants have played a pivotal role in primary health care in Africa for centuries. Significant pharmacological research has been done to validate the use of plant extracts as medicinal remedies in sub-Saharan Africa (Moyo et al., 2015). The rich history of African cultures and their innovative utilization of plants as a source of remedies have been passed down through generations largely by oral tradition (Soelberg et al., 2015).

Besides the gradual loss of ethnobotanical knowledge due to lack of documentation, most authors have highlighted the overharvesting of medicinal material from their natural habitat as one of the major threats to the preservation of traditional medicine. In order to conserve wild plant species, there is a need for reliable

E-mail address: rcpgd@ukzn.ac.za (J. Van Staden).
[1] Tel.: +27 33 2605130.

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data on their distribution and level of use (Ahrends et al., 2011). In many parts of Africa where some studies have been conducted, there are few signs of unsustainable harvesting of medicinal plants, for example reduction in the size of bulbs and other traded plant parts (Williams et al., 2007a), erratic and irregular supply of certain plants at medicinal markets, and increasing distances to harvesting sources (Towns et al., 2014; Williams et al., 2013). In light of the perceived increase in demand of medicinal plants for both the local and international markets, it is imperative for African countries to assess the conservation status of their flora using the standard IUCN Red List Categories. To date South Africa is the only country in the world that has assessed the threat statuses of its entire flora based on the IUCN Red List guidelines but with additional categories, namely, Critically Rare, Rare and Declining (Williams et al., 2013). Medicinal market quantitative surveys can provide a credible source of baseline data on volumes of traded plant species, estimated magnitude of wild population depletion and sustainability of harvesting (Williams et al., 2007a). In their study of medicinal geophytes traded in South African medicinal markets, Williams et al. (2007a) proved that the size of bulbs sold had significantly decreased between 1995 and 2001. Such studies generate valuable data on the magnitude of trade and medicinal plants most at risk of overharvesting, which can contribute to species specific conservation measures. This provides important baseline information for threat and conservation status assessments of medicinal taxa. In this review we highlight the rich floral biodiversity found in Africa, the overexploitation of medicinal plants and their conservation statuses according to the IUCN Red List Categories. In order to ensure and guarantee continuous benefits, we also discuss the currently available and viable methods with potential to help sustain the overall African rich medicinal flora. Even though more than 5400 medicinal plants are recognized and documented in Africa (Iwu, 2014; Neuwinger, 2000), the main emphasis in the current review was on the 51 plant species (from 30 families) published in the African Pharmacopeia and deemed to be the most important on the Continent (Brendler et al., 2010). Nevertheless, other valuable medicinal plant species not captured in the African Pharmacopeia were also highlighted where necessary.

2. Floristic richness and biodiversity hotspots in Africa

The botanical diversity in different parts of the African continent and the inherent ethnobotanical knowledge has been the mainstay of localized traditional herbal medicine systems for thousands of years. However, the globalization of medicinal plants has increasingly exposed these local plant resources to overexploitation, leading to the extinction of some important species. Today, most medicinal plants remain locally-derived, but are utilized internationally. Plants originating from Africa constitute about 8% of the 1100 medicinal plants commercialized globally (Brendler et al., 2010). The increasing commercial value of products from African plants, often available as processed materials in modern packaging and in various dosage forms including teas, tinctures, tablets, capsules and ointments has been critically reviewed (Amoo et al., 2014b; Dzoyem et al., 2013; Mahomoodally, 2013; Makunga et al., 2008; Mncwangi et al., 2012; Moyo and Van Staden, 2014; Stewart and Cole, 2005; Van Wyk, 2008; Vermaak et al., 2014).

The richness of medicinal plant resources in Africa emanates from the vast floral diversity found across the continent, particularly the eight biodiversity hotspots (Table 1). Globally, about 44% of all vascular plant species are confined to only 1.4% of the earth's land surface area (Myers et al., 2000), depicting the high level of floral richness. Biodiversity hotspots in Africa, namely, the Succulent Karoo, Maputaland – Pondoland – Albany, Cape Floristic Region, Madagascar and the Indian Ocean Islands, the Horn of Africa, the Guinean Forests West Africa, Coastal Forests of Eastern Africa and the Eastern Afromontane region, are characterized by unique floral richness and high levels of endemism (Table 1). The Succulent Karoo, which primarily consists of winter rainfall desert and the newly recognized Horn of Africa are the only two hotspots that are entirely arid (CEPF, 2003). However, unlike the Succulent Karoo which has been well-characterized, taxonomic research of the Horn of Africa flora is still largely incomplete and ongoing. According to Ahrends et al. (2011) declining resources for basic biodiversity inventories have affected the tropical regions particularly hard, thus their flora remains severely understudied. The highest level of endemism (89.2%) is found in the Madagascar hotspot with 11 endemic plant families, 310 plant genera and 11,600 plant species (Myers et al., 2000). Based on the level of species endemism, endemic species/area ratios and habitat loss, Madagascar has been classified as the hottest hotspot in the world (Myers et al., 2000). Understandably, one of the major concerns is the loss of Malagasy medicinal plants due to anthropogenic activities from areas that have not yet been explored (Norscia and Borgognini-Tarli, 2006). A similar trend of extensive unique and sharply distinct flora occurs in the Cape Floristic Region with 69% endemism and which holds five of South Africa's 12 endemic plant families and 160 endemic genera (CEPF, 2001; Onstein et al., 2014). It is interesting to know that despite the sustained taxonomic research over the past few decades, new plant species (Magee and Manning, 2010; Muasya et al., 2012; Powell and Magee, 2013) are still being identified and described in the Cape Floristic Region. The floristically complex Maputaland – Pondoland – Albany hotspot, consists of 39 endemic vascular plant genera, and has significant numbers of 'Critically Endangered' (83), 'Endangered' (128) and 'Vulnerable' (323) species (CEPF, 2010). The hotspot's warm temperate forests have a high tree richness of nearly 600 species and a remarkable stem succulent flora (CEPF, 2010). In the Coastal Forests of Eastern Africa hotspot, about 43%of the plant species and 2%of genera are estimated to be endemic (Lovett, 1998a,b,c). Compounding the fragility of this ecosystem is the fact that about 70%of the endemic species and 90%of endemic genera are found in forest habitants (Lovett, 1998c). On the other hand, the mountains of the Eastern Afromontane hotspot though geographically disparate and widely scattered along the eastern edge of Africa, have remarkably similar flora (Lovett, 1998c). The area includes the Eastern Arc Mountains, the Ethiopian Highlands, Tanzanian Highlands and the Chimanimani Highlands in eastern Zimbabwe. Relatively fewer ethnobotanical studies have been undertaken in this region, despite the extraordinary high degree of botanical diversity with some areas reportedly harbouring 3000–4000 plant species per 10,000 km² (Schlage et al., 2000). Furthermore, Schlage et al. (2000) concluded that relatively few of the medicinal taxa found in the Usambara Mountains of the Eastern Arc Mountains have been phytochemically and pharmacologically characterized in detail. Remarkably, the Eastern Arc Mountains is endowed with enormous richness and diversity comprising about 40 endemic plant genera and more than 1100 plant species (CEPF, 2012). The Guinean Forests of West Africa hotspot is also composed of an extensive array of unique plants, including approximately 1800 endemic species.

3. The over-exploitation of medicinal plants in sub-Saharan Africa

The scramble for medicinal plants for local trade and utilization has been recorded in different parts of the continent for many years. As far back as 1946, Jacob Gerstner, a missionary in South Africa predicted the imminent extinctions of 'doomed' medicinal plants (Gerstner, 1946; Williams et al., 2013). In particular, Gerstner (1946) highlighted the overexploitation of *Warburgia*

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