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Review

Pharmacological potential and conservation prospect of the genus *Eucomis* (Hyacinthaceae) endemic to southern Africa

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ABSTRACT

Ethnopharmacological relevance: The genus *Eucomis* (Hyacinthaceae) consists of 10 species that are extensively used in African traditional medicine. This review is an appraisal of current information on the distribution and morphology, traditional uses, pharmacology, toxicology and approaches devised to enhance the conservation of the genus.

Methods: A systematic and comprehensive literature search using electronic searches such as Scopus, Google Scholar, Web of Science and ethnobotanical books was conducted.

Results: Evidence from traditional medicine usage shows wide utilization of this genus for ailments such as respiratory, venereal diseases, rheumatism as well as kidney and bladder infections. Pharmacological screening reported antimicrobial, antiplasmodial, antitumor, cytotoxic, phytotoxic and anti-inflammatory properties.

Conclusions: The potential of the genus *Eucomis* especially in terms of pharmacology cannot be over-emphasized. Apart from the anti-inflammatory properties, the antifungal activity of *Eucomis* remains a valuable reservoir with potential application in the agriculture sector as a source of an affordable biocontrol agent. Based on the speculated toxic constituents in the genus Eucomis, it will be valuable to conduct detailed toxicological studies. Extensive utilization of members of the genus *Eucomis* is causing severe strain on wild populations. Although conventional propagation has been relatively effective in the alleviation of the declining status, micropropagation of members may be vital to guarantee the conservation of wild populations.

Contents

Abbreviations: 2,4-D, 2,4-Dichlorophenoxy acetic acid; 2-iP, N^6-Isopentenyladenine; ABA, abscisic acid; BA, benzyladenine; COX, cyclooxygenase; DCM, dichloromethane; GA_3, gibberellic acid; GA_{4+7}, GA_4 and GA_7 gibberellin mixture; IAA, indole acetic acid; IBA, indole butyric acid; IUCN, Conservation of Nature and Natural Resource; MeJa, methyl jasmonate; MeOH, methanol; MIC, minimum inhibitory concentration; MS, Murashige and Skoog (1962); *m*T, *meta*-Topolin; NAA, α-naphthalene acetic acid; NSAIDs, non-steroidal anti-inflammatory drugs; PAA, phenylacetic acid; PBZ, paclobutrazol; TPA, 12-O-tetradecanoylphorbol 13-acetate

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1. Introduction

The genus *Eucomis* is a member of the Hyacinthaceae (formerly known as Liliaceae) comprising of 41 genera distributed in Europe, South America and Africa. In southern Africa, there are 27 genera and approximately 200 species found in the Cape Floristic Region, South Africa (Pooley, 2005). Among the genera in southern Africa *Eucomis* is endemic to the region. The genus is relatively small, consisting of 10 species (Pooley, 2005). Although *Eucomis* species are generally summer blooming, *Eucomis regia* is winter blooming. The species comprise of deciduous geophytes with long and narrow leaves topped with densely packed flowers (Compton, 1990). The characteristic leaf-like bracts at the peak of the flower spikes earned this genus its Greek name 'eukomes' which refers to 'beautiful headed' (Bryan, 1989). *Eucomis* is commonly called 'pineapple lily' because of the flower spikes that resemble pineapples (Pienaar, 1984).

In traditional medicine, *Eucomis* species are widely utilized against various ailments including respiratory, venereal diseases and rheumatism (Hutchings et al., 1996). Consequently, *Eucomis* species have been evaluated in both *in vitro* and *in vivo* bioassays for anti-inflammatory, antibacterial, antihistaminic and angioprotective potentials (Heller and Tamm, 1981; Amschler et al., 1996). The extensive biological activities of *Eucomis* species have been mainly attributed to phytochemicals such as the homoisoflavanones commonly present in the plant. An in-depth review on the phytochemistry of the genus *Eucomis* is documented (Koorbanally et al., 2006a). The extensive exploitation of *Eucomis* species in traditional medicine together with its slow propagation rate has inevitably resulted in the decline of the majority of species, of which some are endangered/threatened (Raimondo et al., 2009). The current review focuses on the pharmacological characteristics of the genus *Eucomis*. A critical evaluation of available propagation protocols as a possible means of enhancing their conservation status is discussed. Even though members of the genus *Eucomis* are widely utilized globally, the current review is presented from a South African perspective.

2. Distribution and general morphology of *Eucomis* species

2.1. Distribution

Eucomis genus is widely exploited for its medicinal and horticultural value in southern African countries such as South Africa, Botswana, Lesotho, Swaziland, Zimbabwe and Malawi (Pienaar, 1984; Du Plessis and Duncan, 1989). In South Africa, *Eucomis* species are distributed across all the nine Provinces. In terms of species richness, Eastern Cape with nine species is best represented, followed by KwaZulu-Natal with seven species while Northern Cape is the least endowed Province with only one species (Table 1). The distribution pattern of the genus *Eucomis* across the Provinces varies depending on the species. While some species occur in two or more Provinces, other species such as *Eucomis humilis*, *Eucomis montana*, *Eucomis pallidiflora* subspecies *pole-evansii* and *Eucomis zambesiaca* are found only in one Province. This is a demonstration of their specificity to particular climatic conditions within South Africa (Table 1). Their growth and development depend on certain factors such as climatic regions and environmental conditions. For instance, *Eucomis bicolor* is commonly found at the base of the Drakensberg cliffs along moist slopes ranging from 1800 to 2600 m while *Eucomis humilis* is found on slopes that range from 2400 to 2900 m. *Eucomis autumnalis* is distributed in damp craters in grasslands that range from 2100 to 2400 m (Trauseld, 1969). The specificity of *Eucomis* species to certain environmental and climatic conditions are amongst the contributing factors that have resulted in the excessive decline and vulnerable status of the species in South Africa (Raimondo et al., 2009).

2.2. General morphology

Eucomis species are geophytes with ovoid or globose shaped bulbs comprising of hard cortices (Bryan, 1989; De Hertogh and Le Nard, 1993). The bulb size ranges from 50 to 150 mm in diameter and have a perceptible horizontal striped base with brown to black scales (Fig. 1B). The inner part of the bulb is yellow-white and turns black when exposed to air (Mander et al., 1995). The bulbs have branched perennial fleshy contractile roots with root hairs (Fig. 1A). They are characterized by a rosette of smooth often shiny leaves that are lanceolate, elliptic or ovate and bend backwards (Fig. 1C).

The stem ranges from 30 to 100 cm in height depending on the species. A straight cylindrical inflorescence with a pale lime-green flower raceme is located at the top of the flowering stem (De Hertogh and Le Nard, 1993). The flower colour varies from yellowish-green or white with margins varying from pale to dark purple. Flower color turns green on maturity (Fig. 1D). After pollination and fertilization, green or brown fruits appear containing dull blackish-brown seeds (Bryan, 1989; Du Plessis and Duncan, 1989).

The most common feature used for plant identification is flower morphology. However, the aforementioned method is difficult with the genus *Eucomis* because the flowers are morphologically similar. Therefore, features such as fragrance, plant size and leaf color allows for better differentiation among species. Members of the genus emit distinct floral scents. Sweet aroma species include *Eucomis amaryllidifolia*, *Eucomis autumnalis*, *Eucomis comosa*, *Eucomis grimshawii*, *Eucomis pallidiflora* and *Eucomis zambesiaca* while *Eucomis bicolor*, *Eucomis humilis*, *Eucomis montana*, *Eucomis regia*, *Eucomis schijffii* and *Eucomis vandermerwei* emit an unpleasant scent (Zonneveld and Duncan, 2010). The presence or absence of a purple color at the leaf base or flower and the cylindrical shape of the scape are used to distinguish *Eucomis* species. Taken together, these characteristics become more difficult for identification and differentiation among closely-related species or subspecies. Therefore the use of genome size together with nuclear DNA content provides a better tool to distinguish species.

According to Reyneke and Liebenberg (1980), *Eucomis* species have 15 chromosomes which exist either in diploid (small species) or tetraploid (larger species) states. The diploid species ($2n=2x=30$) are *Eucomis amaryllidifolia*, *Eucomis bicolor*, *Eucomis grimshawii*, *Eucomis regia*, *Eucomis schijffii*, *Eucomis vandermerwei* and *Eucomis zambesiaca* while the tetraploid species ($2n=4x=60$) include *Eucomis autumnalis*, *Eucomis comosa*, *Eucomis humilis*, *Eucomis montana* and *Eucomis*