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## PLANT SCIENCES | REVIEW ARTICLE

# *Dioscorea bulbifera*, a highly threatened African medicinal plant, a review

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**Abstract:** *Dioscorea bulbifera* bulbils are used in the treatment of Piles, dysentery, syphilis, ulcers, cough, leprosy, diabetes, asthma, and cancer. It is a raw material for contraceptives, and it is one of the most consumed yam species especially in West Africa. Unfortunately, this plant is at the verge of extinction because of increased harvest for medicinal purpose. This review aims at providing up-to-date information about its photochemistry, clinical benefits, conservation status and best possible way on how this plant can be conserved for future use. Literature database search was employed, and the findings indicate that much as *Dioscorea bulbifera* is of diverse clinical and ethnomedicinal benefits, it's vulnerable to extinction. In order to conserve *Dioscorea bulbifera*, there is a need to enlighten the local inhabitants on its clinical and commercial importance and uses. Also for the sustainable growth of the plant, the government and Non-governmental agencies have to distribute *Dioscorea* bulbils to the farmers for planting and also encourage its planting back into the wild. In addition, micropropagation of the *D. bulbifera* will be the perfect tool for re-establishing the plant in the natural habitat with more advantages of improving growth conditions of the plants.

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### PUBLIC INTEREST STATEMENT

*Dioscorea bulbifera* bulbil is a medicinal plant that treats diverse diseases and ailments. Its extract has been used as alternative contraceptive with the aim of reducing high population in the world. It is not clear how many varieties of this plant may be located in Uganda, but no documentation has been done and therefore this raises a need to characterize it. Also, a number of studies have indicated that this plant is slowly getting extinct; another reason to look for means of conserving it.

**Subjects: Management - Pharmaceutical Science; Biopharmaceutics; Natural Products**

**Keywords: Dioscorea bulbifera; medicinal; threatened**

## 1. Introduction

The biggest percentage of the world's population (70%) depends on Traditional Health Care System to treat various diseases (World Health Organization [WHO], 2002). It is well proved that this kind of system of using herbal medicine offers minimal side effects (Firenzuoli & Gori, 2007) and is relatively of low cost as compared to other systems of conventional medicine thus becoming the preferred system by most patients in developing countries. This has led to overexploitation of medicinal plants for pharmaceuticals, herbal remedies, cosmetics and other natural products that have increased greatly in recent years (Batugal, Kanniah, Lee, & Oliver, 2004). This continuous harvesting practices and over-harvesting for production of medicines have led to degradation of genetic diversity of medicinal plants in the world to an alarming rates (Yadav, Singh, & Verma, 2012). Furthermore, extensive destruction of the plant-rich habitat as a result of forest degradation, agricultural encroachment and urbanization are other factors, that have challenged their existence (Bisht, Bhatt, & Dhar, 2006) and thus increasing the number of threatened plant species (Yadav et al., 2012).

*Dioscorea bulbifera* is one of the medicinal plants whose genetic resources in the world are getting into extinction due to habitat loss, climate change, overexploitation and poor natural regeneration since it is dioecious and chances of finding a fertile seed are automatically reduced (Otoo et al., 2015). *Dioscorea bulbifera* preparation has been used for memory enhancement, anti-aging, constipation and fever (Odugbemi, 2008), and has also been used as an infusion to apply to cuts and sores due to its high composition of the tannin that is used to hasten healing of wounds in a flamed membrane (Anona, Ezeabara, & Regina, 2018). In Cameroon and Madagascar, the pounded bulbils are applied to abscesses, boils and wound infections (Cogne, 2002). The bulbil of *D. bulbifera* has also been identified to contain saponin steroidal phytochemical called diosgenin that possess anti-fertility activity (Shajeela, Mohan, Louis Jesudas, & Tresina Soris, 2011) in addition to many other medicinal uses such as contraceptives, sexual vigour remedy and treatment of piles, dysentery, syphilis, ulcers, tuberculosis, leprosy, cough and diabetes (Table 1). The clinical significance varies greatly depending on the mode of preparations and the administration, hence the need for its conservation.

*D. bulbifera* has a faint odour and a bitter-salty taste. It contains a higher nutritional value compared to other *Dioscorea* species (Anona et al., 2018), with the highest levels of calcium, magnesium, sodium and zinc, highest values of vitamins B1, B3 and C and highest protein content. In spite of the great medicinal application and nutritional value of *D. bulbifera*, food preference is largely given to the flavour of other yam species. It has been left to the diabetic patients and people with other health conditions like obesity since they are more nutritious and less sweet (Okeke, Eneobong, Uzuegbunam, Ozioko, & Kuhnlein, 2008). This leaves it majorly as a staple food for hunters-gatherers living in the forest such as Pygmies in Central Africa and Abayanda in Uganda (Byarugaba, Ndemere, & Midgley, 2007). This has led to the near extinction status of this plant (Okeke et al., 2008) and therefore it is imperative to consider conserving this medicinally useful plant genetic resource.

## 2. Clinical benefits of dioscorea bulbifera

*D. bulbifera* (Family-Dioscoreaceae) has been found to possess profound therapeutic potential. It is commonly used in traditional Indian, African and Chinese medicine in the treatment of sore throat (Sharma & Bastakoti, 2009), breast cancer (Anandpara & Tigar, 2017), and type II diabetes mellitus (Ghosh et al., 2011, 2014, 2015). Through clinical trials, it has been found that *D. bulbifera* has proved effective in the treatment of sub-acute thyroiditis (Nam, Cho, & Kim, 2006). Also, it has been proved that *D. bulbifera* could significantly induce apoptosis of HCT116 human colorectal carcinoma cells with ethyl acetate fraction (DBEAF) exhibiting the most compelling cytotoxicity on HCT116 cells with an IC50 of  $37.91 \pm 1.30 \mu\text{g/mL}$  (Hidayat, Fadhlurrahman, Chan, Mohamad, & Kadir, 2018), and it also has shown anti-helminthic activity against *Fasciola gigantica* and *Pheritima posthuma* at concentration of 100 mg/ml. (Adeniran & Sonibare, 2013).

**Table 1. Ethnomedicinal uses of *D.bulbifera***

Plant part	Preparation	Mode of administration	Medicinal use	References
Bulbil	10 mg of dried bulbil powder is given in a day after menses for five days	oral	Contraceptive	(Das, Talukdar, Dutta Choudhury, & Talukdar, 2014; (Kamble et al., 2010); (Swarnkar & Katewa, 2008)
Bulbil	Bulbils are roasted, cooked as vegetable	topical application, oral	piles, dysentery, syphilis, and ulcers	(Dutta, 2015)
Bulbil	Bulbils are roasted, cooked as vegetable	oral	cough, leprosy, and diabetic	(Dutta, 2015)
Bulbil	Bulbils boiled 2–3 times with ash.	oral	tuberculosis	(Sharma & Bastakoti, 2009)
Bulbil	Bulbils boiled 2–3 times with ash.	oral	sore throat and struma	(Sharma & Bastakoti, 2009)
Bulbil	Bulbils are boiled	oral	sexual vigour food	(Subasini et al., 2013)
Bulbil	Bulbils are boiled	oral	wild food for HIV patients in Uganda	(Nabatanzi, 2016)

More so, *D. bulbifera* has proved to have Anti-HIV-1 integrase compounds. The ethyl acetate and water fractions (1–100 mg/mL) of *Dioscorea bulbifera* bulbils were isolated and tested for their anti-HIV-1 IN activity using the multiplate integration.

assay (MIA). The interactions of the active compounds with IN were investigated using a molecular docking method. Galloyl, catechol, and sugar moieties were found to be successful inhibitors for HIV-1 IN. (Chaniad, Wattanapiromsakul, & Pianwanit, 2016). *D. bulbifera* therefore stands a high chance as a candidate in the treatment of HIV. It's no wonder that it is one of the wild foods commonly eaten by the HIV patients as an accompaniment to staple foods (Nabatanzi, 2016). According to (Kвете et al., 2012), the methanol extract of *D. bulbifera* has an efficient anti-bacterial activity against multidrug resistant (MDR) bacteria like *Enterobacter aerogenes* EA289, CM64, *Klebsiella pneumoniae* KP63, *Pseudomonas aeruginosa* PA124, *Mycobacteria* strain and *Staphylococcus aureus* with the lowest MIC value for the methanol extract and fractions at 16 µg/mL. Their antioxidant and dehydroepiandrosterone activity in older humans has as well been reported by (Araghiniknam et al., 1996) whereby *dioscorea* supplementation increases serum dehydroepiandrosterone sulfate (DHEAS) in humans and modulate lipid levels in older people.

### 3. Phytochemistry *D. bulbifera*

Phytochemical analysis of *D. bulbifera* reveals the presence of saponins, tannins, flavonoids, sterols, polyphenols, glycosides (Ghosh, 2015) and steroidal saponins (Tapondjou, Jenett-Siems, Böttger, & Melzig, 2013). The phytochemicals present vary according to the geographical location, parts of a plant and the extraction solvents used. For example, extraction using Ethyl acetate soluble fraction of 75% ethanol extract of *Dioscorea bulbifera* from China has indicated the presence of flavonol aglycones, namely kaempferol-3, 5-dimethyl ether, caryatin, and catechin. It also contains flavonol glycosides, namely, quercetin-3-O-galactopyranoside, myricetin-3-O-galactopyranoside, and myricetin-3-O-glucopyranoside (Kuroyanagi et al., 2002). In addition, steroidal saponins named diosbulbins A, B, C and D, spirostane glycosides named diosbulbins A, B and cholestane glycoside named diosbulbin C were found to be predominant in 95% ethanolic extract of rhizomes of China (Tapondjou et al., 2013). More so, the aqueous methanolic extract of bulbs of *Dioscorea bulbifera* from India contains 8-epidiosbulbin E acetate (EEA) (Shitole et al., 2008). Diosbulbin B is a demethyl diterpenoid found as

a main constituent of chloroform fraction (Kuroyanagi et al., 2002). Carotenoids such as lutein, zeaxanthin, neoxanthins are also prevalent in *D. bulbifera* (Ghosh, 2015). Methanolic extract of bulbils from Cameroon is found to be rich in clerodane diterpenoids, bafoudiosbulbins A, B, C, F and G (Kuate et al., 2012). Phytoalexin called demethylbatatasin IV and norditerpenoid diosbulbin D were isolated from bulbils from Nigeria and tubers from Bangladesh (Adesanya, Ogundana~, & Roberts~, 1989). Flowers of *D. bulbifera* from Cameroon has a wide range of steroidal saponins namely, dioscoreanosides A, B, C, D, E, F, G, H, I, J and K (Tapondjou et al., 2013).

#### 4. Findings

*Dioscorea bulbifera* is made of diverse phytochemicals that contribute to its ethnomedicinal benefits and that these phytochemicals vary depending on the geographical location and the part of plant and type of solvent used in the extraction process.

Utilization of *Dioscorea bulbifera* greatly impacts on its conservation and sustainability. Its conservation can be done by promoting the utilization of *Dioscorea bulbifera* in order to encourage the farmers to cultivate them as in-situ/on-farm conservation in addition to conducting germplasm collection back up (Trimanto and Hapsari 2015). This is because characterization and proper evaluation of germplasm give reliable information that indicates a range of diversity in the collections, and this is of help to the breeders to select potential breeding stocks (Thomas & Mathur, 2003).

Finally, advanced Processing techniques need also to be explored and developed so that alternative products can be made from *Dioscorea bulbifera* bulbils which may be preferred by younger generation such as contraceptive capsules, and tablets to cure the mentioned ailments.

#### 5. Conclusion

*Dioscorea bulbifera* has a wide spectrum of biological activities due to the chemical diversity, though it is not yet well utilised. There is a need for its conservation through increased utilization, evaluating and proper documentation of its germplasm and also adding value to its medicinal products.

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#### Authors contribution

All authors read and approved the final manuscript.

#### Conflict of interests

No potential conflict of interest was reported by the author.

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#### Correction

This article has been republished with minor changes. These changes do not impact the academic content of the article.

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