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DIOSCOREA BULBIFERA- A REVIEW

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Abstract:

Dioscorea bulbifera is also called Air potato it belongs to yam species. In the present review its habit, habitat, phytochemical constituents, and pharmacological properties are discussed. Phytochemical constituents include two clerodane diterpenoids, Bafoudiosbulbins A 1, and B 2, along with five known compounds: tetracosanoic acid, 1-(tetracosanoyl)- glycerol, trans-tetracosanylferulate, b-sitosterol and 3-O-b-D-glucopyranosyl-b-sitosterol, Bafoudiosbulbins A–C, 3,5,40-trihydroxy-30-methoxybibenzyl, and kaempferol. Pharmacological profile includes Antitumor, Antiinflammatory, Antidiabetic, Reversal of bacterial resistance and Toxicological profiles are discussed here.

Key Words: Dioscorea bulbifeara, Varahikanda, Air potato.

Introduction:

Scientific classification:

Kingdom: Plantae
(unranked): Angiosperms
(unranked): Monocots
Order: Dioscoreales
Family: Dioscoreaceae
Genus: *Dioscorea*
Species: ***D. Bulbifera***[1]

A file picture from author.

Dioscorea bulbifera, the Air potato, belongs to yam species. It is also known as Varahi in Sanskrit, Kaachil in Malayalam and Dukkar Kandin Marathi. The Air potato plant is native to Africa and Asia. It is an invasive species in many tropical areas, including Florida[1].

Description:

Dioscorea bulbifera is a perennial vine with broad leaves and has two types of storage organs. The plant forms bulbils in the leaf axils of the twining stems, and tubers beneath the ground. These tubers are like small, oblong potatoes, family belong to Solanaceae or Dioscoreaceae, they are edible and cultivated as a food crop, especially in West Africa. The tubers often have a bitter taste, which can be removed by boiling. They can then be prepared in the same way as other yams, potatoes, and sweet potatoes. It can grow up to 150 feet tall. Air potato can grow extremely quickly, roughly 8 inches per day, and eventually reach over 60 feet long. It typically climbs to the tops of trees and has a tendency to take over native plants. New plants develop from bulbils that form on the plant, and these bulbils serve as a means of dispersal. The aerial stems of air potato die back in winter season, but resprouting occurs from bulbils and underground tubers. The primary means of reproduction through bulbils. The fruits are in capsular form. Air potato has been used as a folk remedy to treat conjunctivitis, diarrhea and dysentery, among other ailments.[2]

Uncultivated forms, such as those found growing wild in Florida can be poisonous. These varieties contain the steroid, diosgenin, which is a principal material used in the manufacture of a number of synthetic steroidal hormones, such as those used in hormonal contraception.[2] There have been claims[3] that even the wild forms are rendered edible after drying and boiling, leading to confusion over actual toxicity. In some places, such as Florida where it is considered a noxious weed, it is an invasive species because of its quick-growing, large-leafed vine that spreads tenaciously and shades out any plants growing beneath it. The bulbils on the vines sprout and become new vines, twisting around each other to form a thick mat. If the plant is cut to the ground, the tubers can survive for extended periods and send up new shoots later.[4]

Phytochemical constituents:

Two clerodane diterpenoids, Bafoudiosbulbins A 1, and B 2, along with five known compounds: tetracosanoic acid, 1-(tetracosanoyl) - glycerol, trans-tetracosanylferulate, b-sitosterol and 3-O-b-D-glucopyranosyl-b-sitosterol were isolated from the tubers of Dioscorea bulbifera L. var sativa. Their structures were established by spectroscopic

methods (1D and 2D-NMR, MS) and X-ray crystallographic diffraction analysis of compound 1. The CH2Cl2-soluble portion of the crude extract and the two clerodanes were screened for anti-bacterial activity using both agar diffusion and broth dilution techniques against Pseudomonas aeruginosa, Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus, Salmonella typhi, Salmonella paratyphi A and Salmonella paratyphi B. They both the extracts showed significant activities against P. aeruginosa, S. typhi, S. paratyphi A and S. ParatyphiB[5].

From the bulbils of Dioscorea bulbifera L. var sativa, two clerodane diterpenoids, Bafoudiosbulbins F (1) and G (2), together with five known compounds: Bafoudiosbulbins A–C, 3,5,40-trihydroxy-30-methoxybibenzyl, and kaempferol were isolated. Their structures were established by spectroscopic techniques, including 1H, 13C NMR, NOESY, ROESY, COSY, TOCSY, HSQC, and HMBC. The relative stereochemistry of compounds 1 and 2 was assigned on the basis of X-ray crystallographic diffraction analysis. Furthermore, the structure of Bafoudiosbulbin B was revised using extensive 2D NMR techniques as well as chemical transformation[6].

The study of physicochemical, morphological and crystal structure characterization of the starches separated from rhizomes of Dioscorea opposita Thunb. Dioscorea alata Linn., Dioscorea nipponica Makino, Dioscorea bulbifera Linn. and Dioscorea septemloba Thunb. were studied and compared. Amylose content was found to be varying between 13.58% and 20.05%. Water-binding capacity, swelling power, solubility and total starch content of starches differed significantly. Scanning electron micrographs revealed that the surface was smooth or rough, the granules were oval to spherical and the sizewas obviously different. D. nipponica displayed A-type pattern. D.opposita D. alata, D. septemloba and D. bulbifera starches all exhibited C-type crystal. While the crystallinity degree of the starches separated from the five species were about 33.90%, 37.63%, 43.11%, 32.06% and 53.35%, respectively. The gelatinization transition temperatures (To, Tp and Tc) and enthalpy of gelatinization (DHgel) and peak height index (PHI) were determined. D. OT, D. AL and D. BL starches showed the higher enthalpy of gelatinization. Pasting viscosity of D. OT and D. BL starches were much higher than others. The five plants could be separated into two groups: D. OT, D. AL and D. BL; D. ST and D. NM[7].

Pharmacological profile:

Antitumor effect:

An antitumor- promoting effect was found in the extracts/ingredients of a plant used as a traditional medicine in mainland China, using the neoplastic transformation assay of mouse epidermal JB6 cell lines. The ethyl acetate

soluble fraction of 75 % ethanol extract of the rhizomes of *Dioscorea bulbifera* L. showed an inhibitory effect against the tumor promotion of JB6 (Cl 22 and Cl 41) cells induced by a promoter, 12-*O*-tetradecanoylphorbol- 13-acetate (TPA). Further investigation on the constituents of the EtOAc fraction from the rhizomes revealed the chemical structure to be kaempferol-3,5-dimethyl ether (1), caryatin (2), (1)-catechin (3), myricetin (4), quercetin-3-*O*-galactopyranoside (5), myricetin-3-*O*- alactopyranoside (6), myricetin-3-*O*-glucopyranoside (7) and diosbulbin B (8). Constituent antitumor-promoting activities were also examined in the same way. Compounds 1—7, characterized as flavonoids with the two hydroxyl groups at C-7 and C-49, showed themost potent inhibitory effect, but there seemed to be differences in the inhibitory effect between flavonol aglycones and flavonol glycosides. Compared with (2)-epicatechin, (1)-catechin exhibited much stronger inhibitory activity which suggested that chemical stereo structures of compounds affect the efficiency of inhibition. Compound 8 showed moderate activity. The constituents with antitumor-promoting activity from this plant are reported for the first time[8].

Antitumor activities of water extract (fraction A), ethanol extract (fraction B), ethyl acetate extract (fraction C), non-ethyl acetate extract (fraction D) and compound diosbulbin B isolated from Dioscorea bulbifera L. (DB) were investigated in vivo. The results showed that fractions B and C both decreased tumor weight in S180 and H22 tumor cells bearing mice, while fractions A and D had no such effect. Furthermore, fraction C altered the weight of spleen and thymus, and the amounts of total leukocytes, lymphocytes and neutrophils in tumor-bearing mice. Further results showed that compound diosbulbin B demonstrated anti-tumor effects in the dose-dependent manner at the dosage of 2 to 16 mg/kg without significant toxicity in vivo. Furthermore, on the basis of chemical analysis of the above extracts by high-performance liquid chromatography (HPLC) with a diode array detector (DAD), diosbulbin B was found to be the major antitumor bioactive component of Dioscorea bulbifera L. These results suggest that Dioscorea bulbifera L. has potential anti-tumor effects which may be related to influencing the immune system for the first time, and the compound diosbulbin B is the major antitumor component of Dioscorea bulbifera L.[9].

Reversal of bacterial resistance:

Bioassay-guided fractionation of an aqueous methanolic extract of *Dioscorea bulbifera* L. bulbs was performed using organic solvents. A novel plasmid-curing compound was identified as 8-epidiosbulbin E acetate (EEA) (norditerpene) on the basis of modern spectroscopic analysis and X-ray crystallography. EEA exhibited broad-

spectrum plasmid-curing activity against multidrug-resistant (MDR) bacteria, including vancomycin-resistant enterococci. EEA cured antibiotic resistance plasmids (R-plasmids) from clinical isolates of *Enterococcus faecalis*, *Escherichia coli*, *Shigella sonnei* and *Pseudomonas aeruginosa* with 12–48% curing efficiency. The reference plasmids of *Bacillus subtilis* (pUB110), *E. coli* (RP4), *P. aeruginosa* (RIP64) and *Salmonella* typhi (R136) were cured with efficiency ranging from16% to 64%. EEA-mediated R-plasmid curing decreased the minimal inhibitory concentration of antibiotics against MDR bacteria, thus making antibiotic treatment more effective. The antibiotic resistance pattern revealed that the compound was effective in the reversal of bacterial resistance to various antibiotics. In addition, the compound did not show any cytotoxicity against a broad range of human cancer cell lines, namely MCF-7 (breast cancer), SiHa (cervical cancer) and A431 (epidermal carcinoma), and hence has the potential to be used as a lead compound for drug discovery programmes[10].

Antidiabetic activity:

Scientific evaluation of the aqueous extract of Dioscorea bulbifera tubers (DBEA003) for its antihyperglycemic activity was performed in glucose primed and streptozotocin (STZ) treated Wistar rats and antidyslipidemic potential in high fat diet fed C57BL/6J mice, respectively. The antihyperglycemic effect was evaluated in temporarily established hyperglycemic condition by priming Wistar rats with 1.5 g/kg p.o. glucose and rendering them diabetic by the injection of STZ (45 mg/kg, intraperitoneally). Dyslipidemic condition was induced in C57BL/6J mice by feeding them high fat diet. DBEA003 at 250, 500 and 1000 mg/kg doses administered for 3 weeks to STZ treated rats and for 4 weeks to high fat diet fed C57BL/6J mice showed significant antihyperglycemic and antidyslipidemic effects. In STZ treated rats with severe diabetes, the 7- week DBEA003 treatment produced significant reduction in blood glucose level and increase in body weight. Serum glucose and lipid levels were reversed towards normal in DBEA003 in treated high fat diet fed mice[11].

Antiinflammatory effect:

The methanol extract of the bulbs of Dioscorea bulbifera was studied in inflammatory and neuropathic models of pain and further investigated its possible mechanism of action. Dioscorea bulbifera administered orally at the doses of 250 and 500 mg/kg were tested in mechanical hypernociception induced by intraplantar (i.pl.) injection of complete Freund's adjuvant (CFA), lipopolysaccharides (LPS) or prostaglandin-E2 (PGE2), as well as in partial ligation sciatic nerve (PLSN), nociception induced by capsaicin and thermal hyperalgesia induced by i.pl. injection

of CFA. The therapeutic effects of Dioscorea bulbifera on PGE2-induced hyperalgesia were evaluated in the absence and in the presence of l-NAME, an inhibitor of nitric oxide synthase (NOS) and glibenclamide, an inhibitor of ATP-sensitive potassium channels. The extract showed significant antinociceptive effects in persistent pain induced by CFA and on neuropathic pain induced by PLSN. The effects of Dioscorea bulbifera persisted for 5 days after two administrations in CFA-induced hypernociception. Dioscorea bulbifera significantly inhibited acute LPS-induced pain but failed to reduce thermal hypernociception and capsaicin-induced spontaneous nociception. The antinociceptive effects of this plant extract in PGE2 model was antagonized by either l-NAME or glibenclamide. Antinociceptive activities of Dioscorea bulbifera both in inflammatory and neuropathic models of pain and these effects may result, at least partially, from its ability to activate the NO–cGMP–ATP-sensitive potassium channels pathway[12].

Toxicity:

The toxic effects of a diterpene lactone, diosbulbin-D, isolated from *Dioscorea bulbifera* L. on hepatocytes. Using the MTT assay to test the effect of diosbulbin-D on hepatocytes. Selected intracellular enzymes release levels by diosbulbin-D were determined to further validate the toxic effect on hepatocytes. Furthermore, the level of intracellular glutathione and the induction of reactive oxygen species (ROS) by diosbulbin-D were measured by fluorometric and flow cytometry methods. Diosbulbin-D showed toxic effect on hepatocytes and a significant increase in intracellular release levels of LDH and the liver enzymes, alanine aminotransferase and aspartate aminotransferase confirmed diosbulbin-D’s toxic effect. ROS increase was related to the decrease in level of GSH. Cell pretreated NAC almost completely blocked the ROS fluorescence and recovered the cell growth inhibition induced by diosbulbin-D. Diosbulbin-D shows direct toxic effect on hepatocytes. The mechanism could be associated with oxidative stress[13].

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