IJP (2024), Vol. 11, Issue 11 **(Review Article)**

Received on 15 October 2024; received in revised form, 22 November 2024; accepted, 23 November 2024; published 30 November 2024

PHARMACOGNOSTIC ANALYSIS OF *DIOSCOREA BULBIFERA* L.: A GATEWAY TO ITS MEDICINAL BENEFITS

Yuvraj Vishwakarma *, Vikas Pandey, Rajesh Shukla, Devendra Dhanorya, Gourav Bairagi and Vandana Gupta

Faculty of Pharmaceutical Science, Mangalayatan University, Jabalpur - 481662, Madhya Pradesh, India.

Keywords:

Dioscorea bulbifera, Antihyperlipidemic, Anti-microbial, Anti-HIV-IN, Anti- tumour, Anti-funga

Correspondence to Author:
Yuvraj Vishwakarma

Faculty of Pharmaceutical Science, Mangalayatan University, Jabalpur - 481662, Madhya Pradesh, India.

E-mail: uv928356@gmail.com

ABSTRACT: Medicinal plants contain phytochemicals that are recognized for their wide range of therapeutic uses. *Dioscorea bulbifera* often referred to as the air potato or bitter yam, is a plant belonging to the *Dioscoreaceae* family, which includes about 600 species. It holds significant traditional medicinal importance worldwide, being used for treating various ailments. This plant is commonly found in India, Maldives, China, Japan, Indonesia, and is a staple food crop in West Africa. The plant features bulbous aerial tubers, toxic substances like the alkaloid dioscorine, and small, dioecious flowers. *Dioscorea bulbifera* grows in tropical and subtropical regions, preferring loamy soils and temperatures between 20°C and 30°C. It reproduces mainly asexually via bulbs. *Dioscorea bulbifera* is widely used in traditional Indian and Chinese medicine for conditions such as piles, dysentery, syphilis, ulcers, pain relief, and inflammation. The plant's tubers and bulbils are noted for their cytotoxic properties, traditionally used in treating sore throats, goitre, and various other conditions. Phytochemical analyses reveal that the plant contains alkaloids, glycosides, sterols, polyphenols, flavonoids, and saponins, contributing to its medicinal uses. The presence of these compounds varies with the plant's geographical origin, highlighting its versatile medicinal potential.

INTRODUCTION: Phytochemicals found in medicinal plants are abundant and have a wide range of therapeutic applications [1]. *Dioscorea bulbifera* is a distinctive medicinal plant within the Dioscoreaceae family, which comprises around 600 species. It holds significant importance in traditional medicine worldwide [2]. The common names for *Dioscorea bulbifera* include air potato, air yam, bitter yam, cheeky yam and air potato. These names reflect its bulbous aerial tubers and its distribution in various regions [3]. *Dioscorea bulbifera* is typically found in Indonesia, Japan, China, Maldives, and India. It serves as a staple food crop in West Africa.

QUICK RESPONSE CODE

DOI: 10.13040/IJPSR.0975-8232.IJP.11(11).584-94

Article can be accessed online on: www.ijpjournal.com

DOI link: https://doi.org/10.13040/IJPSR.0975-8232.IJP.11(11).584-94

These plants are climbing, perennial, erect herbs, or shrubs with woody stems reaching about 10 meters in length. The leaves are simple, opposite, lobed, and alternate, measuring approximately 20 cm in length with a reticulate venation pattern. The stems are herbaceous and emerge from underground tubers. The aerial bulbs contain toxic substances and the alkaloid dioscorine. Flowers are generally small, minute, dioecious, and occasionally bisexual [4]. *Dioscorea bulbifera* is commonly grown in tropical and subtropical regions with moist conditions. It thrives in temperatures ranging from 12°C to 38°C, with optimal growth occurring between 20°C and 30°C.

The plant prefers loamy soil enriched with high organic content for cultivation [5]. Sexual reproduction in *Dioscorea bulbifera* is uncommon and typically occurs through seeds, while asexual reproduction primarily occurs via bulbs [6]. This plant is frequently utilized in traditional Indian and

Chinese medicinal practices [7]. *Dioscorea bulbifera* L. var. Sativa is employed in Bangladesh for treating leprosy and tumors [8]. In the western highlands of Cameroon, native people use *Dioscorea bulbifera* for treating pig cysticercosis, although the tubers are often discarded after harvest because of their intense bitterness. The roots of *Dioscorea bulbifera*, valued for their cytotoxic properties, have traditionally been used in Chinese medicine to address sore throats and goiter [9]. In India, the bulbs of *Dioscorea bulbifera* are used to treat ailments like piles, dysentery, and syphilis and are applied externally for ulcers, pain relief, and to reduce inflammation [10]. In traditional Chinese medicine, *Dioscorea bulbifera* has been widely used by practitioners to treat various conditions, including hemoptysis, goiter, skin infections, orchitis, pharyngitis, and cancer [11]. Additionally, *Dioscorea bulbifera* has been utilized for its blood-clotting properties to stop bleeding and for detoxifying poisons. Phytochemical studies have revealed compounds in the tubers that are associated with a range of medicinal uses [44].

Occurrence and Distribution: *Dioscorea bulbifera*, also called air potato or air yam, is native to tropical regions of Asia, northern Australia, the Americas, and sub-Saharan Africa. In China, it grows in the southern provinces, including Anhui, Fujian, Gansu, Guangxi, Guangdong, Guizhou, Henan, Jiangsu, Tibet, and Yunnan. Known in Chinese herbal medicine as "Huangdu" and "Huangyaozi," this plant has traditional significance in the region [11, 12].

Flowers: From September to November.

Fruit: Starting from December.

Part Used: Roots, Bulbils, Tubers [13].

Taxonomic Classification:

TABLE 1: TAXONOMIC CLASSIFICATION [13]

Kingdom	Plantae
Subkingdom	Viridaeplantae
Superdivision	Streptophyta
Division	Tracheophyta
Class	Mangoliopsida
Superorder	Lilianae
Order	Dioscoreales
Family	Dioscoreaceae
Genus	Discorea L.
Species	*Dioscorea bulbifera* L.

Vernacular Names:

TABLE 2: VERNACULAR NAMES [14]

Languages	Names
English	Potato Yam,Air potato
Sanskrit	Shukara, Aluka,Varahikanda
Hindi	Kadu Kanda, Ratalu, Varahi Kanda,
Gujarati	Dukkarkanda
Bengali	Ban Alu, Ratalu
Tamil	Kodikilanga, Kattu-k-kaay-valli
Marathi	Manakund, Kadu—Karanda, Varahi
Kannada	Kuntagenasu
Konkani	Karamdo
Malayalam	Pannikizhangu, Kattukachil
Orissa	Pita Alu
Telugu	AdaviDumpa

MORPHOLOGY: *Dioscorea bulbifera*, commonly known as air potato, is a vigorously twining perennial vine that can grow up to 20 meters or more in length. Its stems are non-spiny and freely branching above, with round or slightly angled internodes that twine counter-clockwise. The plant possesses two types of storage organs: aerial bulbils located in the leaf axils of the climbing stems and underground tubers. The tubers resemble small, oblong potatoes and have a bitter taste. The bulbils, which are pale and round to globose, can be up to 13 cm wide and are a distinguishing feature of the plant. The leaves of *D. bulbifera* are visually appealing, arranged alternately, and have a broad heart shape, with long petioles connecting them to the stem. They measure 10-15 cm in length and 7.5-10 cm in width, with a deeply cordate base and an acuminate to shortly caudate apex. The leaves are membranous, glabrous, and have 9-11 prominent, radiating veins originating from the point where the petiole attaches. The petioles can be up to 20 cm long. Flowers are rare in *D. bulbifera*. When present, they are small, pale green, and fragrant, arising from the leaf axils. Male flowers appear in slender, axillary panicled spikes that are pendulous and can reach up to 18 cm in length. The bracteoles are ovate and acute [15].

The perianth of *Dioscorea bulbifera* is light green, with six biseriate lobes, each about 2.5 mm long and linear-oblong in shape. The plant has six free stamens. Female spikes appear in clusters of 1-3, with three staminodes. The ovary is triquetrous and 3-locular, containing two ovules per locule. The styles are three in number, with a 2-fid, reflexed

stigma. The capsules, which serve as the fruit, measure 1.5-2.3 cm by 1-1.5 cm, are oblong, and have three wings. The seeds are partially winged. *Dioscorea bulbifera* reproduces both sexually, through seeds, and vegetatively, through underground and aerial tubers (bulbils). This dual mode of reproduction allows it to spread quickly and dominate entire forests within a single growing season. The aerial stems die back in the winter, but the plant resprouts from the bulbils and underground tubers [13].

FIG. 1: *DISCOREA BULBIFERA*: (I) LEAF (II) TUBER (III) WHOLE PLANT [17] (IV) STEM [18]

The bulbil of *Dioscorea bulbifera* is fairly hard and heavy, dish-shaped, measuring up to 12 cm (5 inches) by 10 cm (4 inches). It is brown with numerous, uniformly distributed, tubercle-like eyes. The plant produces abundant bulbils of various sizes and shapes; in some cultivars, the tuber is suppressed in favour of larger bulbils that contain all the reserve food. Typically, small bulbils are warted, but larger ones can be smooth. Tubers are typically small and round but can reach larger sizes when cultivated, occasionally weighing as much as 1 kg. The edibility of the tubers varies by variety; they can be either toxic or edible. Tubers are renewed annually and have a purplish-black or earth-coloured skin, often coated with numerous small feeding roots, although some cultivated varieties have smooth skin. The flesh inside can range from white to lemon yellow, sometimes with purple flecks, and is very mucilaginous **Fig. 1**. The tubers have a few root and root scars, with a dark brown outer surface and a yellow to light brown inner surface. The odour is indistinct, and the taste is bitter [13].

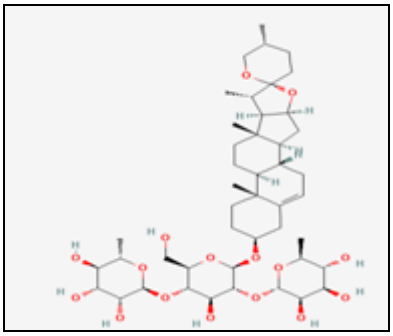
Phytoconstituents: Phytochemical research on *Dioscorea bulbifera* has revealed that it contains a variety of compounds, including alkaloids, glycosides, proteins, fats, sterols, polyphenols, tannins, flavonoids, and saponins, with their occurrence possibly varying depending on the country where the plant is sourced. Inorganic micronutrients found in *Dioscorea bulbifera* include iron (Fe), copper (Cu), zinc (Zn), manganese (Mn), cobalt (Co), molybdenum (Mo), vanadium (V), boron (B), chlorine (Cl), iodine (I), bromine (Br), and sodium (Na) [19].

TABLE 3: PHYTOCONSTITUENTS OF *DIOSCOREA BULBIFERA*

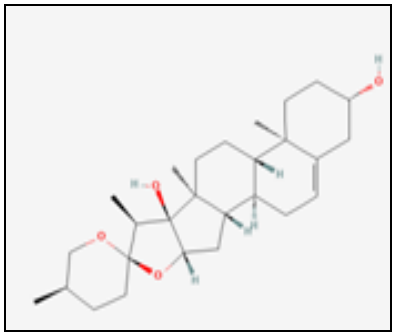
Sr. no.	Category	Phytoconstituents	References
1.	Steroidal Saponins	Dioscoreanoside A-K, Discoreanoside B, Discoreanoside C, Discoreanoside D, Discoreanoside E, Discoreanoside F, Discoreanoside G, Discoreanoside H, Discoreanoside I, Discoreanoside J, Discoreanoside K, Dioscin	20
2.	Steroidal Sapogenin, Spirostane Glycosdes, Cholestane Glycosides	Diosbulbisin A, Diosbulbisin B, Diosbulbisin C, Diosbulbisin D, Diosbulbisides A, Diosbulbisides B, Diosbulbisides C, Diosgenin, Sinodiosgenin	21,22,23
3.	PNorclerodane Diterpenoids	Diosbulbin A, Diosbulbin B, Diosbulbin C, Diosbulbin D, Diosbulbin E, Diosbulbin F, Diosbulbin G, Diosbulbin H, Diosbulbin I, Diosbulbin J, Diosbulbin K, Diosbulbin L, Diosbulbin M, Diosbulbin N, Diosbulbin O, Diosbulbin P, 8-Epidiosbulbin E Acetate	24,25,26,27,28
4.	Clerodane Diterpenoids	Bafoudiosbulbin A, Bafoudiosbulbin B, Bafoudiosbulbin C, Bafoudiosbulbin F, Bafoudiosbulbin G	29,30,31
5.	Flavanoids Derivatives	Quercetin-3-O-β-d-glucopyranoside, Quercetin-3-O-β-d-	32,33

		galactopyranoside, Myricetin-3-0- β-D galactopyranoside, Myricetin-3-0- β-D glucopyranoside, 3,5-dimethoxy-kaempferol, 3,5,3'-trimethoxyquercetin, Caryatin, Hyperoside, Kaempferol, Kaempferol-3-O-β-D- glucopyranoside, Kaempferol-3,5-dimethylether, Quercetin-3-O- galactopyranoside, Myricetin, Isoquerctrin, Lutenin, Quercetin-3-O- β-D- glucopyranoside,7-bis-(4-hydroxyphenyl)-4E, 6E-heptadien-3-one,5,3,4-trihydrox-3,7-dimethoxyflavone.	
6.	Phenanthrenes	2,7-dihydroxy-4-methoxyphenanthrene, 2,7-dihydroxy-3,4,6-trimethoxyphenanthrene, 1,6-dihydroxy-2,5,7-trimethoxyphenanthrene	32,33,34
7.	Carotenoids	Neoxanthin, Auroxanthin,Violaxanthin, Cryptoxanthine	14
8.	Phytosterols	Daucosterol, β-sitosterol, 3-O- β-D-glucopyranosyl-b-sitosterol, Stigmasterol.	20,30,32
9.	Tannins	Protocatechuic acid,Catechin, (+) Epicatechin, (-) Epicatechin	32,34
10.	Volatile oils	Isovanillicacid,Vanillic acid	32,34
11.	Glycosides Derivatives	Methyl-O-α-D-fructofuranoside, Butyl-o- α-fructofuranoside, Ethyl-o-β-D-fructopyranoside,3-phenyl-2-propenyl-O- β-D-Glucopyranoside,2-(4-methoxyphenyl)-ethyl-O- β-D-glucopyranoside, Phenyl-methyl-O- β-D-glucopyranoside. Pennogennin, Pennogenin-3-O- α-Lrhamnopyranosyl-(1-3)-[α-L-rhamnopyranosyl-(1-2)]- β-D-glucopyranoside	21,24,28

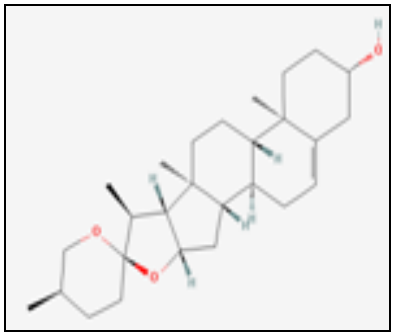
Chemical Structures of Several Key Phytochemicals Present in *Dioscorea bulbifera*:



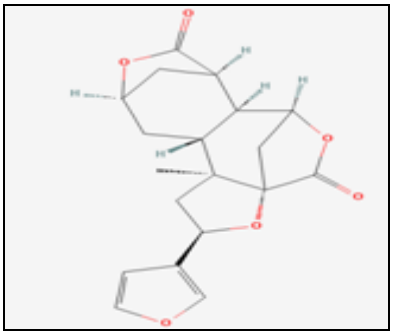
DIOSCIN



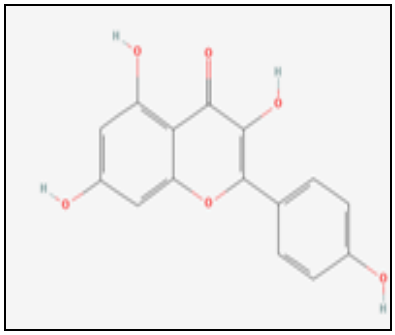
PENNOGENNIN



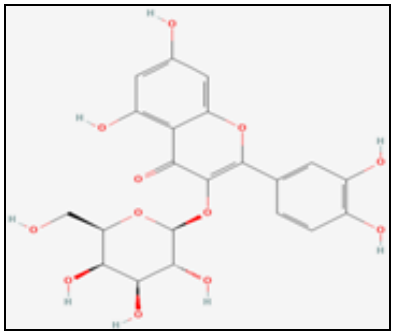
DIOSGENIN



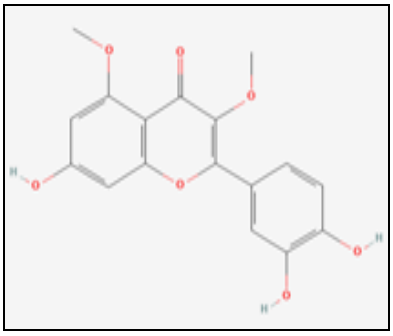
DIOSBULBIN B



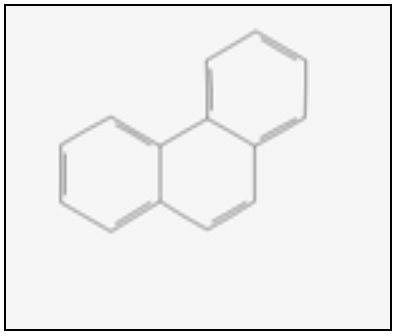
KAEMPFEROL



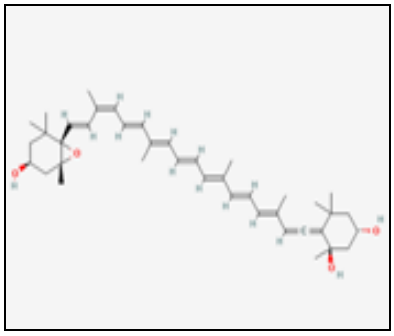
HYPEROSIDE



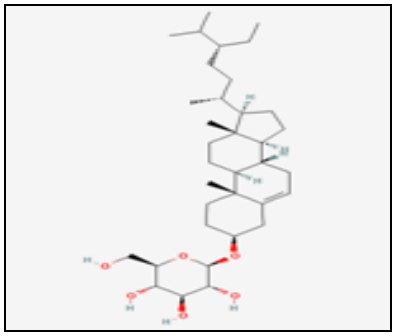
CARYATIN



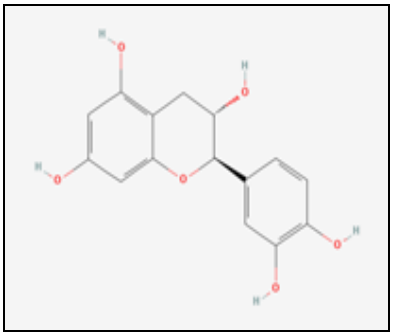
PHENANTHRENE



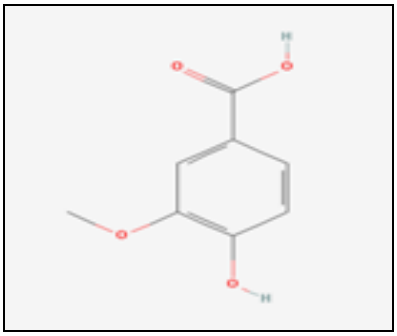
NEOXANTHIN



SITOGLUSIDE



CATECHIN



VANILLIC ACID

TABLE 4: ETHNOBOTANICAL APPLICATIONS OF *DIOSCOREA BULBIFERA*

Plant Parts	Ethnomedicinal Uses	Mode of Action	References
Leaves	A paste made from the leaves is used to treat skin infections	-	[36]
Stem	Crushed twigs and tender shoots are applied to the hair to eliminate dandruff	-	[37]
Tuber	Utilized for treating skin infections	Oral	[38]
Tuber	Consumed raw to stimulate appetite	Oral	[39]
Tuber	Dried bulb powder is administered for five days to treat contraceptive-related conditions	Oral	[40,41]
Tuber	It is boiled twice with ash and utilized to treat struma, throat infections, and tuberculosis	Oral	[40]
Tuber	Roasted and crushed tubers mixed with salt are consumed to alleviate cough	Oral	[42]
Tuber	Crushed roots are combined with cow's milk and given orally to treat asthma and cough	Oral	[43]
Tuber	Utilized for alleviating throat pain	Oral	[44]
Tuber	The tuber is boiled and used to relieve abdominal pain	Oral	[45]
Tuber	Bulbils are boiled and used to enhance sexual vigor	Oral	[46]
Tuber	Bulbils are roasted and cooked as a vegetable, and are served to treat cough, dysentery, piles, ulcers, diabetes, leprosy, and syphilis	Oral	[37]
Tuber	Bulbils are boiled and given to treat HIV patients in Uganda	Oral	[47]

Pharmacological Activities:

Antibacterial Activity: The air-dried bulbils of *Dioscorea bulbifera* were finely ground and extracted three times (for 72 hours each) with hexane, dichloromethane, ethyl acetate, methanol, ethanol, and distilled water. The resulting extract was filtered using Whatman No. 1 filter paper under vacuum and concentrated by evaporating the solvent with a rotary evaporator. The extract was subsequently freeze-dried and kept at -20 °C until required for use. To assess the antimicrobial properties of *Dioscorea bulbifera* extracts, common skin pathogens were selected. The bacterial strains tested included *Staphylococcus aureus* DMST 8840, methicillin-resistant *Staphylococcus aureus* (MRSA) DMST 20651, Staphylococcus epidermidis DMST 3547, Staphylococcus epidermidis DMST 4343, and Pseudomonas aeruginosa DMST 4739.The bacterial strains were subcultured on brain heart infusion agar (BHA) and incubated at 37 °C for 24 hours before testing [48]. To prepare the extract, 64 mg/mL was dissolved in 10% DMSO and subsequently diluted in Mueller Hinton broth (MHB) to obtain concentrations ranging from 0.006 to 64 mg/mL in a 96-well microtiter plate. A 10% DMSO solution served as the control. Fifty microliters of the extract and control were used in the analysis. The bacterial strains were adjusted to a turbidity equivalent to a 0.5 McFarland standard and then diluted 1:100 in MHB. Fifty microliters of this bacterial suspension were added to each well. The microtiter plates were gently tapped at the corners to ensure thorough mixing. Tetracycline served as a positive control, and the plates were incubated at 37 °C for 24 hours. Each minimum inhibitory concentration (MIC) determination was conducted in triplicate, with MIC defined as the lowest concentration of the extract that prevented visible bacterial growth [48]. As represent in **Table 5.** The minimum inhibitory concentration (MIC) was used to evaluate the inhibitory effects of the crude ethyl acetate extract

and the antibacterial fraction from *Dioscorea bulbifera* on all tested bacteria. The MIC values ranged from 0.78 to 1.56 mg/mL for the ethyl acetate extract and from 0.02 to 0.78 mg/mL for the antibacterial fraction. The antibacterial fraction showed the strongest effect against Staphylococcus epidermidis 3547. The ethyl acetate extract of *Dioscorea bulbifera* demonstrated significant antibacterial activity, as reflected in its MIC values. The antibacterial fraction exhibited notably stronger activity against the bacterial strains tested, with lower MIC values across all species, suggesting a higher concentration of active components within this fraction that enhances its antimicrobial effect [48].

TABLE 5: MINIMUM INHIBITORY CONCENTRATIONS (MIC) OF ETHYL ACETATE EXTRACT AND FLAVANTHRIN-CONTANING FRACTION [48]

Sample	MIC (mg/mL)				
	S. aureus DMST 8840	MRSA DMST 20651	*S. epidermidis* DMST 3547	*S. epidermidis* 4343	*P. aeruginasa* DMST 4739
Ethyl acetate extract	0.78	1.56	1.56	0.78	1.56
Flavanthrin-contaning fraction	0.04	0.04	0.02	0.04	0.78
Tetracycline	0.015	0.03	0.015	0.12	0.06

Antifungal Activity: Extracts from the leaves, stems, and tubers of *Dioscorea bulbifera* were screened for antifungal activity against Candida parapsilosis (MTCC 2513). The antifungal activity was assessed using a slightly modified version of the standard disc diffusion method [49, 50].

Each extract was dissolved in dimethyl sulfoxide (DMSO), and three concentrations of the plant extracts (25, 50, and 100 mg/mL) along with standard drugs were prepared. Discs measuring 6 mm in diameter were soaked in the solutions for 12 hours before being placed on swabbed petri plates. After incubating the plates at 37°C for 18 to 24 hours, the zones of growth inhibition around the discs were measured. The sensitivity of the microbial species to the plant extracts was evaluated by measuring the size of the inhibitory zones, including the diameter of the discs. Zones measuring less than 8 mm were considered inactive against the microorganisms [51]. The media used for antifungal test was Sabouraud's dextrose agar/ broth of Hi media Pvt. Bombay, India. It was noted that the peels of *Dioscorea bulbifera* tubers are traditionally used to treat fungal skin infections. Tribal communities in Odisha and Jharkhand collect these tubers from the wild, dry them, peel off the upper layer, and macerate it. The resulting paste is applied externally to treat fungal skin infections. To validate this traditional use, antifungal activity tests were conducted, and the results indicated that tuber extracts were more effective than leaf and stem extracts.

TABLE 6: ANTIFUNGAL ACTIVITY (ZONE OF INHIBITION INMM, MEAN± SD; N=3) OF *DIOSCOREA BULBIFERA* LEAF, STEM, TUBER) AGAINST MTCC 2513 [51]

Plants Part	Concentration (mg/ml)	Aqueous	Methanol	Ethanol
Leaf	25	ZI ≤ 7.0	ZI ≤ 7.0	ZI ≤ 7.0
	50	8.16 ± 0.28	9.0 ± 0.50	9.16 ± 0.28
	100	10.16 ± 0.28	10.50 ± 0.50	11.16 ± 0.76
Stem	25	ZI ≤ 7.0	ZI ≤ 7.0	ZI ≤ 7.0
	50	ZI ≤ 7.0	ZI ≤ 7.0	ZI ≤ 7.0
	100	7.83 ± 0.78	8.50 ± 0.50	9.16 ± 0.28
Tuber	25	8.16 ± 0.28	9.33 ± 0.28	9.50 ± 0.50
	50	10.16 ± 0.28	11.00 ± 0.50	12.00 ± 0.50
	100	11.16 ± 0.28	12.33 ± 0.28	13.00 ± 0.50

(mm: millimetre; SD: Standard Deviation; n: replica; ≤: less than or equal to).

Antihyperlipidemic Activity: The aerial tubers of *Dioscorea bulbifera* were freshly harvested from a farm in Amiri, Imo State, Nigeria. They were sliced into smaller pieces and shade-dried for two weeks. The dried tubers were ground into a coarse powder and then exhaustively extracted using a Soxhlet apparatus with a hydro methanol mixture (80:20). The extraction and subsequent phytochemical screening were conducted following the methods described by Odebiyi and Sofowora [52].

The extracts were filtered and then concentrated to dryness using a rotary evaporator at 40-50°C. The hydromethanol extracts were subsequently stored at 2-5°C until needed for further use. Fifty-five adults male Wistar rats, weighing between 180 and 250 grams, were obtained from the Animal House of the Department of Human Physiology at the University of Port Harcourt for the study. The rats underwent a three-week acclimatization period before the study began, kept under standard laboratory conditions: temperature between 25-29°C, 55-65% relative humidity, and a natural light/dark cycle. During acclimatization, the rats were fed balanced commercial rat chow (Top Feed LTD., Sapele, Nigeria) *ad libitum*. Hyperlipidaemia was naturally induced in the rats by feeding them a specially formulated high-fat diet, consisting of 80% commercial rat chow (Top Feed LTD., Sapele, Nigeria) and 20% rendered cow fat. The experimental design involved dividing the male Wistar rats into eleven groups, consisting of five control groups and six experimental groups. The lipid profile, serum glucose levels, and atherogenic index of Wistar rats, which were induced with hyperlipidaemia using a high-fat diet, tyloxapol, and dexamethasone, were assessed after treatment with the hydromethanolic extract of *Dioscorea bulbifera* [53].

Anti-HIV-1 IN Activity: The bulbils of *Dioscorea bulbifera* were harvested in 2011 from Uttaradit Province, Thailand. A botanist from the Forest Herbarium, Department of National Parks, Wildlife and Plant Conservation, Thailand, identified the plant. The voucher specimen (SKP 062040201) has been stored at the Faculty of Pharmaceutical Sciences; Prince of Songkla University [55]. The HIV-1 integrase (IN) protein was generously supplied by Dr. Robert Craigie from the National Institutes of Health, Bethesda, MD. This enzyme was produced in Escherichia coli and purified following the method outlined by [54]. Dried bulbil powders of *Dioscorea bulbifera* (1.7 kg) were macerated three times with ethanol at room temperature. The mixture was then concentrated under reduced pressure, yielding an ethanol extract of 258.0 g. This extract was subsequently partitioned using hexane, chloroform, ethyl acetate, and water, producing a chloroform fraction (108.15 g), an ethyl acetate fraction (44.44 g), and a water fraction (105.18 g) [55].

TABLE 7: ANTI-HIV-1 INTEGRASE ACTIVITY OF ETOH EXTRACT AND FRACTIONS FROM *DIOSCOREA BULBIFER*

Sample	% Inhibition at various concentration (microgram/millilitre)					
	1	3	10	30	100	IC_{50} (µg/ml)
EtOH	5.33 ± 0.73	10.11 ± 1.50	55.84 ± 0.23	72.11 ± 1.75	89.25 ± 1.61	11.65
$CHCL_3$ Fraction	8.48 ± 0.48	19.67 ± 2.58	90.83 ± 1.18	96.97 ± 1.01	102.42 ± 3.26	5.42
EtOAc Fraction	1.82 ± 0.81	7.70 ± 5.15	93.64 ± 0.05	97.76 ± 0.76	101.21 ± 3.22	6.49
H_2O Fraction	6.65 ± 0.15	10.49 ± 2.64	47.48 ± 7.71	95.44 ± 0.36	98.53 ± 4.04	9.12

The ethyl acetate and water fractions of *Dioscorea bulbifera* bulbils yielded seven compounds. Among these, allantoin, 2,4,3',5'-tetrahydroxybibenzyl, and 5,7,4'-trihydroxy-2-styrylchromone were identified for the first time in this plant. Myricetin exhibited the strongest activity with an IC50 value of 3.15 µM, followed by 2,4,6,7-tetrahydroxy-9,10-dihydrophenanthrene with an IC50 value of 14.20 µM, quercetin-3-O-β-D-glucopyranoside with an IC50 value of 19.39 µM, and quercetin-3-O-β-D-galactopyranoside with an IC_{50} value of 21.80 µM. The potential interactions of the active compounds with the integrase (IN) active site were further explored. Compound 4 demonstrated the best binding affinity to IN, forming strong interactions with several amino acid residues, including Asp64, Thr66, His67, Glu92, Asp116, Gln148, Glu152, Asn155, and Lys159. These residues are involved in both the 3'-processing and strand transfer reactions of IN. Specifically, galloyl, catechol, and sugar moieties were identified as successful inhibitors of HIV-1 IN [55].

Anti-Tumour Activity: Rhizomes of *Dioscorea bulbifera* were gathered in Qingyang, Anhui province, and authenticated by Prof. Shou-Jin Liu from Anhui College of Traditional Chinese Medicine in Anhui, China. A voucher specimen has been preserved in the herbarium of the Institute of Traditional Chinese Medicine at Shanghai University of Traditional Chinese Medicine [56]. The antitumor activities of the water extract (fraction

A), ethanol extract (fraction B), ethyl acetate extract (fraction C), non-ethyl acetate extract (fraction D), and the compound diosbulbin B, isolated from *Dioscorea bulbifera* L., were investigated. Each mouse, except those in the normal group, was subcutaneously injected with approximately 10^6 S180 or H22 ascites tumor cells into the right armpit, following a reported experimental procedure. One day post-inoculation, the tumor-inoculated mice were randomly divided into several groups of ten. Mice treated with 5-fluorouracil (5-Fu) received intraperitoneal injections of the drug at a dose of 25 mg/kg every other day as a positive control. Both the normal (non-tumor-inoculated) and control (tumor-inoculated) groups were administered 0.5% CMC-Na solution (0.2 ml/10 g) orally each day. The treated groups were given specific concentrations of fraction A (275 mg/kg), fraction B (200 mg/kg), fraction C (40 mg/kg), and fraction D (160 mg/kg) *via* intragastric administration for 14 days, starting 24 hours after tumor inoculation. On the 15th day, blood samples from selected groups were collected from the retro-orbital plexus for hematological analysis. All animals were euthanized by cervical dislocation, and the tumors, spleens, and thymus glands were removed, weighed, and photographed. The tumor inhibition ratio (%) was calculated using the formula:

$$\text{Tumor inhibition ratio (\%)} = [(C - T)/C] \times 100,$$

Where, C represents the average tumor weight of the control group (treated with CMC-Na), and T is the average tumor weight of the treated group. The compound diosbulbin B, extracted from the rhizome of *Dioscorea bulbifera*, was found to inhibit the growth of transplanted S180 sarcoma in mice. Diosbulbin B significantly inhibited tumor growth in a dose-dependent manner, with tumor inhibition ratios of 45.76%, 65.91%, 77.61%, and 86.08% at doses of 2, 4, 8, and 16 mg/kg, respectively ($P < 0.05$) [56].

Gastro Protective Activity: The hydroalcoholic extract of *Dioscorea bulbifera* tubers demonstrated gastroprotective activity at doses of 100, 200, and 400 mg/kg against indomethacin-induced gastric ulcers in rats [57].

Neuro Pharmacological Activity: The hydroalcoholic extract of *Dioscorea bulbifera* tuber exhibited central nervous system depressant effects at doses of 100 and 300 mg/kg (administered orally). The treatments significantly reduced spontaneous motor activity and rectal temperature, and prolonged pentobarbitone-induced hypnosis in mice. However, the extract did not affect motor coordination as evidenced by the rota rod test, indicating a central rather than peripheral mechanism of action. Additionally, the extract showed anxiolytic activity in both the plus maze test and head-dip test [58].

Anti-Diabetic Activity: Type II diabetes is characterized by an increase in blood glucose levels after meals. This postprandial glucose surge can be mitigated by inhibiting the activities of α-amylase and α-glucosidase, enzymes involved in carbohydrate digestion. Crude extracts of *Dioscorea bulbifera* have been shown to significantly inhibit α-amylase and trypsin activities (13.2 ± 2% and 4.3 ± 0.2%, respectively). Additionally, aqueous extracts of *Dioscorea bulbifera* tubers demonstrated antihyperglycemic effects in C57BL/6J mice and streptozotocin (STZ)-treated Wistar rats. When STZ-treated Wistar rats were administered 500 mg/kg doses of *Dioscorea bulbifera* extracts, significant antihyperglycemic effects were observed after six weeks of treatment. Various solvent extracts (ethyl acetate, methanol, petroleum ether, and 70% ethanol) of *Dioscorea bulbifera* were evaluated for their antidiabetic properties, with the ethyl acetate extract showing optimal results by inhibiting α-glucosidase by 99.6% and α-amylase by 73.39%. In a study by Ghosh and colleagues, diosgenin derived from *Dioscorea bulbifera*was identified as a promising new drug candidate for type II diabetes. Ethyl acetate extracts of *Dioscorea bulbifera* containing diosgenin exhibited the highest inhibition rates of 82.64 ± 2.32% for α-glucosidase and 72.06 ± 0.51% for α-amylase [59].

Anti-viral Activity: Concerning the pharmacological properties of *Dioscorea bulbifera*, only a limited number of studies have explored its antiviral activities. Various fractions of ethanolic extracts, including butanol, ethyl acetate, acetone, and ether, have been found to inhibit the coxsackie B1-VI virus [61]. The ethyl acetate and acetone fractions were identified as the most effective in inhibiting viral activity compared to other fractions.

Researchers also suggested that ethanol extracts at concentrations of 0.017-0.034 mg/ml from *Dioscorea bulbifera* could suppress RNA virus transcription and eliminate DNA viruses. Diosgenin, a compound derived from *D. bulbifera*, has been shown to inhibit the replication of the Hepatitis C virus at low doses. Additionally, hyperoside has been found to inhibit Hepatitis B virus activity both in laboratory settings and in living organisms, without being toxic to the host cells.[62]Quercetin increases the inhibition of tumor necrosis factor in a dose-dependent manner against vesicular stomatitis virus, encephalomyocarditis virus, and herpes simplex virus type 1.

CONCLUSION: The pharmacognostic examination of *Dioscorea bulbifera* L. highlights its notable medicinal properties and reinforces its importance in traditional medicine. This research identifies a range of phytochemical components, including alkaloids, flavonoids, and saponins, that are responsible for the plant's therapeutic benefits. The existence of these bioactive substances indicates potential anti-inflammatory, antioxidant, and anticancer effects, positioning *Dioscorea bulbifera* as a strong candidate for future pharmaceutical exploration. Moreover, the morphological and anatomical characteristics revealed in this study offer crucial information for the accurate identification and quality assessment of the plant, ensuring that medicinal products derived from it are both effective and safe. The ethnobotanical knowledge associated with *Dioscorea bulbifera* further highlights its enduring significance across cultures, particularly in treating conditions such as respiratory issues, diabetes, and gastrointestinal problems. In summary, *Dioscorea bulbifera* is an invaluable asset in herbal medicine, warranting additional investigation to uncover its pharmacological properties and mechanisms. By merging traditional practices with contemporary scientific methods, we can fully harness its therapeutic potential. This plant not only embodies a rich legacy of medicinal use but also offers a pathway to the development of new therapies that align with the increasing interest in natural remedies and holistic health. Future research should aim to isolate specific compounds and conduct clinical trials to validate its medicinal claims and broaden its applications in modern healthcare.

ACKNOWLEDGEMENT: Nil

CONFLICT OF INTEREST: Nil

REFERENCES:

1. Shajeela PS, Mohan VR, Jesudas LL and Soris PT: Antifertility acitivity of ethanol extract of *Dioscorea esculenta* (L.) Schott on male albino rats. International Journal of Pharm Tech Research CODEN 2011; 3: 946-954.
2. Saravanan M and Ignacimuthu S: Hypocholesterolemic effect of Indian medicinal plants - A review. Med Chem 2015; 5: 040-049.
3. Bajaj YPS: *Dioscorea balcanica* Kosanin and *D. caucasica* Lipsky: *In-vitro* culture and production of diosgenin. In: Biotechnology in agriculture and forestry 43Medicinal and Aromatic Plants XI," Springer, Berlin Heidelberg, New York 1999; 85-102.
4. Tindall HD: Vegetables in the Tropics. MacMillan, Oxford 1983; 0-333: 24268-8.
5. Martín FW: Tropical yams and their potential. Part 2. *Dioscorea bulbifera*. Agriculture Handbook, United States Department of Agriculture 1974; 466.
6. Miller JH: Nonnative Invasive Plants of Southern Forests: A Field Guide to Identification and Control. Southern Research Station 2003; 62.
7. Chaniad P, Tewtrakul S, Sudsai T, Langyanai S and Kaewdana K: Anti-inflammatory, wound healing and antioxidant potential of compounds from *Dioscorea bulbifera* L. bulbils. PLoS ONE 2020; 15(12): e0243632. https:// doi.org/10.1371/journal.pone.0243632.
8. Murray RDH, Jorge ZD, Khan NH, Shahjahan M and Quaisuddin M: "Diosbulbin d and 8-epidiosbulbin e acetate, norclerodane diterpenoids from *Dioscorea bulbifera* tubers," Phytochemistry 1984; 23(3): 623–625.
9. Komori T: "Glycosides from *Dioscorea bulbifera*," Toxicon 1997; 35(10): 1531–1535.
10. Gupta D and Singh J: "p-Hydroxy acetophenone derivatives from *Dioscorea bulbifera*." Phytochemistry 1989; 28(3): 947–949.
11. Editorial Board of Chinese Materia Medica, Huangyaozi. Zhong Hua Ben Cao (Chi nese Materia Medica). Shanghai Science and Technology Press, Shanghai 1999; 7278–7280.
12. Guan XR, Zhu L, Xiao ZG, Zhang YL, Chen HB and Yi T: Bioactivity, toxicity and detoxification assessment of *Dioscorea bulbifera* L.: a comprehensive review. Phytochemistry Reviews 2017; 16: 573–601.
13. Galani Varsha J and Patel Divyeshkumar: Department of pharmacology, Indukaka Ipcowala College of Pharmacy, New Vallabh, India 2010 DOI: 10.19080/IJESNR.2017.04.555650.
14. Khare CP: Ayurvedic Pharmacopoeial plant drugs-Expanded therapeutics. CRC Press, Boca Raton, London, Newyork 2016; 227-228.
15. Anonymus: Indian Medicinal Plants. ICMR, New Delhi 2009; 9: 458 459.
16. Subasini U, Thenmozhi S, Sathyamurthy D, Vetriselvan S and Victor Rajamanickam G: Pharmacognostic and phytochemical investigations of *Dioscorea bulbifera* L. Int J Pharm & Life Sci 2013; 4(5): 2693-2700.
17. Bishwa Bhusan Kundua, Karan Vannia , Ayesha Farheena, Priyanka Jhac, Devendra Kumar Pandeya and Vijay Kumar: Plant Biotechnology Lab, Division of Research and Devel opment, Lovely Professional University,

Phagwara, 144411, Punjab, India 2020 https://doi.org/10.1016/j.sajb.2020.07.028.
18. Kadambini Das, Swati Celia Topno, Jaydeep Kumar Sahu, Sanjeet Kumar and Ghodke Anita Sureshrao: Biological Archives 2024; ISBN: 978-81-970898-9-3 DOI: https://doi.org/10.5281/zenodo.11524677.
19. Tapondjou LA, Jenett-Siems K, Bottger S and Melzig MF: Steroidal saponins from the flowers of *Dioscorea bulbifera* var. sativa Phytochemistry 2013; 95: 341- 350.
20. Liu H, Chou GX, Wu T, Guo YL and Wang SC: Steroidal sapogenin and glycosides from the rhizomes of *Dioscorea bulbifera*. J Nat Prod 2009; 72: 1964-1968.
21. Das A: Agro-techniques of selected medicinal plants. TERI Press, India 2008; 1: 85-88.
22. Patel K, Gadewar M, Tahilyani V and Patel DK: A review on pharmacological and analytical aspects of diosgenin: a concise report. Nat Products Bioprospect 2012; 2(2): 46-52.
23. Komori T: Glycosides from *Dioscorea bulbifera*. Toxicon 1997; 35: 1531-1536.
24. Tang Y, Xue YB, Zhou L, Zhang JW and Yao GM: New norclerodane diterpenoids from the tubers of *Dioscorea bulbifera*. Chem Pharm Bull (Tokyo) 2014; 62(7): 719-724.
25. Wang G, Liu JS, Lin BB, Wang GK and Liu JK: Two new furanoidn or diterpenes from *Dioscorea bulbifera*. Chem Pharm Bull (Tokyo) 2009; 57(6): 625-627.
26. Liu H, Chou GX, Guo YL, Ji LL and Wang JM: Norclerodane diterpenoids from rhizomes of *Dioscorea bulbifera*. Phytochemistry 2010; 71(10): 1174-1180.
27. Shriram V, Jahagirdar S, Latha C, Kumar V and Puranik V: A potential plasmid-curing agent, 8-epidiosbulbin E acetate, from *Dioscorea bulbifera* L. against multidrug-resistant bacteria. Int J Antimicrob Agents 2008; 32(5): 405-410.
28. Kuete V, Betrandteponno R, Mbaveng AT, Tapondjou LA and Meyer JJ: Antibacterial activities of the extracts, fractions and compounds from *Dioscorea bulbifera*. BMC Complement Altern Med 2012; 12: 228.
29. Teponno RB, Tapondjou AL, Gatsing D, Djoukeng JD and Abou-Mansour E: Bafoudiosbulbins A, and B, two anti-salmonellal clerodane diterpenoids from *Dioscorea bulbifera* L. var sativa. Phytochemistry 2006; 67(17): 1957-1963.
30. Teponno RB, Tapondjou AL, Donatien G, Djoukeng JD and Mansour EA: Bafoudiosbulbins F and G, further clerodane diterpenoids from *Dioscorea bulbifera* L var sativa and revised structure of Bafoudiosbulbin B. Phytochemistry 2008; 69(12): 2374-2379.
31. Gao HY, Hou BL, Kuroyanagi M and Wu LJ: Constituents from anti tumor-promoting active part of Dioscorea bulbifera L. in JB6 mouse epidermal cells. Asian J Tradit Med 2007; 2(3): 104-109.
32. Gao HY, Kuroyanagi M, Wu LJ, Kawahara N, Yasuno T and Nakamura Y: Antitumor-promoting constituents from *Dioscorea bulbifera* L. in JB6 mouse epidermal cells. Biol Pharm Bull 2002; 25(9): 1241-1243.
33. Liu H, Tsim KWK, Chou GX, Wang JM and Ji LL: Phenolic compounds from the rhizomes of *Dioscorea bulbifera*. Chem Biodivers 2011; 8(11): 2110-2116.
34. Tang Z, Zhou Y, Zeng Y, Zang S and He PG: Capillary electrophoresis of the active ingredients of *Dioscorea bulbifera* L. and its medicinal preparations. Chromatographia 2006; 63(11-12): 617-622.
35. Kuete V, Betrandteponno R, Mbaveng AT, Tapondjou LA and Meyer JJ: Antibacterial activities of the extracts, fractions and compounds from *Dioscorea bulbifera*. BMC Complement Altern Med 2012; 12: 228.
36. Girach RD, Shaik AA, Singh SS and Ahmad M: The medicinal flora of Similiphar forests, Orissa state, India. Journal of Ethnopharmacology 1999; 65: 165–172.
37. Dutta B: Food and medicinal values of certain species of Dioscorea with special reference to Assam. Journal of Pharmacognosy and Phytochemistry 2015; 3: 15–18.
38. Tiwari L and Pande PC: Indigenous veterinary practices of Darma Valley of Pithoragrah district, Uttranchal. Indian Journal of Traditional Knowledge 2006; 5: 201–206.
39. Mishra RK, Upadhyay VP and Mohanty RC: Vegetation ecology of the Similipal Biosphere Reserve, Orissa, India. Applied Ecology and Environmental Research 2008; 6: 89–99.
40. Swarnkar S and Katewa SS: Ethnobotanical observation on tuberous plants from tribal area of Rajasthan (India). Ethnobotanical Leaflets 2008; 12: 647–666.
41. Kamble SY, Patil SR, Sawant PS, Sawant S, Pawar SG and Singh EA: Studies on plants used in traditional medicine by Bhilla Tribe of Maharashtra. Indian Journal of Traditional Knowledge 2010; 9: 591–598.
42. Singh N, Pangtey YPS, Khatoon S and Rawat AKS: Some ethnobotanical plants of Ranikhet region, Uttaranchal. Journal of Economic and Taxonomic Botany 2009; 33: 198–204.
43. Teron R: Studies on Ethnobotany of Karbi-Anglong District, Assam: Trans-cultural Dynamism in Traditional Knowledge. PhD. thesis Gwahati University, Assam 2011.
44. Mbiantcha M, Kamanyi A, Teponno RB, Tapondjou AL, Watcho P and Nguelefack TB: Analgesic and Anti-Inflammatory Properties of Extracts from the Bulbils of *Dioscorea bulbifera* L . var sativa (Dioscoreaceae) in Mice and Rats. Evidence-based Complementary and Alternative Medicine 2011; 912935.
45. Abhyankar RK and Upadhyay R: Ethno medicinal studies of tubers of Hoshanga bad, M.P. bulletin of environment. Pharmacology and Life Sciences 2011; 1: 57–59.
46. Subasini U, Thenmozhi S, Sathyamurthy D, Vetriselvan S, Victor Rajamanickam G and Dubey GP: Pharmacognostic and phytochemical investigations of *Dioscorea bulbifera* L. International Journal of Pharmaceutical and Life Sciences 2013; 4: 2693–2700.
47. Nabatanzi A: Wild food plants used by people living with hiv/aids in nakisunga sub-county, Uganda. African Journal of Food, Agriculture, Nutrition and Develop Ment 2016; 16: 11310–11330.
48. Donruedee Sanguansermsri, Phanchana Sanguansermsri, Kittisak Buaban, Vachira Choommongkol, Chareeporn Akekawatchai, Noree Charoensri, Ian Fraser and Nalin Wongkattiya: BMC Complementary Medicine and Therapies 2024; 180.
49. Pakshir K, Leila B, Zahra R, Manuchehr S and Kamiar Z: *In-vitro* activity of six antifungal drugs against clinically important dermatophytes. Journal of Microbiology 2009; 2(4): 158-163.
50. Mathur A, Singh R, Yousuf S, Bhardwaj A, Verma SK, Babu P, Gupta V, Prasad GBKS and Dua VK: Antifungal activity of some plant extracts against Clinical Pathogens. Advances in Applied Science Research 2011); 2 (2): 260-264.
51. Kadambini Das, Swati Celia Topno, Jaydeep Kumar Sahu, Sanjeet Kumar and Ghodke Anita Sureshrao: 2024 DOI: 10.5281/zenodo.11524677 Biological Archives, Volume I; ISBN: 978-81-970898-9-3.

52. Odebiyi OO and Sofowora EA: Phytochemical screening of Nigerian medicinal plants II. Journal of Natural Products (Lloydia) 1977; 41(3): 234-46.
53. Bruno Chukwuemeka Chinko: Datonye Victor Dapper and Olaghaguo Maestephen Adienbo 2020; 22(1): 16-25, 2020; Article no.JAMPS.54783 ISSN: 2394-1111, DOI: 10.9734/JAMPS/2020/v22i130151.
54. Goldgur Y, Craigie R, Cohen GH, Fujiwara T, Yoshinaga T, Fujishita T, Sugimoto H, Endo T, Murai H and Davies DR: Structure of the HIV-1 integrase catalytic domain complexed with an inhibitor: a platform for antiviral drug design. Proc Natl Acad Sci USA 1999; 96: 13040–13043.
55. Prapaporn Chaniada, Chatchai Wattanapiromsakula, Somsak Pianwanitc and Supinya Tewtrakula: Anti-HIV-1 integrase compounds from Dioscorea bulbifera and molecular docking study. Pharmaceutical Biology 2016; 54(6): 1077–1085 http://dx.doi.org/10.3109/13880209.2015.1103272.
56. Jun-Ming Wang, Li-Li, Christopher J, Branford-White, Zai-Yong Wang, Kai-Kai Shen, Hai Liu and Zheng-Tao Wang: Antitumor activity of *Dioscorea bulbifera* L. rhizome *in-vivo*, 2012. doi:10.1016/j.fitote.2011.12.001.
57. Balasubramanian J, Dhanalakshmi R, Jibnomen P and Manimekalai P: A preclinical evaluation on antioxidant and gastroprotective effect of *Dioscorea bulbifera* in wistar rats. Indian J Innovation Discovery 2012; 3(1): 1-8.
58. Galani VJ and Patel DM: A Comprehensive Phytopharmacological Review of *Dioscorea bulbifera* Linn. Int J Environ Sci Nat Res 2017; 4(5): 555650.
59. Bishwa Bhusan Kundua, Karan Vannia, Ayesha Farheena, Priyanka Jhac, Devendra Kumar Pandeya and Vijay Kumara: *Dioscorea bulbifera* L. (Dioscoreaceae): A review of its ethnobotany. Pharmacology and Conservation Needs 2020. https://doi.org/10.1016/j.sajb.2020.07.028.
60. Chaniad P, Wattanapiromsakul C, Pianwanit S and Tewtrakul S: Anti-HIV-1 integrase compounds from *Dioscorea bulbifera* and molecular docking study. Pharm Biol 2016; 54(6): 1077–85. https://doi.org/10.3109/13880209.2015.1103272 PMID: 26864337.
61. Xu YZ, Bai CX, Zhou Q, Shen XW, Zheng SZ, Fu ZS and Chen H: Study on the ethanol extract of Dioscorea bulbifera in inhibiting inactived-virus. Chinese Phar maceutical Bulletin 1988; 23: 535–537.
62. Wu LL, Yang XB, Huang ZM, Liu HZ and Wu GX: *In-vivo* and *in-vitro* antiviral activity of hyperoside extracted from *Abelmoschus manihot* (L) medik. Acta Phar macologica Sinica 2007; 28: 404–409.

How to cite this article:
Vishwakarma Y, Pandey V, Shukla R, Dhanorya D, Bairagi G and Gupta V: "Pharmacognostic analysis of *Dioscorea bulbifera* L.: a gateway to its medicinal benefits". Int J Pharmacognosy 2024; 11(11): 584-94. doi link: http://dx.doi.org/10.13040/IJPSR.0975-8232.IJP.11(11).584-94.