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Taxonomy, distribution and uses of air potato

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Abstract

Air potato also called *Dioscorea bulbifera* is a staple food for various tribal group. It is a monocot, herbaceous, tuber-yielding climber plant belong to the family Dioscoreaceae. *Dioscorea bulbifera* is explored for their valuable properties throughout the world. The tubers and bulbils are edible as it has starch, low fat, fibers and minerals which provide it nutritional value. Secondary metabolites are saponins, sapogenins, carotenoids, tannins alkaloids and flavonoids. The commercially viable phyto steroidal sapogenin diosgenin are also found in this plant. Due to present of secondary metabolites, diosgenin, cortisones, bafoudiosbulbins, diosbulbins, xanthins, dioscin and dioscrine etc., it is used to treat diabetes, cancer, microbial infections, cardiac problems, digestive abnormalities, syphilis, typhoid, goiter and throat infection etc. The plant extracts also show antioxidant, anti-inflammatory, antihyperlipidemic, antihelminthic and antileprosy activity. Various *in vitro* and *in vivo* studies have been done to perform their various healing properties.

Keywords: *Dioscorea bulbifera*, herbal medicine, diosgenin, antihyperglycemic

1. Introduction

Plants are God gift providing us to complete all our basic needs *i.e.* food, shelter, cloth and medicine for a delightful life^[1]. Due to the property of production of secondary metabolites by plants, they play an important role in drugs synthesis. World Health Organization (WHO) states that the dream "Health for All" can only be achieved with the uses of herbal plant as medicines, because raw material is source for all drugs^[2]. Different tribal groups of the world use *Dioscorea bulbifera* as a source of food with high caloric and medicinal value along with wide range of adaptations^[3].

2. Taxonomy, Morphology and Distribution

Dioscorea sp. (having about 682 species) is a genus of monocot Dioscoreaceae family and *Dioscorea bulbifera* is most common species of this genus^[4,5].

2.1 Taxonomic Classification

According to Bentham and Hooker (1862-1883),

Phanerogams
Monocotyledons
Epigynae
Dioscoreaceae
Dioscorea bulbifera

According to Hutchinson's system of classification (1959),

Angiospermeae
Monocotyledons
Corroliferae
Dioscoreales
Dioscoreaceae
Dioscorea bulbifera.

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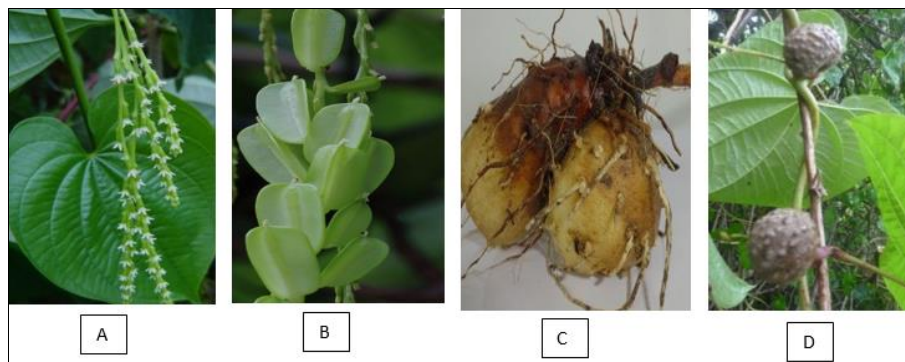


Fig 1: A. Flowers, B. Fruits, C. Tubers and D. Bulbils of *Dioscorea bulbifera*.

2.2 Local Names

This plant is known worldwide for its edible tubers. In India, it has different vernacular names in different area.

Hindi – Ratalu, Pahadi Alu, Ban Alu.

English- Air Potato, Aerial Yam.

Sanskrit- Varahikanda.

Marathi- Varahi, Dukarkand.

Assamese- Bon Alu.

Oriya- Pit Alu.

Bengali- Ban Alu.

2.3 Morphology

2.3.1 Vegetative Structure

2.3.1.1 Habit: Clockwise twinning herb (having about 25-30m length).

2.3.1.1 Stem: Smooth glabrous stem.

Leaves: Simple, Alternate, 5-11 Veined, Smooth and Chordate Shaped Leaves.

2.3.2 Floral Character

2.3.2.1 Inflorescence: Spike with Unisexual Flowers.

2.3.2.2 Flower: Unisexual, White in Color, Perianth is Tubular.

Auxiliary Bulbils: Spherical, Dark Brown and Abundant.

2.3.2.3 Tubers: Random Shaped and Sometimes Hairy^[6].

Due to dioecious nature, pollination and fertilization potency and rate of seed setting is very low. In this condition, bulbils and tubers are the only way to propagation of this plant. The propagation of this plant through bulbils are easy than seed because seed germination rate is very low^[7].

2.4 Distribution

This plant is mostly distributed in hot, humid and tropical regions. Geographically, it is abundantly found in Asia and Africa continent and also distributed in some regions of central and South America. This plant is not found in western hemisphere. In India, it is distributed in all over country in wild, but in North- East region of country, it is also cultivated for their edible tubers^[8]. This plant is abundantly reported in Assam, Arunachal Pradesh, Mizoram, Karnataka, Maharashtra, and Uttar Pradesh in wild. Due to their beautiful appearance, it is also grown in house gardens as ornamental plant.

3. Nutritional Importance of *Dioscorea bulbifera*

Dioscorea bulbifera is a wonderful source for food and as well as medicine. In Preliminary test of tubers and leaves, the presence of nutraceuticals and pharmaceutical compounds are

observe (Table: 1)^[9, 10].

Table 1: Preliminary constituents of tubers and leaves of *Dioscorea bulbifera*. (+ = present, - = absent).

Compounds	Tubers	Leaves
Glucose & Fructose	+	+
Starch	+	+
Protein	+	+
Anthraquinone glycosides	-	+
Cardiac glycosides	+	+
Flavonoids	+	-
Alkaloids	+	-
Tannins	+	-
Phenolics compound	+	-
Saponins	+	-

It is an important climber plant which is staple food for a big population in Central and South America, Asia and Africa and plays an important role in economy in tropical and subtropical regions^[11]. Tubers are used as substitute for potato in various communities in the world. In India, hill regions mostly North-East region, it is staple food for local and tribal people. Its tubers are rich diet having antioxidants and nutritional value. This diet is used by local and tribal people for nutrition but they also stay healthy due to their medicinal value^[12]. Cultivated bulbs are less bitter than wild and ideal for consumption as food. Bitter Tubers are boiled in water for edible sweet tuber whereas Bulbils are nontoxic and safe to be eaten^[13]. These cultivated bulbs are use after roasting by tribal population in world and India especially in north east regions, Madhya Pradesh, Chhattisgarh, Orissa and Jharkhand etc^[14]. India enjoy a great diversity of crop and air potato is one out of them, which contain carbohydrates, low amount of fat, fibers, calories and minerals such as iron, calcium and phosphorus etc. Due to this reason, it is nutrient rich option and can process into other kind of foods^[15].

4. Phytochemical Constituents

In wild conditions, tuber is very bitter due to accumulation of various types of secondary metabolites. These secondary metabolites are raw materials for synthesis of various types of drugs for human and animals. In recent studies, there are seven clerodane diterpenoids i.e. Bafoudiosbulbins-A to G^[16] sixteen Diosbulbins (A-P) and near about 150 types of medicinal extracts^[17] are reported form bulbils, tubers and leaves of this plant. It is a good source of Diosgenin. Diosgenin-derived steroids are 1 out of 10 most recommended medicine of herbal medicine^[18]. Due to the presence good quantity of various phytochemicals, this plant is used in treatments of various types of physiological and microbial disorders (Table: 2).

Table 2: Important Medicinal Phytoconstituents and their uses.

Phytoconstituents	Medicinal Uses	References
Dioscoreanoside- A to –K.	Skin diseases, apoptotic effect.	[19]
Dioscin	Anticancerous activity	[20]
Spiroconazole-A	Antilarvicidal effect, Anticancerous, Antileishmanial.	[21]
Diosgenin	Used in treatment of neurological disorders, cardiac problems, diabetes and Metabolic syndrome.	[22, 23, 24]
Diosbulbisin-A to –D	Anti-inflammatory	[25]
Diosbulbiside-A to –C	Hepatic cancer, cytotoxic activity	[26]
Bafoudiosbulbin –A to -G	Antimicrobial activity	[16, 9]
Diosbulbin-A to –P	Antitumor	[17]
8-Epidiosbulbins-E-acetate	Anticancerous agent	[23]
Dioscrine	Birth control	[25]

5. Curing properties of *Dioscorea bulbifera*

Dioscorea bulbifera can be source of immense possibilities in treatment of new diseases either physiological or microbial. It has many ancient traditional uses and still valuable and is used in all Indian medical system viz. Ayurveda, Homeopathy, Folk Medicine, Siddha, Unani etc. All parts of this plant have medicinal properties but tubers are main source of drugs due to storage properties. In Folk Medicine System, it is used for various kinds of illness and thus this plant has ethno-medicinal value as well as used in modern pharmaceutical industries.

5.1 Physiological Disorders

5.1.1 Antiproliferation Activity

Alcoholic extract of this plant show aromatase inhibiting activity to reduce estrogen and progesterone level to treat breast cancer [27]. Diosgenin can affect the cyclooxygenase-up regulation and Caspase activity to induce apoptosis in cancerous cells and *HeLa* cells respectively [28]. Diosgenin can be used in various carcinomas, lung cancer and human chronic myeloid leukemia [22].

5.1.2 Antidiabetic Activity

Copper nanoparticles synthesized *Dioscorea bulbifera* explants show antidiabetic activity [23]. *Dioscorea bulbifera* is used to synthesis of gold, silver and platinum etc. nanoparticles and plant with this ability have immense property of antidiabetic, antimicrobial and anticancerous activity [29]. In Alloxan induced diabetic rats, antidiabetic effects had been performed by using *Dioscorea bulbifera*. In many countries, the synthetic drug of diabetes is much costly. Therefore it can be a wonderful plant for those countries [30].

5.1.3 Cardiac Vascular Problems: Diosgenin induces cholesterol degradation without interfering Neiman n-Pick C1-Like 1 protein (a protein that regulate cholesterol absorption) of intestinal apical membrane of absorptive enterocytes [24]. Diosgenin is also use in all attributes which cause cardiac problems [31].

5.2. Antimicrobial Activity

It has ability to cure microbial infections. Bafoudiosbulbins are potential drugs against multidrug resistant (MDR) Bacteria [9]. The petroleum, ether and chloroform extract of its bulb shows antifungal (against *Aspergillus niger*, *A. fumigatus*, *A. nigricans*, *A. flavus* etc.) and antibacterial (against *E. coli*, *Basilosaurus*, *Staphylococcus* etc.) activity [32]. Butanol and ethyl acetate extraction of this plant can inhibit Cocksackie B I-VI Virus and after inhibition of virus, cell can survive [19]. Extract of silver nanoparticles synthesized tuber have great potential to increase the antibacterial activity of various broad spectrum antimicrobial agent [33].

5.3 Contraceptive Drugs

Diosgenin is raw material for synthesis of cortisteroids, sex hormones and contraceptives drugs [34]. Dioscrine (a potent precursor of this plant) have potency to birth control [25].

5.4 Others

Extract of bulb used in indigenous system of medicines to cure cardiac and neurological disorders [35], memory enhancement and throat infection [36], anti-inflammatory [37], antihyperglycemic activity [38] and antileishmanial [39] etc. Its tubers and bulbils are rich source of phenolics, flavanoids (catechin, kaempferol, catechuic acid) and steroids having antithyroid, antileprosy and anthelmintic activity [40]. In the presence of alcoholic extracts of *Dioscorea bulbifera*, stimulation of osteogenesis activity of osteoblastic cells has been seen *in vivo* condition on rat skeletons [41].

6. Discussion and Conclusion

A plant which acts as food source as well as valuable drugs source is like icing on the cake. *Dioscorea bulbifera* is such type a plant, which overcome our food demand and a rich source of diosgenin and other kinds of drugs. In India, it is used as staple food after cereals as a nutrient source of carbohydrate, fiber, low fat, minerals. Its carbohydrates are good for diabetic patient because of present of other antinutritional factor i.e. secondary metabolites. These secondary metabolites are unique in this plant and enormous potency to cure various diseases either physiological (cancer, heart problem, tumor, diabetes, thyroids, hemorrhoids, arthritis, goiter, Pain, etc.) or Microbial (Leprosy, typhoid, syphilis, throat infection, Malaria, Measles, Small pox, worm infection, immunity booster, digestive tract infection, UTI etc). It is good source of effective drugs against neurological disorders (such as Alzheimer's disease, Parkinson's disease, and nervous injury, Neuroinflammation, Multiple Sclerosis, Strokes and Thrombosis etc) [35], cardiovascular diseases [36], diabetes etc [29]. Cultivation of tubers and bulbils of air potato overcomes food scarcity in tribal population and ethno-medicinal knowledge about Air Potato had been proved as a blessing for human being.

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