Ethnopharmacological Potential and Medicinal Uses of Miracle Herb *Dioscorea* spp.

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**ABSTRACT**

*Dioscorea* a well-known source of Diosgenin-steroid raw material, is one of the oldest tuber crop cultivated or harvested from wild in the tropical region throughout the world and make up one of the chief food items for a number of tribal groups. In India there are about 50 species of *dioscorea*, mainly found in North-East region which is rich in tropical root and tuber crops. *Dioscorea* produces rhizomes or bulbs, which are having rich medicinal and economic value. The rhizomes are used for the treatment of different diseases like cardiovascular system disorders, central nervous system disorders, disease of bones and joint metabolic disorder, digestive disorders, sore throat for struma, diarrhea, irritability, abdominal pain, dysfunctional changes in the female reproductive system, skin diseases, oncology and immune deficiency and autoimmune diseases, anti-diabetes, neuroprotectiveused, decrease oxidative stress and many more disordered conditions. Diosgenin is a precursor for the chemical synthesis of drug like steroids and has a great importance for pharmaceutical industry. *Dioscorea* contains various bioactive chemical substances like diosgenin, corticosterone, and sigmasterol, which are of great market value. The current study is to appraise the medicinal properties, phytochemicals, and pharmacological activities of *Dioscorea*.

**Keywords:** *Dioscorea*, chemical constituents, pharmacological activities.

**INTRODUCTION**

*Dioscorea species* is a climber herb with rhizomatous rootstock. It belongs to the family Dioscoreaceae. The genus *Dioscorea* belongs to division Monocotyledon comprises 350-400 species. Dioscorea is spread all over the tropics and subtropical regions in the world, 96% production occur in Africa. Other production centers are South America, the Caribbean islands and also found in South East Asia. The species (deltoidea) is mainly found in India, China, Nepal, Bhutan, Pakistan, Afghanistan and Vietnam. In India the plant species are mostly distributed in Kashmir to Assam at altitudes of 550-3100m. In Indian Himalayan regions, it is found in Arunanchal Pradesh, Sikkim, Assam, Meghalaya, Jammu and Kashmir, Himanchal Pradesh, and Uttarakhand. This plant is special because its rhizomes contain Diosgenin, which is a phytosterogen that convert into the hormone progesterone. Diosgenin is a basis for anti-infertility drugs such as contraceptive pills, and sex hormones, since testosterone and supplements are used by body builders to increase their testosterone levels and build muscle strength. *Dioscorea* tubers are straight and zinger like shaped. The tubers Of *Dioscorea* are used in the management of a number of diseases such as gastrointestinal disorders, sour throat from struma, diarrhea, irritability, abdominal pain, wounds, burns and anemia. The tubers are also supposed to possess activities like antimicrobial, antioxidant, stomachic and hypoglycemic activities. Besides it, *Dioscorea* is used extensively in the treatment of dysentery, piles and chronic liver pain disease.
The antitumor effects of diosgenin have been shown in various studies. Diosgenin is used for the target drug delivery system for cancer therapy. Diosgenin has been tested for its potential as a potential antitumor agent. Diosgenin is associated with a change of several cell signalling events which are necessary for cell growth/proliferation, differentiation, epithelial-mesenchymal transition migration, and apoptosis, as well as oncogenesis and angiogenesis. Within the various phases of tumorigenesis, Diosgenin is believed to induce apoptotic cell death in various stages of tumorigenesis and thus avoiding their malignant transformation. The antitumor effects of diosgenin have been demonstrated, to occur through p53 activation, immune-modulation, cell cycle arrest, modulation of caspase-3 activity, and activation of the transcription STAT3 signalling pathway. Diosgenin also shows antitumor effects by decreasing the VEGF expression in PC3 cells, depending on dose. Diosgenin also shows antiproliferative activity, for various cancers namely, in prostate cancer (PC-3 and DU-145 cells) [24]. It has been reported that diosgenin reduces the VEGF expression in PC-3 cells, depending on dose, signifying this steroid can inhibit angiogenesis by interfering with this factor. Diosgenin is associated with a change of several cell signalling events which are necessary for cell growth/proliferation, differentiation, epithelial-mesenchymal transition migration, and apoptosis, as well as oncogenesis and angiogenesis. Within the various phases of tumorigenesis, Diosgenin is believed to induce apoptotic cell death in various stages of tumorigenesis and thus avoiding their malignant transformation. The antitumor effects of diosgenin have been demonstrated, to occur through p53 activation, immune-modulation, cell cycle arrest, modulation of caspase-3 activity, and activation of the transcription STAT3 signalling pathway. Diosgenin also shows antitumor effects by decreasing the VEGF expression in PC-3 cells, depending on dose. Diosgenin also shows antiproliferative activity, for various cancers namely, in prostate cancer (PC-3 and DU-145 cells) [24]. It has been reported that diosgenin reduces the VEGF expression in PC-3 cells, depending on dose, signifying this steroid can inhibit angiogenesis by interfering with this factor. Diosgenin is associated with a change of several cell signalling events which are necessary for cell growth/proliferation, differentiation, epithelial-mesenchymal transition migration, and apoptosis, as well as oncogenesis and angiogenesis. Within the various phases of tumorigenesis, Diosgenin is believed to induce apoptotic cell death in various stages of tumorigenesis and thus avoiding their malignant transformation. The antitumor effects of diosgenin have been demonstrated, to occur through p53 activation, immune-modulation, cell cycle arrest, modulation of caspase-3 activity, and activation of the transcription STAT3 signalling pathway. Diosgenin also shows antitumor effects by decreasing the VEGF expression in PC-3 cells, depending on dose. Diosgenin also shows antiproliferative activity, for various cancers namely, in prostate cancer (PC-3 and DU-145 cells) [24]. It has been reported that diosgenin reduces the VEGF expression in PC-3 cells, depending on dose, signifying this steroid can inhibit angiogenesis by interfering with this factor. Diosgenin is associated with a change of several cell signalling events which are necessary for cell growth/proliferation, differentiation, epithelial-mesenchymal transition migration, and apoptosis, as well as oncogenesis and angiogenesis. Within the various phases of tumorigenesis, Diosgenin is believed to induce apoptotic cell death in various stages of tumorigenesis and thus avoiding their malignant transformation.
Diosgenin was also examined for its anti-microbial effects, namely, against fungi, bacteria, protozoa, and virus. As for the human pathogens like Candida albicans, C. glabrata, and C. tropicalis, this steroid show weak antimicrobial activity against all the tested organisms [40, 41]. In addition the above organisms, diosgenin also has little to no effect against the fungi like Aspergillus flavus, Aspergillus niger, Trichoderma harzianum, and Fusarium oxysporum. On contrary to this, the sapogenin showed considerable vulnerability against various Gram-positive (Bacillus subtilis, Bacillus cereus, Staphylococcus aureus, and Staphylococcus epidermidis) and many Gram-negative (Escherichia coli and Salmonella typhi) pathogens [42]. Besides, diosgenin has the antiamebic activity against Naegleria fowleri trophozoites at the cellular and molecular levels. Furthermore, it is less toxic to mammalian cells at therapeutic levels than that of amphotericin B, which is currently used to treat N. fowleri infections [43]. In addition, diosgenin shown to be effective in some viral diseases. Diosgenin due to its antioxidiant activity can be useful in HIV patients with dementia [44]. Moreover, the steroid exhibits antiviral activity against Hepatitis C Virus (HCV) in invitro studies. Diosgenin acts by reducing plasma cholesterol and HCV requires cholesterol for an efficient multiplication that is this shows antiviral effect [45].

**Anti-inflammatory and Immunological Activity**

The anti-inflammatory activity of Diosgenin is known to show anti-inflammatory activity however, the mechanism of action is yet uncertain. D.H.Jung et al. [46] studied that a diminution in the production of several inflammatory mediators, including NO and interleukins 1 and 6, in murine macrophages which had been pretreated with diosgenin and stimulated with lipopolysaccharide/interferon-γ. Moreover, a study in mouse was carried out in which it was evidenced that diosgenin has an inhibitory effect on the production of superoxide generation in bone marrow activated neutrophils and it was observed that this steroid exhibits antiviral activity against Hepatitis C Virus (HCV) in invitro studies. Diosgenin acts by reducing plasma cholesterol and HCV requires cholesterol for an efficient multiplication that is this shows antiviral effect [45].

**Effect on Cardiovascular System**

Various studies indicated that, diosgenin has a considerable effect on lipid levels by reducing the level of total cholesterol (TC) in plasma and Low density lipoproteins (LDL) and increase the ratio of high density lipoproteins (HDL) to total cholesterol by decreasing cholesterol absorption and increasing cholesterol secretion [49]. Diosgenin is found to have concentration dependent vasorelaxant in superior mesenteric rings studied against phenylephrine as a standard. Diosgenin acts by increasing intracellular calcium concentrations in mesenteric endothelial cell loaded with FURA-2. Besides it, nitric oxide (NO) level is also increased by diosgenin [40]. Diosgenin was investigated for vasodilatory effect via porcine resistance left anterior descending coronary artery and it was found that diosgenin through protein kinase G signaling cascade and an opening of BK (Ca) channel of arterial smooth muscle cells caused an acute endothelium-independent coronary artery relaxation [61]. Diosgenin effects were examined in mouse by means of myography and confocal microscopy for contraction of smooth muscle cell and calcium signaling in isolated aorta. Diosgenin was also observed to have a potential therapeutic value for vascular disorders by inhibiting receptor-mediated calcium signals and smooth muscle contraction in the isolated aorta [54].

**Effect on Blood System**

Diosgenin was investigated to have anti-thrombosis effect in both invitro and in vivo studies by using thrombotic rat inferior vena cava and pulmonary thrombosis mice models, it resulted with repressed platelet accumulation, thrombosis and extended activated partial thromboplastin time (APTT), prothrombin time (PT) and thrombin time (TT) in the models depending on dose used. Anti-thrombotic effect of diosgenin is also demonstrated as it increases bleeding time and clotting time [53].

**Effect on Central Nervous System**

Effect of diosgenin on nervous system was investigated and is reported to have action on potential generation in human cortical neurons (HCN-1A) and big potassium (BK) channel activity improvement was also found. It also increased intracellular Ca2+ in human cortical neuronal-1A cells. HCN-1A cells contain alpha- subunit of BK (Ca) – channels seen by Western blotting technique. Therefore, diosgenin may have affect on the activity of cortical neurons by acting on these channels [64]. Further
a study, showed diosgenin significantly affect acetylcholinesterase (AchE) inhibitory activity [65].

**Effect on Reproductive System**

Diosgenin was investigated on ovariectomized rats and was found to show effect on the calpain isoform expression in ovariectomized rats. As compared to the normal controls expression of mu- or m-calpain was found to be reduced in the ovariectomized group [66]. Diosgenin was observed to considerably increase the mammary development scores, when studied for its effect on the growth of mammary epithelium for about fifteen days through factors of increase in DNA content, increase in number of ducts and appearance of terminal end buds. Diosgenin and estrogen when used concurrently, showed increase of estrogenic effect of diosgenin particularly at the higher dose level [67].

**Diosgenin as a raw material for steroid**

There is a three step efficient synthesis for the commercial production of 16-dehydropregnenolone acetate (16-DPA) which is a potent steroid drug intermediate obtained from diosgenin, in an overall yield of 60%. The steps are; acetylolysis (isomerisation) of diosgenin 3 to pseudodiosgenin diacetate 4, Oxidation of pseudodiosgenin diacetate 4 to Diosone 5, Hydrolytic degradation of Diosone 5 to 16-DPA 1 [68].

Table 2: Ethnobotanical and medicinal uses of common Dioscorea species

<table>
<thead>
<tr>
<th>Botanical name</th>
<th>Part of Plant</th>
<th>Ethno-botanical/medicinal use</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dioscorea alata</strong> L.</td>
<td>Tuber [69]</td>
<td>Treatment of piles</td>
</tr>
<tr>
<td></td>
<td>Tuber [70]</td>
<td>Reduce weakness</td>
</tr>
<tr>
<td></td>
<td>Tuber [71]</td>
<td>Wormicide for stomach worms</td>
</tr>
<tr>
<td><strong>Dioscorea belophylla</strong> (Prain) Voigtex Haines</td>
<td>Tuber [72]</td>
<td>Taken with hot water is given for the treatment of fever, malaria, headache, and Dysentery</td>
</tr>
<tr>
<td><strong>Dioscorea bulbifera</strong> L.</td>
<td>Tuber [73, 74, 75, 76, 77]</td>
<td>Appetizer.</td>
</tr>
<tr>
<td></td>
<td>Leaves [78]</td>
<td>Analgesic for labour pain, antacid, anti-inflammatory and for treating Dysmenorrhea.</td>
</tr>
<tr>
<td></td>
<td>Tubers [74]</td>
<td>Skin diseases.</td>
</tr>
<tr>
<td></td>
<td>Tubers [79]</td>
<td>Analgesic for throat pain</td>
</tr>
<tr>
<td></td>
<td>Tubers [80]</td>
<td>Antipyretic.</td>
</tr>
<tr>
<td></td>
<td>Tubers [81]</td>
<td>Treatment of boils and dysentery.</td>
</tr>
<tr>
<td></td>
<td>Tubers [82]</td>
<td>Antidiarroheal</td>
</tr>
<tr>
<td></td>
<td>Tubers [83]</td>
<td>Cooling agent</td>
</tr>
<tr>
<td></td>
<td>Tubers [84]</td>
<td>Treatment of skin infection</td>
</tr>
<tr>
<td></td>
<td>Tubers [85]</td>
<td>Anticough and antiseptic</td>
</tr>
<tr>
<td></td>
<td>Tubers [86]</td>
<td>Antiacid and ulcers treatment</td>
</tr>
<tr>
<td></td>
<td>Stem [81]</td>
<td>Antidandruff.</td>
</tr>
<tr>
<td></td>
<td>Tubers [87]</td>
<td>Taken with cow milk for the treatment of cough and Asthma.</td>
</tr>
<tr>
<td></td>
<td>Tubers [88]</td>
<td>Treatment for typhoid when used with Curcuma aromatica</td>
</tr>
<tr>
<td></td>
<td>Tubers [89]</td>
<td>Treat ulcer, piles, syphilis, and dysentery, and used to kill hair lice.</td>
</tr>
<tr>
<td></td>
<td>Tubers [90]</td>
<td>Used as contraceptive</td>
</tr>
<tr>
<td></td>
<td>Tubers [91]</td>
<td>Treatment of abdominal pains. and ulcers</td>
</tr>
<tr>
<td></td>
<td>Tubers [92]</td>
<td>Used with salt to cure cough.</td>
</tr>
<tr>
<td><strong>Dioscorea dumetorum</strong> (Kunth) Pax</td>
<td>Tuber [89]</td>
<td>Poison for arrow heads</td>
</tr>
<tr>
<td></td>
<td>Tuber [88]</td>
<td>Used for treatment of jaundice</td>
</tr>
<tr>
<td><strong>Dioscorea esculenta</strong> (Lour.) Burkill</td>
<td>Tuber [93]</td>
<td>Appetizer</td>
</tr>
<tr>
<td></td>
<td>Tuber [94]</td>
<td>Antidiarroheal</td>
</tr>
<tr>
<td></td>
<td>Tuber [95]</td>
<td>Poison for arrow heads</td>
</tr>
<tr>
<td></td>
<td>Tuber [96]</td>
<td>Antidiarroheal</td>
</tr>
<tr>
<td><strong>Dioscorea hamiltonii</strong> Hook.f</td>
<td>Tuber [97]</td>
<td>Medicine for eyes</td>
</tr>
<tr>
<td></td>
<td>Tuber [98]</td>
<td>Fish poison</td>
</tr>
<tr>
<td></td>
<td>Tuber [99]</td>
<td>Used to treat peeling out of skin</td>
</tr>
<tr>
<td></td>
<td>Tuber [100]</td>
<td>Antiemetic and purgative</td>
</tr>
<tr>
<td><strong>Dioscorea hirtiflora</strong> Benth</td>
<td>Tuber [90]</td>
<td>Used to cure gonorrhea</td>
</tr>
<tr>
<td><strong>Dioscorea hispida</strong> Dennst</td>
<td>Tuber [91]</td>
<td>Medicine for eyes</td>
</tr>
<tr>
<td><strong>Dioscorea kamoonensis</strong> Kunth</td>
<td>Tuber [88]</td>
<td>Treatment of Rheumatoid arthritis</td>
</tr>
<tr>
<td><strong>Dioscorea oppositifolia</strong> L.</td>
<td>Tuber [84]</td>
<td>Post pregnancy nutrition tonic</td>
</tr>
<tr>
<td></td>
<td>Leaf [85]</td>
<td>Taken with honey to increase sperm</td>
</tr>
</tbody>
</table>
CONCLUSION

The above study revealed that Dioscorea contains various phytochemicals such as Diosgenin, saponin, flavonoids, dioscorin and other important constituents. These chemicals have vast activities like anticancer, antimicrobial, cardiac activities, CNS effects and many more. For this reason, Dioscorea is a potential medicinal plant of interest in the treatment/prevention of several diseases. Diosgenin which is the most identified compound in Dioscorea species is a precursor of steroidal drugs as estrogen. Thus it can be said that Dioscorea is a packet which encloses medication for a number health conditions.

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