

PAST AND PRESENT STATUS OF DIOSCOREA DELTOIDEA; A HIGHLY THREATENED WILD MEDICINAL PLANT IN NIHRI TEHSIL OF HIMACHAL PRADESH, NORTH WESTERN HIMALAYAS

¹*Tara Devi Sen, ²Bhawna Kumari and ³Tanuja Thakur

¹Assistant Professor. Department of Botany, Sardar Vallabhbhai Patel. Cluster University, Mandi, HP, India.

²Vallabh Government College Mandi (H.P).

³Research Associate. Sardar Vallabhbhai Patel. Cluster University, Mandi, HP, India.

*Corresponding Author: Dr. Tara Devi Sen

Assistant Professor. Department of Botany, Sardar Vallabhbhai Patel. Cluster University, Mandi, HP, India.

Article Received on 25/09/2021

Article Revised on 15/10/2021

Article Accepted on 05/11/2021

ABSTRACT

Present study has been conducted in Nihri Tehsil of district Mandi Himachal Pradesh, North Western Himalayas to know the past and present status of *Dioscorea deltoidea* and devise strategies for its conservation. *D. deltoidea* is known by its common name Wild Yam and by local name *singali-mingali* in study area. It has been traditionally harvested from wild habitat as a source of medicine, food and income by locals for both personal and commercial uses. Being rich in medicinal values its tubers are high in demand in both national or international market. Tubers are also sold in local market and for this purpose these are unsustainably harvested in large scale from wild habitat without ensuring conservation. Tubers of *D. deltoidea* are also consumed traditionally as a food supplement in various traditional dishes mainly to harness their rich medicinal values. This knowledge of its utilization is inherited and passed from one generation to another by local communities. But from recent few years natural population of this plant has declined significantly and knowledge as well as practice of its utilization has also reduced remarkably. Reasons behind this are habitat fragmentation; unsustainable harvesting; pollution; advancement in medical sciences; erosion of traditional belief and traditional healthcare system. This is clearly revealed by use value index of *D. deltoidea*; In past use value index was higher; $UV_{past} = 0.36$ and at present it is reduced to 9 time of its previous use; $UV_{current} = 0$. As a result, *D. deltoidea* is at the verge of extinction in study area and need both in-situ as well as ex-situ conservation.

KEYWORDS: Endangered, Nihri, *Dioscorea deltoidea*, Domestication Conservation.

INTRODUCTION

The use of medicinal plants for welfare of humanity and curing various human disease is as old as human civilization. It is estimated that the number of medicinal plants has been in the range of 40,000 to 70,000.^[1] which implies that almost 25% of all plants have some sort of medicinal use somewhere in the world. This traditional practice of medicine has been passed from one generation to another and has continued to develop an orthodox medicine therapy. This also leads to isolation of some pure bioactive compounds and ultimately the development of novel synthetic compounds such as some alkaloidal drugs. Frantic efforts has been made from time to time to improve the medicinal plants or their herbal products of improved quality by utilizing these indigenous traditional practices.^{[2][3]} Since, today 25% of prescribed medicines contain the ingredients derived from plants^[4] this shows that wild plant species still form the foundation of modern healthcare practices throughout

the world. Wild edible and medicinal plants are also gaining importance in our current food and medicine system due to their very less or no side effects on body as compare to drugs. So, many people round the world are engaged in harvesting and trading of those wild floral elements as a source of income which have tremendous therapeutic potential. This contribute to well being and socio-economic upliftment of local communities at one hand and threatening existence of many wild herbs at another. As during and after COVID-19 there will be a significant increase in collection and harvesting of immunity boosting herbs, which will further lead to risk of their threatening if not harvested sustainably.^{[5][6]} According to IUCN and TRAFFIC researchers, India being a part of IHR is a hub of the wild-collected herbal industry in Asia, but key species of this region are facing risk of extinction. Many of them have declined significantly due to their over-exploitation to meet the demand of domestic and foreign medicinal industry.

Therefore, their risk of extinction has become one of the most significant problem of IHR. *D. deltoidea* is one of such naturally growing herb of Nihri tehsil of district Mandi HP which has been over-exploited for its edible, medicinal and commercial uses. Tubers of this plant are high in demand in national and international market for their bioactive chemical substances like diosgenin, corticosterone and sigmasterol. In past this plant was luxuriant in natural habitat in Nihri and used to be an easy source of income for local communities, its tubers has been unsustainably harvested and commercially exploited for this purpose. Tubers has also been consumed traditionally as food supplement in variety of traditional dishes to harness their rich medicinal value. So, natural population of this plant has declined significantly in Nihri and at present it is facing a high risk of extinction throughout the study area. Therefore, strongly need conservation. This species is also reported to be endangered in India and Nepal due to its over exploitation for industrial use^{[7][8][9][10]}, thus need in-situ and ex-situ conservation on large scale. Focused studies to evaluate the past and present status of *D. deltoidea* in Nihri, its indigenous uses, edible, medicinal and economic potential for local people has not been attempted so far in Nihri tehsil of district Mandi HP, North Western Himalayas. So present study has been undertaken with following main objectives.

OBJECTIVES

1. To know the habit, habitat, morphology, nativity, distribution and harvesting practice of *Dioscorea deltoidea* in Nihri.

2. To document the indigenous: medicinal, edible and economic uses, of *Dioscorea deltoidea* in Nihri.
3. To know the past and present status of *Dioscorea deltoidea* in Nihri\
4. To document the factor responsible for threatening of *Dioscorea deltoidea* in its natural habitat.
5. To know the medicinal and economic potential of *Dioscorea deltoidea* for local people of Nihri.
6. Need for domestication of *Dioscorea deltoidea* in Nihri
7. To devise strategies for conservation of *Dioscorea deltoidea* in Nihri
7. Conclusion

METHODOLOGY

STUDY AREA

The present study has been conducted in the Nihri tehsil (latitude 31°43'12.5" N and longitudes 77°07'01.2" E) of district Mandi, Himachal Pradesh. Initially it was a sub-tehsil in Sunder Nagar. It is located 69 Km from District headquarter Mandi. Altitudinal range of study area varies from 900 -2800m It covers approximately 28,508-hectare area, comprises of 19 Panchayats, 203 villages. The total human population of the study area is 20,280. It supports diverse habitat, species, communities and ecosystem (Data collected from Panchayat Secretary, Tehsil representatives, DPF) (Fig 1)

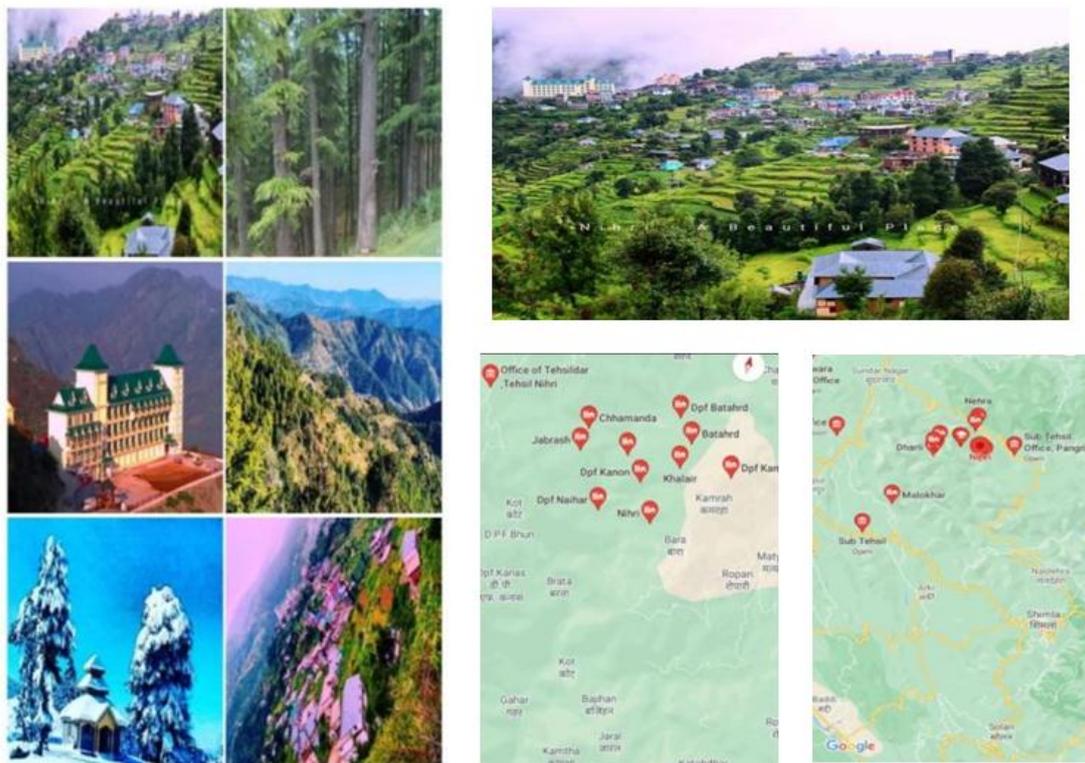


Fig.1: General overview of Study Area.

Method

Present study is based on both primary and secondary data (Interview, literature review and People Biodiversity Register study). *D. deltoidea* vine is identified with the help of flora of Mandi.^[11] The nativity of the species has been identified following.^{[12][13][14]} Survey and sampling of *D. deltoidea* was done between 1500-2800 m in the study area. 10 villages were selected at different altitudinal ranges to collect the information. The knowledgeable persons of the study area, panchayat representatives, biodiversity management committee members were interviewed through questionnaire for its past and present status, indigenous uses, harvesting practice and range of occurrence. Information on local names, plant parts used, indigenous knowledge and utilization pattern of this plant was gathered and analyzed.

The knowledgeable persons of the study area, panchayat representatives, biodiversity management committee members were interviewed through questionnaire for its past and present status, indigenous uses, harvesting practice and range of occurrence. Information on local names, plant parts used, indigenous knowledge and utilization pattern of this plant was gathered and analyzed.

Used value Index was used to assess the relative importance of plant. Two basic Uv was calculated: Current Use Value (UV_{current}), based only on the citations of plants reported by the informants for uses still practiced at the present time; a Past Use Value (UV_{past}), based on the citations of plants reported by the informants as used only in the past (Table 1 & 2; Fig 1)

Table 1: List of villages selected at different altitudinal ranges for gathering information.

S. no	Village name	Altitude (in m)	Latitude	Longitude
1.	Prali	1611.47	31°37'42.1" N	77°05'21.3" E
2.	Bhakha	1796.49	31°38'87.0" N	77°08'38.3" E
3.	Pandar	1802.58	31°40'73.1" N	77°07'52.4" E
4.	Jabrash	1858.67	31°38'04.1" N	77°04'15.7" E
5.	Manjhar	1869.03	31°42'56.8" N	77°06'81.6" E
6.	Chowki	1910.18	31°41'92.5" N	77°07'26.5" E
7.	Dulho	1950.72	31°37'10.3" N	77°07'11.9" E
8.	Upper Nihri	2105	31°37'87.8" N	77°06'31.7" E
9.	Shalta	2100	31°38'11.4" N	77°03'72.1" E
10.	Rohanda	2216.20	31°43'89.1" N	77°04'22.7" E
11.	Sanaut	2341.47	31°43'17.0" N	77°11'11.4" E
12.	Kanjihra	2576.47	31°45'49.1" N	77°07'49.5" E

Table 2: List of Key Informants of Study area.

S.no	Name	Age	Gender	Address	Occupation
1	Jeet Ram	66	M	Vill.Bhakha P.O and tehsil Nihri	Hakkim
2	Parkash	43	M	Vill.Alyaas P.O and tehsil Nihri	Teacher
3	Champa Devi	45	F	Vill.Khanyog P.O and tehsil Nihri	Agriculture
4	Pitamber Lal	47	M	Vill.Prali P.O and Tehsil Nihri	Agriculture
5	Lal Chand	40	M	Vill.Dulho P.O and Tehsil Nihri	Guard
6	Savita Kumari	42	F	V.P.O and tehsil Nihri	Pachayat assistant
7	Pawna Thakur	38	F	Vill.Shalta P.O and tehsil Nihri	Agriculture
8	Manju Verma	25	F	Vill.Lalag P.O and tehsil Nihri	Nurse
9	Neha Kumari	30	F	V.P.O Chowki tehsil Nihri	Agriculture
10	Himmati Devi	70	F	Vill.Pralii P.O and tehsil Nihri	Agriculture
11	Gaihari Devi	73	F	Vill.Upper Nihri P.O and Tehsil Nihri	Midwife





Fig. 2: Gathering information from local people & BMC members.

3. Habit, habitat, morphology, nativity, distribution and harvesting practice of *Dioscorea deltoidea* in Nihri

D. deltoidea is a member of family Dioscoreaceae commonly known as Wild Yam and locally as *Singalingali*.

3.1 Habit, habitat & Distribution

It is a herbaceous perennial climber of Western Himalayas, commonly found scattered in forest and shrubberies from 1700- 3000 m altitudinal range. In *Nihri* it is found at an altitude range of 1750 to 2800m. It usually grows as a vine that climb & supports itself by twining around the branches of other plants. Vine grows best in temperate region with well drained, loamy soil

rich in humus and organic matter. It needs shade and moisture to grow. Sometime it is also cultivated around homes and gardens. Usually 50-60gm tuber pieces with 1-2 buds are used commercially for its mass propagation.

3.2 Morphology

D. Deltoidea is a glabrous, twinning vine, with tuberous roots growing upto 3 m tall. Its leaves are simple, alternate, long- petiolate variable, usually ovate-lanceolate, 5- 15 to 4- 10 cm, acuminate, base widely cordate, lobes rounded, sometimes dilated outwards. Male spikes solitary, 7- 35 cm long. Female spikes 7.5 – 15 cm long, solitary. Capsules are 2- 2.5 cm long and broadly winged. Seeds are winged all round. (Fig. 3)



Fig. 3: Morphology.

3.3 Nativity

D. deltoidea plant is native to Indian oriental.^{[13][14]}

3.4 Harvesting

The optimum harvesting time of tubers is considered when plants reach their maximum size usually these are harvested after three years or when becomes dormant. Tubers are best harvested in winters before the emergence of buds (dormant stage) it is believed that diosgenin and yamogenin contents are highest during this time and plant has completed its flowering and fruiting too, thus disseminated bulbils which are also means of propagation, so it would be the best time to harvest.

4. Indigenous edible, medicinal and commercial uses, of *D. deltoidea* in Nihri.

Indigenously tubers of *D. deltoidea* are utilized as a source of food, medicine, and income for local communities.

4.1 Edible Uses

Underground tubers of *D. deltoidea* are edible and are eaten boiled or cooked in addition to potatoes. They are slightly bitter in taste, so need to be thoroughly cooked before consuming. Some local dishes like *parantha*, *bhale*, *dahin-bhalle* etc. can be prepared from tuber of this plant in addition with potatoes to harness its rich medicinal values. Tubers are excellent addition to these traditional dishes in small quantities. Tubers are also utilized to prepare local alcoholic drink for its its rich

medicinal value. In past local community is largely involved in production and commercial selling of liquors prepared with addition of wild herbs like *D. deltoidea*, *Arisaema tortuosum tubers*, *Arisaema jacquemontii tubers*, *Angelica glauca*, *Selinum vaginatum* etc but with

strict law against production of local alcoholic drinks for commercial uses, at present this practice is limited to very few communities, specially those residing in temperate hilly areas where it is consumed to keep body warm in extreme winters.^[15] (Table. 4)

Table 4: Traditional edible uses of *D. deltoidea*.

Edible uses	Ingredients	Recipe	Photo
Kachuri	Tubers, 1 kg; wheat flour, 7-8 cup amount; yeast, 5-10 g; mustard oil, 1/2 liter; fenugreek powder, 1/2 table spoon; cumin seed, 1 tea spoon; turmeric powder, 1-3 table spoon; red chillies; 10-15; grated ginger, 250 g; Chopped green coriander, tirmir (<i>Zanthoxylum armatum</i>), mint (<i>Mentha piperita</i>) and curry (<i>Murraya koeingii</i>) leaves, 2-3 cup amount and salt according to taste.	For preparing <i>kachuri</i> prepare dough of wheat, flour along with yeast. Allow to rest dough for 3-4 hour. Boil tubers till these are soft. Mesh boiled tubers manually and add spices listed above. Mix well into fine paste. Roll dough already made into small disc or round bread spread and stuff it with paste. Give a deep fry to the stuffed disc in hot mustered oil and take them out. Repeat this for whole dough and paste, now <i>kachuri</i> is ready to serve.	
Bhalle	Tubers, 1 kg; mustard oil, 1/2 liter; fenugreek powder, 1/2 table spoon; cumin seed, 1 tea spoon; turmeric powder, 1-3 table spoon; red chillies; 10-15; garlic, 250 g; grated ginger, 250 g; mustard seed powder, 3-4 table spoon, Chopped green coriander, tirmir (<i>Zanthoxylum armatum</i>), mint (<i>Menthapiperita</i>) and curry (<i>Murraya koeingii</i>) leaves, 2-3 cup amount and salt according to taste.	Boil tubers till they are soft. Mesh them manually and make paste of mashed tubers and spices listed above in same sequence. Now make small round bread spread with a hole in center with this paste. Put oil in a fry pan and deep fry these breads spread with hole called as <i>bhalla</i> traditionally. Repeat this process till whole paste is over. <i>Bhalle</i> are ready to serve as snack.	
Veg	Tubers and Potato, 1k g; mustard oil, 3-4 table spoons; coriander powder 1 table spoon; fenugreek powder, 1/2 table spoon; cumin seed, 1 tea spoon; turmeric powder, 1/2 table spoon; red chillies; 2-3 medium sized chopped onions, 2-4; garlic, 4-5 cloves; ginger paste, 1/2 table spoon; 1 cup amount chopped green coriander leaves and salt according to taste	For preparing vegetable, the tubers are first boiled and brown peel is taken off. Then these are cut into small pieces and fried in hot oil along with spice listed before in sequence, as is done with potatoes. Garnish the recipe with chopped coriander leaves and serve with chapattis. The preparation tastes very good. If it is to be taken with rice, then add 4 cups of water or curd and cook for another 5 minutes to serve with rice.	

<p>Pickle:</p>	<p>Chopped tubers, 1 kg; mustard oil, 1/2 liter; fenugreek powder, 3-4 table spoon; cumin seed, 1 tea spoon; turmeric powder, 1-3 table spoon; red chilies; 10- 15; garlic, 250 g; grated ginger, 250 g; mustard seed powder, 3-4 table spoon and salt according to taste.</p>	<p>Wrap tubers in a cotton cloth to prepare a pauch. Boil this pauch containing tubers for 10- 15 minutes by continuous rotating the pauch, so that all tubers get soft equally, Let them cool down and cut into small pieces. Dry tuber pieces or fragments in full sunlight for full day. Saute tubers in hot mustard oil along with spices listed above. Add mustard powder to make pickle sour, mix well and put in a ceramic jar. After 10 to 15 days pickle is ready to eat. It can be preserved for 2 to 3 years.</p>	
<p>Parantha</p>	<p>Tubers and Potato, 1 kg; wheat flour, 7-8 cup amount; mustard oil, 1/2 liter; fenugreek powder, 1/2 table spoon; cumin seed, 1 tea spoon; turmeric powder, 1-3 table spoon; red chilies; 250 g; grated ginger, 250 g; ajwain (caraway seeds), 1 tea spoon; Chopped green coriander and <i>curry (Murraya koeingii)</i> leaves, 2-3 cup amount and salt according to taste.</p>	<p>Boiled tubers are meshed manually. Mix meshed tubers well with spices and make fine paste. This paste is now stuffed into the wheat flour dough and made into breadspread. Put oil on <i>tawa</i> (Flat fry pan) and cook both sides of stuffed bread spread by putting some oil. Repeat this process till whole paste and dough is over. Serve hot with pickle/butter/curd/<i>chutney</i>.</p>	
<p>Local alcoholic drink</p>	<p>10-12kg Barley, tuber of plant, Other herbs (<i>Arisaema tortuosum tubers, Arisaema jacquemontii tubers, Angelica glauca, Selinum vaginatum</i>), <i>Cannabis leaves</i>, <i>fermentation equipment</i></p>	<p>Take 10-12 kg barley flour (<i>Hordeum vulgare</i>) and mix to it finally chopped whole <i>D. deltoidea</i> plant and some other medicinal herbs of rainy season like <i>Arisaema tortuosum tubers, Arisaema jacquemontii tubers, Angelica glauca, Selinum vaginatum etc.</i> Mix all well and prepare dough. Now make small bread spread from this dough and place inside wooden blocks. Collect <i>Cannabis sativa</i> green foliage and spread on floor of a dark room as a mat. Put all the wooden blocks containing bread spread over the <i>Cannabis</i> mat and also</p>	

		<p>cover the bread spread with cannabis leaves. Keep this setup for 12-15 days. Take out dry bread spread for further fermentation. Bread spread prepared like this can be used as small fragments for further fermentation and kept or preserved for rest of the year. Now for fermentation take a large piece of bread spread, mix it with koda millet flour (<i>Paspalum scrobiculatum</i>) and water then place in a clay vessel. Air tight this setup and again place in dark room. After 30-45 days alcoholic beverage is ready to drink it can be used upto next six to eight months.</p>	
--	--	--	---

4.2 Medicinal uses

Local people eat tubers of *D. deltoidea* both fresh or dried (in the form of powder) to alleviate constipation. These are also used to treat urinary tract and kidney related disorders. Juice of tuber is taken in the evening time as a remedy to treat roundworm.

4.3 Commercial uses

Root tubers of this plant are high in demand in both national and international market. These are also sold in

local market at the rate of 300 to 500/kg and usually harvested from natural habitat.

4.4. Other Uses

Vine of this plant is used to make rounded base called *binna* locally to place clay pots (Matka) in villages. Other traditional uses of this plants practised in past are 2-3 gm of rhizome is given orally to get relief from snake bite. Paste of tuber is used to kill body lice. It was also heavily used to wash clothes (Fig.4).



Fig. 4: *Binna* (Base) from vine of *D. deltoidea* used to place clay pots.

5. Past and present status of *D. deltoidea* in Nihri

To know the threatened status of *Dioscorea deltoidea* use value index (UVI) was used to assess its relative importance. Used value (UV) is taken on the basis of People biodiversity registers reports, field studies, personal observations and interaction with local communities of the study area. According to the data analysis (Table 2, Fig2), utilization of *D. deltoidea* was more frequent in past as compare to present. Based on the citation reported by informants, use value in past was higher (UV past =0.36) and is nine times less than before (UV current =0.4). This data clearly shows rapidly

declining population and traditional use of this plant in study area and at present natural population of *D. deltoidea* has drastically declined in natural habitat to the extent that it is almost to be extinct in near future. Therefore, frantic efforts are needed in study area to conserve this plant both in-situ and ex-situ.

6. Factor responsible for threatening of *D. deltoidea* in its natural habitat

The most important causes of extinction of *D. deltoidea* is its over exploitation from core natural habitat. Uprooting of tubers also results in decreases soil binding,

as a result; soil erosion and land sliding occur. This type of threat is also reported by other workers too in many other plants.^{[16][17]}

1. Over-exploitation of tubers due to easy approachable harvesting sites like Rohanda, Chowki, Pandar etc. in study area.
2. Habitat fragmentation resulted due to developmental activities, agricultural extension, rapid urbanization and modernization,
3. Climatic changes, pollution, deforestation has changed adaptability of many important wild floral elements leading to their extinction from natural habitat.
4. Lack of traditional knowledge and utilization of medicinal plant in primary health care among young generation has significantly rendered traditional practice of conserving many important wild herbs.
5. Advancement in medical sciences, partially documented or undocumented knowledge on ethno medicine began to deplete.
6. Well planned field visits in search of some plants containing active ingredients by botanist, herbalists and chemists is also a threat to know the present status of wild herbs.

All these factors have significantly reduced the natural population of *D. deltoidea* in study area requiring its domestication and conservation.

7. Medicinal and economic potential of *D. deltoidea* for local people of Nihri

D. deltoidea has more trade, and medicinal value than being used locally. It is continuously available in national and international markets showing its constant demand. So, it can be a potential source of income for local communities.

7.1 Medicinal potential

D. deltoidea is a potential source of promising bioactive compounds, such as *diosgenin* and is being used against different ailments, such as gastrointestinal and urogenital disorders, diarrhoea, irritability, abdominal pain, wounds, intestinal worms, anemia. Diosgenin which is a steroidal aglycone is precursor to chemical synthesis of many hormones.^[18] It produces rhizomes or bulbils which is rich in sapogenin steroidal compounds. These compounds have immense medicinal, industrial and commercial importance. *D. deltoidea* is expectorant and sedative. It is involved in treatment of cardiovascular system, central nervous system, dysfunctional changes in the female reproductive system, disease of bones and joint metabolic disorders, skin diseases, oncology and immunodeficiency's and autoimmune diseases.^{[7][19][20]} The powder from rhizome of plant is taken orally to cure dysentery, abdominal pain and piles.^[21] (Table.5)

Table 5: Chemical constituents in *D. deltoidea*.^{[20][22]}

Chemical constituents	Compounds	Plant part	Biological uses
Carbohydrates			
Alkaloids	Dioscorine,	Tuber	anti-microbial, anti-hypertensive, anti-cancer, anti-inflammatory, anti-human immunodeficiency virus (HIV) and many others,
Tannin		Tuber	
Flavonoids		Tuber	antioxidant, anti-inflammatory, antihypertensive, antidiabetic, antimicrobial, anticonvulsant, sedative, antidepressant, anti-proliferative, anticancer, cardioprotective, antiulcerogenic and hepatoprotective activity
Steroidal Saponin Glycosides	Dioscin & aglycone is Diosgenin, Small quantity of hecogenin	Tuber	antitumor, anti-inflammatory, anticancer, androgenic, estrogenic, and contraceptive drugs, used as a precursor of sex hormones (progesterone), corticosteroids (corticosterone) and contraceptives.
Resin	Botagenin		
Sterol	Stigmasterol; B-sitosterol; Campesterol	Tuber	
Phytochemicals: 2,5 D- Spirostan; 3,5 dienes; Smilagenone		Tuber	
Other: Ascorbic acid, Ash, proteins, thiamine, Niacin, Beta –carotene, Riboflavin, Al, Ca, Cr, Co, Fe, Mg, Mn, P, Na, Si, Zn		Tuber	

7.2 Economic potential

A large number of pharmaceutical products are available in national, intercontinental market both online and offline, showing its tremendous medicinal and commercial

value (Table. 6). So, plant should be domesticated and cultivated in large scale both in private and public land to utilize it as a potential source of income.

Table 6: Economic Potential of *D. deltoidea*.

Name of the product	Biological roles of the product	Product
Wild Yam Root	This product increases energy level of our body. It also helps in the treatment of sleeping disorder, hot flushes, night sweats and memory problems.	 ₹508.76
Equisalud HOLOFIT Dioscorea	It is a supplement which support our immune system.	 ₹1,321
Nature's life WILD YAM	It is a wonderful product for women especially. This is a Natural product to improve the hormonal balance after menopause. It helps in production of progesterone in body. It is a perfect natural supplement without any side effect.	 Nature's Life, Wild Yam, 1,000 mg, 100... ₹941.36

8. Need of domestication and conservation

As *D deltoidea* is a potential source of food, medicine and income for local people, but has attained critically endangered threatened status due to unsustainable harvesting practice of its tubers from natural habitat. As a result its use and occurrence is almost negligible at present in Nihri. For its optimum utilization, it is strongly recommended to bring under human cultivation or domestication with government support and initiatives like in other areas of HP (Fig:5) This will boost health, immunity and rural prosperity of local community along with conservation of both traditional knowledge and *D deltoidea*.

9. Strategies for conservation of *Dioscorea deltoidea*

For better results cultivation in private and public land should be encouraged. There should be collaboration between farmers, collectors, buyers, shopkeepers and

industries to ensure a proper management of plant produce. Marketing and illegal trade should be checked strictly. Conservation strategies which are successful in other areas of IHR (Kullu, Manali, Devidardh etc) should also carried out in Nihri. There is a need of trained and skillful personals to handle and take care of endangered species like *D deltoidea*. Methods and strategies for sustainable use like harvesting tubers by habitat rotation and keeping some plants as such in natural habitat should be strictly implemented. To make conservation cost-effective collaboration of governmental and non-governmental agencies with local communities should be carried. Grants and aids should be encouraged and utilized sustainably.

1. Awareness among inhabitants for sustainable harvesting and utilization.
2. Developing threatened plant nurseries.

3. Food value of tubers in dry or fresh form should be calculated.
4. Lab testing of local alcoholic drink prepared with this plant and providing permit for its selling to local people engaged in its preparation.
5. Domestication of *D. deltoidea* to promote it as a source of income by distributing seeds to local communities.
6. Large scale cultivation in natural habitat by making user groups of local communities
7. Engaging young minds in cultivation and traditional processing of *Dioscorea deltoidea*
8. Strict law against illegal trading.



Fig. 5: In-situ & Ex-situ conservation of *D. deltoidea* in kullu and Devidarh (HP).

DISCUSSION

Western Himalaya is always a center of attraction to the researchers due to its rich floral biodiversity. A large number of medicinal and economically important plants of this region are used worldwide in food and medicinal industry. Due to their high nutritional, economical and medicinal potential they are harvested unsustainably without ensuring their conservation. Because of this many valuable plants like *D. deltoidea* have become threatened. Literature review also reveals that *D. deltoidea* has mention in the list of highly threatened wild medicinal plant of IHR. In general many workers has done work on different aspects of *D. deltoidea* in Himalayas mainly in countries like India, Pakistan and Nepal, like on overview of its threatened and endangered status^{[7][8][9][16][17][23][5][24][25][26][27][28][29]}, on its edible and medicinal uses both traditional and modern medicinal, which show its vast potential in treating a wide range of present day ailments^{[7][18][19][20][21][22]}; many researchers has also worked on its chemical constituents and they have devised region specific conservation strategies.^{[4][30][31][32][33][34]} In past *D. deltoidea* had been used to play an important role in uplifting socio-economic status of local people of Nehri. It was utilized in primary health care system to alleviate diseases like constipation, urinary tract and kidney related disorders, its tubers were also eaten as food supplement and to wash clothes, it was a good source of income for locals. But utilization of *D. deltoidea* has declined progressively as the population of this plant declined remarkably in natural habitat due to over-exploitation. Therefore awareness and efforts are needed among inhabitants for its sustainable harvesting and conservation. As it is a

potential source of promising bio active compounds and an important ingredient or raw material for many present-day drugs with high commercial demand and value. So, it should be domesticated and cultivated in large scale to uplift socio-economic status of local communities of Nihri

CONCLUSION

Natural population and traditional practice of utilization of *D. deltoidea* is at the verge of extinction at Nihri. Significant efforts have been made by forest department to conserve this plant both in-situ and ex-situ in other areas of Himachal Pradesh like Kullu, Manali, Devidarh etc. Similar efforts are needed to conserve *D. deltoidea*; a plant with huge commercial and medicinal value in Nihri. As both tubers and bulbils of *D. deltoidea*, are deciding plant part for its existence in natural habitat and their unsustainable harvesting practice has immensely declined its past luxuriant natural population, so frantic efforts are needed for its domestication and conservation.

ACKNOWLEDGEMENT

Authors are highly indebted to the inhabitants, BMC members of respective panchayats, forest and tehsil officials of of Nihri area for providing valuable information about past and present status of *D. deltoidea*. Sincere thanks also go to Dr S.S. Samant, Dr. Chiranjit Parmar, botany department of SVPCU Mandi for their encouragement, support and cooperation. A special thanks to Mr. Ashutosh Kumar, Mr Subodh Negi & Mr. Manoj kumar for their immense help and co-operation during study. Authors are also highly thankful to DEST Himachal Pradesh for providing funds to carry on this research.

REFERENCES

1. DAMTOFT, S., FRANZYK, H., & JENSEN, S. Biosynthesis of Iridoids in Syringa and Fraxinus. Part 2. Carbocyclic Iridoid Precursors. *ChemInform*, 1996; 27(9).
2. Schippmann, U. W. E., Danna Leaman, and A. B. Cunningham. "A comparison of cultivation and wild collection of medicinal and aromatic plants under sustainability aspects." *Frontis*, 2006; 75-95.
3. Rasool Hassan, B. A. Medicinal plants (importance and uses). *Pharmaceut Anal Acta*, 2012; 3(10); 2153-2435.
4. Qureshi R, Waheed A, Arshad M, Umbreen T. Medico-ethnobotanical inventory of tehsil Chakwal, Pakistan. *Pakistan Journal of Botany*, 2009; 41(2): 529-538.
5. Sen, T. D., The Role of Wild Food Plants of Himachal Pradesh in Boosting Immunity to Combat COVID-19. *Journal of Scientific Research in Medical and Biological Sciences*, 2021; 2(2): 23-62. <https://doi.org/10.47631/jsrmb.v2i2.238>
6. Devi T., Diversity, Distribution, Nativity and Indigenous Uses of Crop Wild Relative of District Mandi Himachal Pradesh and Their Potential

- in Crop Improvement Programme". International Journal of Scientific Research in Biological Sciences, 2021; 8(1): 108121.
7. Dangwal LR, Chauhan AS. *Dioscorea deltoidea* Wall. Ex Griseb. A Highly Threatened Himalayan Medicinal Plant: An Overview. International Journal of Pharmacology and Bio Sciences, 2015; 6(1): 452-460.
 8. Das S, Choudhury MD, Mazumder PB. In Vitro Propagation of Genus *Dioscorea* - A Critical Review. Asian Journal of Pharmaceutical and Clinical Research, 2013; 6(3): 26-30.
 9. Rokaya MB, Sharma LN. *Dioscorea deltoidea* in Nepal: Cross Validating Uses and Ethnopharmacological Relevance. Asian Journal of Ethnopharmacology and Medicinal Food, 2016; 2(2): 17-26.
 10. Sen, T. D., & Thakur, T. Threatened Plants of Tungal Valley, North Western Himalayas: Their Diversity, Distribution, Indigenous Uses and Need of Conservation." World Journal of Pharmaceutical and Life sciences (WJPLS), 2021; 7(10): 120-132.
 11. Singh PB, Singh, "Flora of the Mandi District Himachal Pradesh North West Himalaya". Bishen Singh Mahendra Pal Singh, Dehradun, 1918.
 12. Samant, S. S., & Dhar, U. Diversity, endemism and economic potential of wild edible plants of Indian Himalaya. *The International Journal of Sustainable Development & World Ecology*, 1997; 4(3): 179-191.
 13. Samant, S.S. "Diversity, nativity and endemism of vascular plants in a part of Nanda Devi Biosphere Reserve in west Himalaya". *Himalayan Biosphere Reserves, (Biannual Bulletin)*, 1999; 1(1&2): 1-28.
 14. Samant, S.S., Dhar, U. and Rawal, R.S. "Assessment of Fuel resource diversity and utilization patterns in Askot Wildlife Sanctuary in Kumaon Himalaya, India, for conservation and management". *Environment Conservation*, 2000b; 27(1): 5-13.
 15. Sen, T. D., & Thakur, T. Some Ethnomedicinal Plants of Western Himalayas Useful in Making Local Alcoholic Drinks. *Journal of Scientific Research in Medical and Biological Sciences*, 2021; 2(3): 75-103.
 16. Smith OC, Larsen HO. Alpine medicinal plant trade and Himalayan mountain livelihood strategies. *The Geographical Journal*, 2003; 169(3): 243-254.
 17. Shinwari ZK, Qaisar M. Efforts on conservation and sustainable use of medicinal plants of Pakistan. *Pakistan Journal of Botany*, 2011; 43(1): 5-10. Shinwari ZK. Medicinal plants research in Pakistan. *Journal of Medical Plants Research*, 2010; 4(3): 161-176.
 18. Semwal, P., Painuli, S., & Cruz-Martins, N. *Dioscorea deltoidea* Wall. Ex Griseb: A review of traditional uses, bioactive compounds and biological activities. *Food Bioscience*, 2021; 100969.
 19. Hamayun M. Traditional uses of some medicinal plants of Swat Valley, Pakistan. *Indian Journal of Traditional Knowledge*, 2007; 6(4): 636-641.
 20. Ali. Plant Growth – A note on the Vegetative Growth in *Dioscorea deltoidea*. *Journal of Aromatic and Medicinal plants*, 2012; 1(8): 2-6.
 21. Kumari P, Joshi GC, Tiwari LM. Indigenous uses of Threatened ethno medicinal plants used to cure different diseases by ethnic peoples of Almora district of Western Himalaya. *International Journal of Ayurvedic and Herbal Medicine*, 2012; 2(4): 661-678.
 22. Chandra, S., Saklani, S., & Mishra, A. P. In vitro antimicrobial activity of Garhwal Himalaya medicinal plant *Dioscorea deltoidea* tuber. *Int. J. Herbal Med.*, 2013; 1: 67-70.
 23. Pandey, H. K., & Deendayal, D. S. Threatened medicinal plant biodiversity of western Himalaya and its conservation. *Ministry of Defense. Defense research and development organization. Biodiversity: Life to our mother earth*, 2006; 281-95.
 24. Jain, SK. 1991. *Dictionary of Indian folk medicine and ethnobotany*, New Delhi, India: Deep Publications. [[Google Scholar](#)]
 25. Samant, SS, Dhar, U and Palni, LMS. 1998. *Medicinal plants of Indian Himalaya: diversity distribution potential values*, Nainital, India: Gyanodaya Prakashan. [[Google Scholar](#)]
 26. Rai, LK, Prasad, P and Sharma, E. Conservation threats to some important medicinal plants of the Sikkim Himalaya. *Biol Conserv.*, 2000; 93: 27–33. [[Crossref](#)], [[Web of Science](#) ®], [[Google Scholar](#)]
 27. Samant, S. S., Dhar, U., & Palni, L. M. S. (Eds.). *Himalayan medicinal plants: potential and prospects* (No. 14). GB Pant Institute of Himalayan Environment & Development Kosi-Katarmal, Almora, 2002.
 28. Samant, SS and Pal, M. Diversity and conservation status of medicinal plants in Uttaranchal State. *Indian For.*, 2003; 129(9): 1090–1108. [[Google Scholar](#)]
 29. Kala, CP. Medicinal plants of the high altitude cold desert in India: diversity, distribution and traditional uses. *Int. J Biodivers Sci Manage.*, 2006; 2(1): 43–56. [[Taylor & Francis Online](#)], [[Google Scholar](#)]
 30. Abrol, B. K., Chopra, I. C., & Kapoor, L. D. Exploitation of *Dioscorea deltoidea* in NW Himalayan region. *Planta Medica*, 1963; 11(01): 44-52.
 31. Santapau, H., & Randeria, A. J. The botanical exploration of the Krishnagiri National Park, Borivli, near Bombay. *Journal of the Bombay Natural History Society*, 1970; 53: 185-200.
 32. Pant, S., & Samant. Diversity, distribution, uses and conservation status of plant species of the Mornaula Reserve Forests, West Himalaya, India. *The International Journal of Biodiversity Science and Management*, 2006; 2(2): 97-104.
 33. Rana, M. S., & Samant, S. S. Diversity, indigenous uses and conservation status of medicinal plants in Manali wildlife sanctuary, North western Himalaya, 2011.

34. Singh, A., Lal, M., & Samant, S. S. Diversity, indigenous uses and conservation prioritization of medicinal plants in Lahaul valley, proposed Cold Desert Biosphere Reserve, India. *International Journal of Biodiversity Science & Management*, 2009; 5(3): 132-154.