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Comprehensive Notes on Commercial Utilization, Characteristics and Status of Steroid Yielding Plants in India

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Abstract

The present article provides comprehensive information on the species used largely as commercial steroids in India. Details regarding part(s) used, characteristics and commercial utilization of important steroid yielding plant species are given in the present communication.

Keywords: Commercial use, Steroid yielding plants.

Introduction

India has a rich heritage of plant based drugs both for use in preventive and curative medicines. Steroids and their related active metabolites are of great value in drug and pharmaceutical industry. They have numerous and diversified physiological functions and pharmacological effects such as influence on carbohydrate, protein, fat and purine metabolism; on electrolyte and water balance; on the functional capacities of the cardiovascular system viz., kidney, skeletal, muscle, nervous system and some organs and tissues. The term steroid (= sterol like) is derived from sterol (In Greek, Stereos= solid and ol=alcohol) as most of these compounds contain alcoholic group. All the steroids are structurally related and mostly saturated, colourless compounds found in plants and animals. Steroid includes a variety of compounds, among which sapogenins hold a very important position. Sapogenins when linked with sugar constitutes the saponins. Saponins are natural products, which have the property of forming soapy leather when shaken with water.

Production of steroid drugs is a large scale industry (Applezweig, 1962). In 1967, total world consumption of steroids precursors was one thousand tones, two third of which came from diosgenin and the remaining one third from the variety of miscellaneous sources. Other steroidal alkaloids that could become available in large quantities are tomatidine, Solasodine and Neotigogenin. Till today, more than four thousand plant species have been investigated which has resulted in the identification of some thirty naturally occurring steroids sapogenins many of which could provide valuable source materials for steroids compounds.

Steroidal Sapogenin Yielding Plants

A. Diosgenin Source

S. No.	Name of Plant	Part used
1	*Allium fuscoviolacenum*	Bulbs
2	*Allium narcissifolium*	Bulbs
3	*Aspidistra elatior*	Under ground parts
4	*Balanites roxburghii*	Fruits and leaves
5	*Convallaria keisukei*	Under ground parts
6	*Costus speciosus*	Rhizome
7	*Dioscorea composita*	Rhizome
8	*Dioscorea floribunda*	Rhizome
9	*Dioscorea deltoidea*	Rhizome
10	*Dioscorea gracillima*	Rhizome
11	*Dioscorea polystachya*	Rhizome
12	*Dioscorea prazeri*	Rhizome
13	*Dioscorea sativa*	Rhizome
14	*Dioscorea septembola*	Rhizome
15	*Funkia ovata*	Leaves
16	*Kallstroemia pubescens*	Whole plant
17	*Ophiopogon japonicus*	Tuber
18	*Paris polyphyalla*	Tuber
19	*Polygonatum latifolium*	Leaves
20	*Polygonatum multiflorum*	Leaves
21	*Smilax exfelsa*	Leaves
22	*Solanum introsum*	Fruits
23	*Solanum indicum*	Fruits
24	*Tamas communis*	Under ground parts
25	*Tribulus terrestris*	Over ground parts
26	*Trigonella foenum*	Leaves and seeds
27	*Trigonella tschonoskii*	Under ground parts

B. Solasodine Source

S.No.	Name of Plant	Part Used
1	*Solanum eleagnifolium*	Fruit
2	*Solanum jubatum*	Fruit
3	*Solanum incanum*	Fruit
4	*Solanum khasianum*	Fruit
5	*Solanum laciniatum*	Fruit, Leaves and stem
6	*Solanum mammosum*	Fruit

7	*Solanum marginatum*	Fruit and Leave
8	*Solanum platanifolium*	All parts
9	*Solanum sodomaeum*	Fruit, leaves and bud
10	*Solanum tomentosum*	Leaves
11	*Solanum trachysyphyum*	Fruit and Leaves
12	*Solanum trilobatum*	Fruit
13	*Solanum verbascifolium*	Fruit
14	*Solanum xanthocarpum*	Fruit

C. Hecogenin Sources

S.No.	Name of Plant	Part Used
1	*Agave species*	Leaves

D. Yamogenin Sources

S.No.	Name of Plant	Part Used
1	*Asparagus officinalis*	Roots
2	*Smilax aspera*	Leaves
3	*Trigonella foenum graceum*	Roots and Leaves

Commercially source material for steroids is only few species belonging mainly to the genus *Dioscorea* and *Solanum*. Although diosgenin has been identified in other species such as *Costus speciosus, Trigonella foenum graceum* and *Kallstromia pubescens* but there is no evidence at present that they would be interesting commercially, and therefore, they have not been described in detail. Efforts have been directed towards the cultivation of several *Solanum* species as the source material for the production of steroids. Genus *Dioscorea*, with over 600 species is widely distributed in tropical world, except few species in temperate. Some of the species like *Dioscorea alata* and *Dioscorea esculenta* have been cultivated for a long for their edible tubers. There are about 15 species of this genus, which are known to contain steroidal sapogenins chiefly diosgenin. In the world, Mexico, Guatemala, Costa Rico, India and China are the major diosgenin producing countries. Most of the world production of diosgenin today is met from Central American species mainly *Dioscorea floribunda* and *D. composita*. The total turnover of bulk steroids in the world is estimated to be about 500 million US dollars and estimated world usage to be somewhere between 550-650 tones of diosgenin. In India, *Dioscorea deltoidea* and *D. prazeri* occurring in North-West and North-East Himalayas respectively are the natural sources of diosgenin.

Species Characteristics and Uses of Steroid Yielding Plants

***Dioscorea deltoidea* Wall.**

It occurs throughout the North Western Himalayas extending from Kashmir and Punjab

eastwards to Nepal and China at the altitude of 900-3000 meters above msl. It completes growth cycle in five years. It is an extensive climber with unarmed stem twining to the left. Leaves alternate, rhizome horizontal, scattered roots, skin light brown. Part used is rhizome and harvesting is done after three years during December, at dormant stage. Diosgenin varies from 2-5% on dry weight basis.

***Dioscorea prazeri* Prain & Burkill**.

The plant occurs in wet parts of Eastern Himalayas including North Bihar, West Bengal, Nepal, Sikkim, Bhutan and Abhore hills upto 5500 meters and prefer well drained soils particularly river banks. It is a climber with smooth or slightly ridged, unarmed stem twining to the left. Leaves are alternate or rarely opposite. Part used is rhizome which is short rather stout, gray brown to nearly black, creeping horizontally. Diosgenin varies between 2-5% on dry weight basis.

***Dioscorea floribunda* Mart & Gal**

It was introduced in India from Central America and is now grown in parts of Karnataka, Assam and Goa. Like *D. deltoidea*, it is also perennial vine and life cycle goes for 1-4 years. Part used is rhizome and diosgenin content lies between 3-3.5% on dry weight basis. Two years crop is found more economical and therefore two years old plant yield 2.5-3.0 kg rhizome.

***Dioscorea composita* Hemsl**.

It also is a native to Central America and is grown successfully under Jammu conditions in India. The plant is quite hardy and vigorous which completes its life cycle in 1-5 years. The highest gains in tuber growth are obtained only after 4-5 years. Average diosgenin content is 2-4% on dry weight basis. Among *Dioscorea deltoidea, D. floribunda* and *D. composita*, the later is preferred for commercial production of diosgenin. Moreover, diosgenin obtained from its tuber has highest purity.

Uses

Diosgenin after converted into 16-Dehydropregnenolon acetate is most widely used as an active ingredient in preparation of many steroid drugs, sex hormones and oral contraceptive pills. Saponins of *Dioscorea* are used for washing silk, wool and hair, and as fish poison. They are also reported to kill lice. Cortisone prepared from these species is used in rheumatic diseases and ophthalmic disorders.

Dioscorea spp., which are commercial source of diosgenin, has limitations in ensuring large supplies on a sustained basis due to its restricted distribution in few localities. It becomes necessary to search for an alternative botanical source, which could be easily cultivated under a wide range of agroclimatic conditions and provide the industry with the raw material at comparative price. *Costus speciosus* satisfies all the criteria of such a substitute.

***Costus speciosus* (Koenig) Sm.**

It is a common plant with a tuberous rhizome, distributed throughout India up to an elevation

of 4000 meters amsl. It is 4-10 meters in height with large lanceolate leaves about one foot in length. Flowers are in red colour with white limbs and yellowish centers. It is often cultivated as ornamental plant. Part used is rhizome which constitutes average diosgenin 2-4% on dry weight basis.

Uses

The rhizome is edible and is used for cooking purpose and is mucilaginous without aroma. It is rich in starch but the fibre content is high when compared with other tuber food. The rhizome is used for tonic purpose and as anthelmintic in Uttar Pradesh.

***Trigonella foenum graceum* Linn.**

An aromatic annual, about 30-60 cm tall is found wild in Kashmir, Punjab and upper gangetic plains and also cultivated in many parts of India. Seeds are the source of two steroidal sapogenins namely diosgenin and gitogenin. The presence of few more sapogenins including yamogenin has also been reported.

The seeds are used as condiment and for flavouring the food preparations. Diosgenin was first raw material source to be used for high volume production (Djerassi, 1966) because it was available in a readily purified form and at sufficiently high volume that was cheaply collected.

Solasodine, as a nitrogen analogue of diosgenin, seems to be in a strong competitive position with diosgenin itself. Indeed, solasodine derived from *Solanum laciniatum* is reported to be the sole source of cortisone and progesterone in the USSR (Alekseenko et al.,1976). In India,*Solanum khasianum* and certain other species are being cultivated for the local production of solasodine for the use in Indian pharmaceutical industry. Solasodine occurs mainly in the genus *Solanum*. This genus comprises about 2000 species distributed in the warmer regions of the world. About 22 species are endemic to India.

***Solanum khasianum* Clarke.**

It is widely distributed in the Indian sub-continent extending from sea level to 2000 meters and is reported from Khasi, Jaintia and Naga hills of Assam and Manipur and in Arunachal Pradesh up to 1850 meters. It also occurs in Sikkim, West Bengal, Orrisa, Upper Gangetic plains, lower hills of Himalayas and in Nilgiris to an altitude of 1600 meters. It is reported from North-East, North-West, Southern as well as Central India and extends up to Burma and China.

It is a stout, much branched under shrub varying in height between 0.75m to 1.5m with almost straight prickles, leaves ovate and lobed. Lobes triangular and prickly on both the surfaces. The flowers are white. The berries are yellowish or greenish. The seeds are smooth brown and compressed. Part used is berry and solasodine content lies between 1-3% on dry weight basis. The main limitation of this species is that it bears spines that are quite vicious. Moreover solasodine is obtained only from berries. Therefore this species is paving way for the use of *Solanum laciniatum* and *Solanum aviculare* in the commercial utilization.

***Soalnum laciniatum* Ait**.

Commonly known as Kangaroo apple and was introduced in India from Russia. It is a perennial shrub but mostly grows up to two years. It is about 2 meters in height with long trifurcated dark green leaves and purplish stem and branches. The flowers are purplish blue. Berries are borne in bunches of 5-7 with dark green colour but turn to yellowish orange colour at maturity. Seeds are small flat, round and brownish in colour. Part used are leaves, stem and berries. Leaves contain solasodine content to 1-3.8% and berries (unripe greenish yellow) contain 3.5-4.0% of solasodine on dry weight basis. *Solanum khasianum* and *S. laciniatum* are worth considering for foliar production of solasodine.

Uses: Solasodine is used in production of sex hormones and oral contraceptive pills.

***Agave* Linn.**

Agave is a large genus with short stemmed half woody plant species, bearing a rosette of long, erect, pointed and fleashy leaves. In various species like *A. Americana, A. cantala, A. sisalana, A. angustifolia,* leaves yield a valuable fibre.

Uses: Hecogenin is used for making sex hormones and oral contraceptive pills.

From the foregoing facts, it is clear that in order to establish and support a broad based steroid industry, it is imperative to start large scale cultivation of various species like *Dioscorea composita* and *D. floribunda* and development of high yielding verities and mutants *i.*e. *Solanum khasianum* to ensure sustainable supply of source material.

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