

## Medicinal Importance of the Genus *Agave*

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### Abstract

The leaves, root, sap and core of *A. sisalana*, *A. americana*, *A. cantala*, *A. angustifolia* and *A. vera-cruz* are used for the treatment of various human diseases, particularly venereal diseases. These five species are rich sources of different saponins of medicinal importance. Of the saponins hecogenin is the starting material for the synthesis of cortisones, cortisol, prednisolone, prednisone, dexamethasone, beta methasone, triameinalone and others. Similarly, tigigenin is used for prednisolone, hydrocortisone and oral contraceptive cyproterone. Attempts on microbial transformations of other saponins are underway. Hecogenin may be converted to pregnane derivatives, specially 16 DPA which has great demand in pharmaceutical industries. In vitro synthesis of hecogenin from *A. sisalana* and *A. ammitensis* is a distinct possibility.

*Agaves* are a source of food, beverage, sugar, syrup, fiber, cellulose, wrap paper for culinary use, silage for livestock, ornamental plants, wax, methane gas and many other products (1—5). There is a recent trend all over the world for the greater use of plant based drugs of the traditional Indian systems for the treatment of human diseases for various reasons. The detailed account of this ongoing developments are available in various literature (6—11). Keeping this upsurge on phytomedicines in view, and the fact that only 5—15% of the approximately 250,000 species of higher plants have been systematically investigated, the potential of others need to be explored for new sources of phytomedicines. This rely on the clues obtained from historic, traditional, folkloric or ethnobotanical uses of plant parts as medicine (6—8). In this context, the genus *Agave*, being grown in varied edapho-climatic conditions in India, offers excellent opportunities for direct therapeutic uses. In addition, this genus also has rich load of

various saponins which may be used for the manufacture of corticosteroids having great demand in pharmaceutical industries world over.

As we turn our focus on *Agave* for medicinal materials; it is worthwhile to mention that several modern techniques (NMR, 2DNMR, multidimensional NMR, HPLC, IRS, UV mass spectrometry) augmented by sophisticated instrumentation, are currently in vogue for isolation and characterization of bioactive principles in other crops. Drug designing, modifications, combinatorial chemistry and other tools are currently being employed for pharmacological analysis (11—14). These techniques, if employed in *Agave*, will generate quick and accurate information to develop an inventory on *Agave* for future drug research. The medicinal potentialities of *Agave* are yet to be explored in a big way because there remained an information gap between detailed ethnomedical uses and chemical constituents of different plant parts. This article has been

designed to fulfill this gap. Finally, the local names of each species have been provided for initial identification but standard botanical description must be followed for commercial exploitation.

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#### *The Genus Agave, in General*

The leaves, as also the root when cut, yield a saccharine juice (nauseous odor and acid taste) which has resolvent and alternative properties (a medicine that makes a change in the functions) especially useful in syphilis. The sap is laxative, diuretic (promotes the flow of urine), emmenagogue (promotes menstrual flow); used in scurvy, scrofula (inflammation of lymph node due to tuberculosis with glandular swelling) and cancer. The large, moist, fleshy leaves are used as poultice; the fresh juice is applied to bruises and contusions (bruise without rupture of blood vessels). The pulp of the leaves placed between folds of muslin is applied to the eye in conjunctivitis (inflammation of the mucous membrane covering the anterior surface of the eye-ball); it is also used, mixed with sugar, in gonorrhoea. A decoction (four ounces/one pint of water) of roots is employed in secondary syphilis (15, 16).

*Agave sisalana* Persine ex. Engelm. Syn.

*A. rigida* Mill Var *sisalana* Englem (*Sisal*)

The juice of the leaves is ecbotic (moulting effect) and lowers blood pressure. Roasted sisal leaves are used to remove headache and pain in knee joints. The juice extracted from roasted leaves, mixed with 10—20 black pepper seeds, is used to treat swelling of throat of cattle. The sisal dust may cause pulmonary fibrosis to the workers engaged in

making ropes and twines. During decortication of leaves for fiber extraction, a pulpy material is separated out which contains, apart from usual chemical, hecogenin (0.1%) in combination with tigogenin, wax and 11% fermentable sugars, the latter is, however, not profitable to prepare alcohol (13—19).

#### *Chemical Constituents*

A process for isolation of hecogenin from juice has been standardized (17, 20);  $5\alpha$ -Pregn-16-en-3 $\beta$ -O1-20-one, mp 202 C, was isolated (21,22).

Neotigogenin, sisalagenin, gloriogenin, 9, 11-dehydro hecogenin, diosgenin and yamogenin isolated from leaves; two new trihydroxysapogenins-hainangenin and hongguan-genin-isolated along with known compounds—tigogenin, neotigogenone, neotigonenin, sisalagenin, hecogenin,  $5\alpha$ -pregnan-3 $\beta$ , 20 $\beta$ -diol, 12-epirockogenin, chlorogenin and  $\beta$ -sitosterol from leaves (23, 24).

#### *Occurrence and Distribution*

Sisal extensively cultivated in India in Nil Dongri, Jharsuguda, Manasanikani, Sonpur and Kardadhman areas of Orissa, and to certain extent in Palamau district of Bihar, Bilaspur of Madhya Pradesh and pockets of Tamil Nadu, Andhra Pradesh, Karnataka, Maharastra and West Bengal.

#### *Local Names*

English : Indian agave, sisal, sisal hemp, sisal agave, Bahama hemp; Bengali : sisal; Assam : sonn.

#### *Agave americana* Linn

If the central bud be lopped off at the flowering season, the cut stem discharges freely a sour liquid, which ferments rapidly and forms the Pulque Beer of the Spaniards, or, by distillation, a kind of brandy known as Mexical. Beside this, in Mexico, a strong spirit is prepared from the sap, known as

Mezcal, also a kind of brandy of 80 degrees of strength, a sweet, thick substance resembling honey, a concentrated gum used in medicine, brown-sugar, leaf-sugar, sugar-candy, and vinegar of excellent quality, so that this is considered one of the most important economic plants of Mexico (15).

Leaves are used as laxative, emmenagogue, diuretic and also useful in scurvy. They are employed as a resolvent in syphilis, scrofula and cancer. Slices of leaves applied as poultice (16) and used in bruises and rheumatism (pain and stiffness in the joints or muscles of the body). The pulp of leaf is a good remedy for gonorrhoea. The leaf-juice is used for warts, cancerous ulcers and putrid tumors (25).

The roots are diuretic, diaphoretic (promotes sweating), antisiphilic and are said to find their way to Europe mixed with Sarsaparilla. The core of the plant is used for the treatment of ascites (abnormal accumulation of serous fluid in peritoneal cavity), dropsy (neurological disorder), venereal sores, dysentery (15, 20). Various parts of plant are used for ascites (abnormal accumulation of serous fluid in peritoneal cavity), anasarca (accumulation of fluid in subcutaneous connective tissues), toothache; and as antiseptic, antipyretic and alternative. In homoeopathy, mother tincture is used in the sore in the mouth, in scurvy, in afflictions, in teeth, pains and swelling in legs, in constipation, gonorrhoea (25).

#### Chemical Constituents

Steroid saponin—hecogenin (0.15%), 5 $\alpha$ , 25 D-spirostan-3 $\beta$ -c1-12-one (0.17%) mp 252 C, chlorogenin, 5 $\alpha$ , 25D-spirostan-3 $\beta$ , 6 $\alpha$ -diol (0.13%), and two other compounds, mp 259 C and 273 C isolated from leaf. Seeds yielded neotigogenin, kammogenin along with hecogenin. Altogether, ten steroidal saponins

—agavosides A, B, C, C', D, E, E, G, H and I—isolated from the leaves; common aglycone was hecogenin, while sugars were glucose, galactose, xylose and rhamnose. Structures of most agavosides A, B, C, C', D, E, H and G elucidated as Agavoside A (R=Gal); Agavoside B (R=Gal (4 $\rightarrow$ 1) Glu); Agavoside C (R $\pm$ Gal (4 $\rightarrow$ 1) Glu (4 $\rightarrow$ 1) Glu); Agavoside C' (R=Gal (4 $\rightarrow$ 1) Glu (4 $\rightarrow$ 1) Glu (2 $\rightarrow$ 1) Glu); Agavoside D (R=Gal (4 $\rightarrow$ 1) Glu (4 $\rightarrow$ 1) Glu [(2 $\rightarrow$ 1) Glu] (3 $\rightarrow$ 1) Rha); Agavoside E (R=Gal (4 $\rightarrow$ 1) Glu (4 $\rightarrow$ 1) Glu [(2 $\rightarrow$ 1) Xyl] (3 $\rightarrow$ 1) Rha (4 $\rightarrow$ 1) Rha); Agavoside G (R=Gal (4 $\rightarrow$ 1) Glu (4 $\rightarrow$ 1) Glu [(2 $\rightarrow$ 1) Xyl] (3 $\rightarrow$ 1) Rha); Agavoside H (R=Gal (4 $\rightarrow$ 1) Glu (4 $\rightarrow$ 1) Glu [(2 $\rightarrow$ 1) Xyl] (3 $\rightarrow$ 1) Rha (4 $\rightarrow$ 1) Rha) respectively and anticancer activity was found to be positive (22, 26, 27). Chlorogenin, kaempferol-3-glucoside and 3-rutinoside isolated from flower (25).

#### Occurrence and Distribution

The century plant is extensively used for hedges in many parts of India such as east and west coasts, upper gangetic plains and Punjab. It is at home under widely different climatic conditions, various altitudes and poor agro-resource base.

#### Local Names

English: The century plant, American aloe, carata; Sanskrit: Kalakantala; Hindi: Bauskeora, Barakanwar, Kantala; Bengali: Dilatipat, Koyan; Gujjeti: Jangli Kunrara, Jangli Kunvara; Telegu: Kithanara, Rakashimatalu; Tamil: Rakashimatalu; Malayalam: Bhuttale, Budkkattalenaru; Uriya: Birhotokumari; Punjabi: Kantala.

*Agave angustifolia* Haw, syn. *A. wrightii*

#### Drummond and Prain

Lodhas use dried leaf powder in warm water (3:1) as laxative. Leaves contain hecogenin, tigogenin and gitogenin (16). Lodhas

apply root paste as cure for septic wounds. During treatment period, they do not allow the patient to take sugar and chilli. Santhals apply juice obtained from squeezing fermented leaves about 5 ml with paste of 21 black peppers as cure for swelling of throat of cattle (28). The juice of leaves is applied to bruises and roots are diuretic and diaphoretic (20). The plant extract is blood pressure depressor and found to be anti-microbial in vitro (25).

#### *Occurrence and Distribution*

It is naturalized in the sub-Himalayan tract and outer Himalayas and many other parts.

#### *Local Names*

English : The dwarf aloe ; Sanskrit : Kantala, Telegu : Bulurakkasi, Kittanara, Samata, Tamil : China erumaikkattalai, Seemakathalai, Hindi : Khetki.

#### *Agave cantala* Roxb.

The leaves are used in boils, burn, cut and wound and as diuretic, antiseptic, blood purifier, laxative and analgesic, remedy for urinary infection, a general tonic. The leaf-paste is used to relieve pain and decoction is used for the treatment of scanty menstruation (25). Roots are anthelmintic (destroys or expels intestinal worms), used in diarrhea, fever, goiter (chronic enlargement of the thyroid gland), paralysis and skin diseases. The plant is used by the Santhals in anasarca ascites, dropsy, dysentery and syphilis (19).

The leaves contain hecogenin (0.15%) which can be recovered from the wastes after fiber extraction. Leaves also contain saponases suitable for conversion of *Discorea* saponin to diosgenin (29). Presence of diosgenin (0.03%) along with hecogenin reported (22, 30).

#### *Chemical Constituents*

New saponin—cantalanin A isolated from leaves and characterized (27). Isolation and structure elucidation of cantalanin B from fru-

its were done (31),  $\beta$ -sitosterol, tigogenin, hecogenin, 9-dehydrohecogenin, gitogenin, manogenin, 9-dehydromanogenin and chlorogenin isolated from leaves (32); new steroidal saponin (I) isolated from roots and its structure determined (33); tigogenin, diosgenin, hecogenin, gitogenin and chlorogenin isolated from root stalks (34).

#### *Occurrence and Distribution*

East and west coast, upper Gangetic parts and Panjab.

#### *Local Names*

Bengali : Bilati anarash, Punjab: Kantala, Kitki.

#### *Agave vera-cruz* Mill

Stem is a rich and cheap source of polyfructosans of the type of insulin and its isomers. These branched fructans have been indicated to be an useful chemotaxonomic aid (35). The plant is used as pergative (20).

#### *Chemical Constituents*

The juice of leaves contains hecogenin (0.1%) only (17, 20). Extraction and isolation process for hecogenin from juice standardized (17). 9 (II)-dehydrohecogenin isolated from leaves; trisaccharides—1-kestose and neokestose-tetrasaccharides-nystose and another related to neokestose isolated from stem (23, 27, 36).

#### *Occurrence and Distribution*

Andhra Pradesh, Maharashtra, Karnataka and Madhya Pradesh, Assam, West Bengal, Mumbai.

#### *Local Names*

Hindi : Kuwarbuti, Rakaspatta, Tamil : Kattazha, Telegu ; Kattalai.

#### *Sapogenins and Future Prospects*

Corticosteroids, sex hormones and contraceptive pills belong to steroid drugs, manufactured from hecogenin ( $C_{27}H_{42}O_4$ ) and diosgenin, belonging to the group of "sapogenins" Sapogenins has the basic structure of steroid

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