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Review Article

Gymnema Sylvestre-An Antidiabetic Plant

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Abstract

Gymnema Sylvestre R. Br. (Asclepiadaceae) is a herb distributed throughout the world. The leaves of *G. sylvestre* used in India and parts of Asia as a natural treatment for diabetes or "sweet urine." This plant is also used for controlling obesity in the form of Gymnema tea. The herb's active ingredient, gymnemic acid, is extracted from leaves and roots of the plant. It has been observed that there could be a possible link between obesity, Gymnemic acids and diabetes. The plant is documented to possess beneficial effects as digestive, anti-inflammatory, diuretic, hypoglycemic and antihelmentic. It is believed to be used in dyspepsia, constipation, jaundice, haemorrhoids, cardiopathy, asthma, bronchitis and leucoderma. A scrutiny of literature revealed some notable pharmacological activities of the plant such as antidiabetic, antiobesity, hypolipidaemic, and antimicrobial, free radical scavenging and anti-inflammatory. This review will try to put forth an overall idea about the plant.

Key words: Gymnema Sylvestre, Gymnemic acid, Obesity, Hypoglycemic.

Introduction

Gymnema sylvestre R. Br. is a woody, vine-like plant which climbs on bushes and trees in the Western Ghats in South India and to the west of those mountains in the territory around the coastal city of Goa. It came to be known as "destroyer of sugar" because, in ancient times, Ayurvedic physicians observed that chewing a few leaves of Gymnema suppressed the taste of sugar. *G. sylvestre* is a plant used in India and parts of Asia as a natural treatment for diabetes or "sweet urine." The herb's active ingredient, gymnemic acid, is extracted from leaves and roots and helps to lower and balance blood sugar levels [1-2].*Gymnema sylvestre* leaves contain triterpene saponins belonging to oleanane and dammarene classes. Oleanane saponins are gymnemic acids and gymnemasaponins, while dammarene saponins are gymnemasides. Beside this, other plant constituents are flavones, anthraquinones,

hantri-acontane, pentatri-acontane, a and ß-chlorophyl, phytin, resins, d-quercitol, tartaric acid, formic acid, butyric acid, lupeol, ß-amyrin related glycosides and stigmasterol. The plant extract also test positive for alkaloids. Leaves of the species yield acidic glycosides, anthraquinones and their derivatives. Among these bioactive compounds of *Gymnema sylvestre*, gymnemic acids have anti-diabetic, anti-saccharine and anti-inflammatory activities [3-5]. The taxonomy of the plant is described in table 1[6].

Table 1: Taxonomy of Gymnema sylvestre

Kingdom	Plantae
Subkingdom	Tracheobionta
Superdivision	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Asteridae
Order	Gentianales
Family	Asclepiadaceae
Genus	*Gymnema*
Species	*sylvestre*

History

Indian physicians first used *Gymnema* to treat diabetes almost 2,000 years ago. The primary application was for adult-onset diabetes, a condition for a condition once described as “honey urine” and is continued to be recommended today in India. The leaves were also used for stomach ailments, constipation, water retention and liver disease. In the 1920s, preliminary scientific studies found some evidence that *Gymnema* leaves can reduce blood sugar levels, but nothing much came of this observation for decades [7,8].Today, *Gymnema* has become increasingly popular in the United States as a supportive treatment for diabetes. The leaves are used in herbal medicine preparations [9-11]. The leaves, when chewed, interfere with the ability to taste sweetness, which explains the Hindi name gurmar:"destroyer of sugar." In India, there is a locally descended medical science with the history of 2,000 years called "AYURVEDA" in which all treatments are done with natural materials [8].

Chemical composition

The major bioactive constituents of *Gymnema sylvestris* are a group of oleanane-type triterpenoid saponins known as gymnemic acids. The latter contain several acylated (tigloyl, methylbutyroyl etc.,) derivatives of deacylgymnemic acid (DAGA) which is the 3-*O*-glucuronide of gymnemagenin (3,16,21,22,23,28-hexahydroxy-olean-12-ene). The individual gymnemic acids (saponins) include gymnemic acids I-VII, gymnemosides A-F, and gymnemasaponins. *G. sylvestre* leaves contain triterpene saponins belonging to oleanane and dammarene classes. Oleanane saponins are gymnemic acids and gymnemasaponins, while dammarene saponins are gymnemasides. Besides this, other plant constituents are flavones, anthraquinones, hentriacontane, pentatriacontane, α and β-chlorophylls, phytin, resins, d-quercitol, tartaric acid butyric acid,lupeol, β-amyrin-related glycosides and stigmasterol [12].

Table 2: Yields of antisaccharine principle; gymnemic acid from Gymnema sylvestre leaves by different extraction methods [75]

Extraction method	**Sample**	**Weight of powdered leaves (gm)**	**Gymnemic Acid isolated (gm)**	**Yield in % age on moisture free basis (m.f.b)**
Method-I: With ethanol 95% afterdefatting&Chromatography	A	200	10.7	6.15
Method-II: By separating in to acidic, alkaline and neutral fractions	B	200	7.3	4.2
Method-III: With ethanol 80% without defatting	C	500	15.9	3.65
Method-IV: Aqueous Extraction	D	500	7.2	1.66

Macroscopic Characteristics

Leaves of *G. sylvestre* are green in colour and stem is hairy and light brown. Leaf is 2-6 cm in length and 1-4 cm in width. The leaves are simple, petiolate, rounded to cordate base, margin entire,opposite with acute apex, reticulate venation, pubescent on both the surfaces. The odour is characteristic and taste of leaf is slightly bitter and astringent. It also possesses remarkable property of paralyzing the sense of the taste for sweet substances for few hours [13-14].

Fig. 1 Gymnema Sylvestre leaves

Microscopic characterstics

Petiole

Transverse section of petiole is horse shoe shaped. The epidermis is barrel shaped single layered,thick walled covered with uniseriate, multicellular, non-glandular trichomes. The cortex is collenchymatous and vascular bundles are amphicribal and three in number. Well developed phloem consists of sieve tubes, companion cells and phloem parenchyma. The xylem consists of vessels, tracheids and tracheidal fibres. The starch grains are polygonal, simple or compound in two or many groups. The rosette crystals of calcium oxalate are present more towards the centre [13-15].

Lamina

The epidermal cells of lamina are square shaped with outer convex wall and thin cuticle. When viewed transversally, epidermal cell surface are interrupted with trichomes, which are uniseriate, multicellular with 2 to 5 celled, present in abundance on both the surfaces. Single layered closely arranged palisade cells are present just below the adaxial epidermis. Vascular bundles are amphicribal and the mesophyll is 3-5 celled thick [13-15].

Stem

The transverse section of stem is circular in outline. The epidermis is barrel shaped and thick walled. Trichomes are multicellular, uniseriate and 185-485 µ long and 9-25 µ broad. The cork is 3 to 5 layered thick and cortical cells are latterly elongated and collenchymous. The phloem well developed consists of large sieve plates, companion cells and phloem parenchyma. The xylem is in the form of a continuous cylinder transverse by narrow medullary rays. The endodermis is conspicuous and the pericycle is broad [13-14].

Powder

The powdered material is slight yellowish green in colour, bitter in taste with pleasant aromatic odour. On microscopic examination, it shows thick walled, uniseriate multicellular trichomes, anomocytic stomata, idioblast with rosette crystals of calcium oxalate, starch grains, remnants of collenchymatous and parenchymatous cells; vessels, tracheids, tracheidal fibres, sbast fibres and sieve plates [13-14, 16].

Identification test

When powder is treated separately with 1 N aqueous NaOH and 50% KOH, shows green fluorescence under UV 254 nm and orange colour with 50% HNO3 in daylight. General identification tests for *G. Sylvestre* hydro-alcoholic extracts are as given below: The dilute solution suppresses the sweet taste buds, it gives copious foam appearance when shaken with water and on addition of dilute acid, it forms a voluminous precipitate [15-16].

Purity test

Purity test of *G. sylvestre* depicts the following characteristics:

1) Maximum moisture content should not morse than 6 percent,
2) Total ash content should not more than 12 percent,
3) Heavy metal content in leaves or leaves extract should not more than 40 ppm and in the final dosage form, it should not more than 10 ppm [16, 17].

Pharmacological Actions

Blood sugar balance is made of the root and leaf of the plant *Gymnema* or its extraction. Its functions can explain as follow:

1.The *Gymnema* molecule's affinity with sugar molecular acceptor is 20 times more than dextrose. The acceptor that can absorb sugar in the small intestine cannot absorb sugar when occupied by *Gymnema*. As the result, the blood sugar consistency plays down.
2. As same reason, *Gymnema* can act on the taste buds in the tongue. The tongue feels no sweet taste when chewing *Gymnema* and candy at the same time.
3. The blood sugar is controlled by insulin and the insulin is produced by β -cells in the pancreas. Usually, in the adult diabetic, if the β -cell has been damaged, *Gymnema* can help the β -cell regenerate and thus lessen the diabetic symptoms. Therefore blood sugar balance and blood sugar balance II are effective for both dependent (infant) and adult diabetics [18-19].

[a] Blood Sugar Level
Gymnema leaves, whether extracted or infused into a tea, suppress glucose absorption and reduce the sensation of sweetness in foods effects which may deliver important health benefits for individuals who want to reduce blood sugar levels or body weight. *G. sylvestre* is a woody climbing plant that grows in the tropical forests of central and southern India, Deccan peninsula, Assam, and some parts of Africa whose leaves are used in herbal medicine preparations [20-21].
Gymnema leaves raise insulin levels by regeneration of the cells in the pancreas that secrete insulin. Other research has shown that *Gymnema* also improves uptake of glucose into cells by increasing the activity of the glucose utilizing enzymes, and prevents adrenaline from stimulating the liver to produce glucose, thereby reducing blood sugar levels [22]. The leaves are also noted for lowering serum cholesterol and triglycerides. It also abolishes the taste of sugar, which effectively suppresses and neutralizes the craving for sweets. The leaf extracts contain gymnemic acid which inhibits hyperglycemia and also acts as a cardiovascular stimulant [23].
The primary clinical application for this botanical is as an antidiabetic agent. *Gymnema* has been the subject of considerable research since the 1930s, with promising results for types 1 and 2 diabetes. *Gymnema* has been successful in controlling the blood sugar level without reducing it to below the normal blood sugar level, an effect seen with the use of insulin or oral hypoglycemic sulphonylurea compounds. *Gymnema* provides a simple and effective method to help maintain healthy glucose levels. It works safely within your current regimen to promote proper pancreatic function. *G. sylvestre* significantly reduces the metabolic effects of sugar by preventing the intestines from absorbing the sugar molecules during the process of digestion. Because there is a change in the absorption of sugar, there is a consequent change in the blood sugar level.
[b] Diabetes
As early as 1980s, researchers have started to study the anti-diabetic effects of G. *sylvestre* leaves extracts. *G. sylvestre* leave extract appears to have the benefits on supporting blood glucose homeostasis of diabetic rats through increased serum insulin levels via repair or regeneration of the endocrine pancreas [23-33]. In diabetic rabbits, dried leaf powder of *G. sylvestre* regulated the blood sugar levels by increasing the enzyme activities affording the utilisation of glucose by insulin dependent pathways. Thus, *G. sylvestre* appears to correct the metabolic defects in liver, kidney and muscle. In 1990, researchers started to conduct study of *G. Sylvestre* leaves extract on human beings. Researchers from India administered a water-soluble extract of the leaves of *Gymnema sylvestre* to 27 patients with insulin-dependent diabetes mellitus (IDDM) on therapy63. They found that the *G. sylvestre* leaves extract enhance endogenous insulin. In another study of 22 Type 2 diabetic patients on conventional oral anti-hyperglycaemic agents, researchers applied *G. sylvestre* leave extracts as supplements to these patients and five of the 22 diabetic patients were able to discontinue their conventional drug and maintain their blood glucose homeostasis with *G. sylvestre* leaf extract alone[34].

In late 1990s, researchers reported that gymnemic acid contributed to anti hyper-glycemic effect of *G. sylvestre* leaves. In a study of rats, high doses of gymnemic acids increased fecal cholesterol and CA-derived bile acid excretion. While, other studies suggested that the stimulatory effects of gymnemic acid IV [or G. sylvestre leaves] on insulin release may be related to the increased cell permeability, rather than by stimulating exocytosis by regulated pathways. There are different kinds of gymnemic acids and related compounds. Gymnemoside b and gymnemic acids III, V, and VII exhibit a little inhibitory activity against glucose absorption, but the principal constituents, gymnemic acid I and gymnemasaponin V, lack this activity [35]. Although *G. sylvestre* has been used to treat a number of conditions, it is best known for its apparent ability to lower blood sugar levels. Results from case reports and studies in humans and animals suggest that it may work in several ways to help control both type 1 and type 2 diabetes. First, the acids contained in *G. sylvestre* seem to decrease the amounts of sugar that are absorbed from foods. As a result, blood sugar levels may not increase as much as usual after meals. Secondly, *G. sylvestre* may promote the production of insulin by the body. It is possible that *G. sylvestre* may even prompt the

pancreas to develop more β cells, the source of insulin. It may also make body cells more responsive to the insulin that is available. Finally, several studies have shown that chewing on the leaves of *G. sylvestre* dulls the sense of taste for sweet foods. Participants in studies tended to consume fewer sweet-tastes in foods and drinks after using *G. sylvestre*.

Thousands of years ago, Type II diabetes was treated with *Gymnema*. The plant's sugar-destroying property was revealed when a person chewed one or two leaves. *Gymnema* was said to paralyze a person's tongue to the taste of sugar and bitter tastes. That taste-blocking reaction lasted for several hours [36-41]. During that time, leaves supposedly provided a slight block to the taste for salty foods, while the taste for acidic foods was not affected. By blocking the taste buds from tasting sugar, *Gymnema* blocked sugar in the digestive system, resulting in a decrease in blood sugar, also known as a hypoglycaemic effect. This medicinal action has been studied since the late1930sR.
In vivo studies have indicated that extracts of *G. sylvestre* containing gymnemic acid suppress the elevation of blood glucose levels by inhibiting glucose uptake in the intestine [42] and by increasing insulin release from the pancreas. The major mode of action was proposed to be through increased permeability of the α -cell plasma membranes, leading to unregulated loss of insulin from the cells. The high saponin glycoside content of the extract is thought to be responsible for this action. In addition, a calcium 2 sensitive component is present; some degree of insulin release may occur through channel independent calcium influx into the β -cells, perhaps through the pores formed by plasma membrane disruption.

[c] Weight Loss

Gymnema could also reduce and alter the taste of sugar, and it does just that. By placing the herb on your tongue or drinking the tea, the perception of sugar or aspartate is reduced or eliminated completely. That may come in handy if you want to deter a binge on chocolate cheesecake. Some articles state that this is not true so I tried it myself by breaking open a capsule and placing a small amount in my mouth. It did indeed eliminate the perception of sugar. The effect lasted for about 15 minutes as I sampled other foods and drinks. Sweet Relief gum is available which contains *Gymnema.* In a randomized, double-blind, placebo-controlled 8 week-study of 60 overweight subjects, combo of (-)-hydroxycitricacid, niacin-bound chromium and *G.sylvestre* extract facilitated a reduction in excess body weight and BMI, and promoted healthy blood lipid levels [43].

[d] Lipid Lowering

Animal data: A dose-dependent increase in fecal cholesterol and cholic acid-derived bile acid excretion has been demonstrated in rats. A 3-week study showed a decrease in apparent fat digestibility and an increase in excretion of neutral sterols and acidic steroids in rats receiving an extract of *G. sylvestre* leaves and either a normal or high-fat diet. Total serum cholesterol and triglycerides also were decreased significantly. After 10 weeks, plasma triglycerides were lower in *Gymnema*-fed rats than in controls, but the difference in plasma total cholesterol levels was no longer significant [44-47].Clinical data: Reduction in plasma cholesterol, triglycerides, and free fatty acid levels was observed in 2 studies of diabetic patients who received supplements of *Gymnema* in addition to their usual antidiabetic medication (eg, insulin, glibenclamide, or tolbutamide). In contrast, these levels increased gradually from baseline in the control group patients not taking *Gymnema*. It should be noted that lipid lowering was a secondary endpoint in these studies, which were designed to demonstrate the antidiabetic effects of *Gymnema* [48]

[e] Suppression of Sweet Taste

Gymnema extract interferes with the ability of the taste buds to taste sweet and bitter flavours (such as sugar or quinine), but the ability to taste sour, astringent, or pungent substances is maintained [49-50].Animal data: In rats, taste response to sucrose, fructose, lactose, and maltose was markedly suppressed by gurmarin, a protein extracted from *G. sylvestre;* response to saccharin sodium was weaker. Minimal response to sodium chloride, hydrochloric acid, and quinine hydrochloride was noted. Preference for sucrose recovered within 1 or 2 weeks after cessation of *Gymnema* intake [51].Clinical data: Research reveals no clinical data regarding the use of *Gymnema* for suppression of sweet taste. Gymnemic acid combined with the recognized site of sugar, and so it prevents sugar from combining [52-53].

[f] Inflammation

Anti-inflammatory properties of *Gymnema* have been demonstrated. Biochemical markers of inflammation, such as α-glutamyl transpeptidase, superoxide dismutase, and lipid peroxides are enhanced, increasing protection against leukotrienes and free radicals and aiding rapid tissue repair and remodelling [54-56]. Animal data: Histamine release from mast cells was inhibited by extracts of *G. sylvestre* in vitro.103 Moderate inhibition of carrageenan-induced rat paw edema was induced by an aqueous extract of the leaves of *G. sylvestre;* naproxen produced superior inhibition of edema. However, efficacy of *Gymnema* was similar to naproxen in a peritoneal ascites model in mice. Unlike naproxen, *Gymnema* did not inhibit beneficial granuloma formation and the gastric mucosa was not irritated by high doses [57-58]. Clinical data: Research reveals no clinical data regarding the use of *Gymnema* for inflammation [59].

[g] Antibacterial Effects

Indian researchers demonstrated antimicrobial activity of an ethanolic extract of *G. sylvestre* leaves against Bacillus pumilis, B. subtilis, Pseudomonas eruginosa and Staphylococcus aureus.The ethanolic extract of *G. sylvestre* leaves demonstrated antimicrobial activity against Bacillus pumilis, B. subtilis, Pseudomonas aeruginosa and Staphylococcus aureus and inactivity against Proteus vulgaris and Escherichia coli [60-63].

[h] Free radical scavenging activity

In vitro, the inhibitory effects of DPPH radicals and LDL oxidation were found with aqueous extract of *G. sylvestre. G. sylvestre* require 32.1 µl, for scavenging 50% of the DPPH radicals [64].

Traditional use

Susruta describes *G. sylvestre*, as a destroyer of madhumeha (glycosuria) and other urinary disorder. It is also reported to be bitter,astringent, acrid, thermogenic, anti-inflammatory, anodyne, digestive, liver tonic emetic, diuretic, stomachic, stimulant, anthelmenthics, laxative, cardiotonic, expectorant, antipyretic and uterine tonic. It is useful in dyspepsia, constipation and jaundice, haemorrhoids, renal and vesicle calculi, cardiopathy, asthma, bronchitis, amenorrhoea, conjunctivitis and leucoderma [65-67]. The drug is also used in the composition of ayurvedic preparations like Ayaskri, Varunadi kasaya, Varunadighrtam, Mahakalyanakaghrtam [68].

Ethanobotanical uses

There are over four hundred different tribal and other ethnic groups in India. Each tribal group is having their own tradition, folk language, beliefs and knowledge about the use of natural resources as medicines. The plant is reported to be useful in ethnobotanical surveys conducted by ethnobotanists. It has been documented that the Jungle Irulas inhabitants of Nagari Hills of the North Arcot District, Bombay and Gujarat from India have the habit of chewing a few green leaves of *G. sylvestre* in the morning in order to keep their urine clear and to reduce glycosuria. Bourgeois classes of Bombay and Gujarat also chew fresh leaves for the same effect. In Bombay and Madras, 'Vaids' are known to recommend the leaves in the treatment of furunculosis and madhumeha. The juice obtained from root is used to treat vomiting and in dysentery and plant paste is applied with mother milk to treat mouth ulcer. [69-70].

Toxicological Study

No adverse reactions were reported in a long-term study of insulin-dependent diabetic patients. However, consider the possibility of hypoglycaemia. Systolic blood pressure was raised in spontaneously hypertensive rats fed a high sucrose diet. The clinical significance of this finding is unknown.The plant has not been associated with published reports of human toxicity; however, it is possible that as few as 12 tablets of some otc preparations could cause a demonstrable hypoglycaemic reaction in humans. Blood urea, uric acid, and haemoglobin levels remained in the normal range in patients receiving *Gymnema* supplements in addition to their usual ant diabetic medication, suggesting the absence of hepato- or nephrotoxicity at normal doses. In an acute toxicity study in mice, no gross behavioural, neurologic or autonomic effects were observed. The acute LD 50 was 3990 mg/kg. The safety ratio (LD 50 /ED 50) was 11 and 16 in normal and diabetic rats, respectively. The main side effect, as such, is that as it can reduce blood sugar levels, some caution may be necessary if you take it with other agents, such as herbs or pharmaceutical drugs, which might lower blood sugar. If blood sugar levels fall too low, side effects include shakiness, sweating, confusion, distorted speech and loss of muscle control may occur. Very little information is available on side effects of *G. sylvestre* relating to pregnancy or breast feeding, or its use for infants. Therefore, we advise caution in using *Gymnema* in these circumstances. *Gymnema* is a remarkable herb which, if used bearing in mind the above cautions, can be a huge benefit both to those who truly want to cut down their consumption of sweet foods and those with blood sugar issue. of course, if on medication you should consult your doctor before taking *Gymnema*: but if you have 'blood sugar lows' and are not on medication, try *Gymnema*.

Dosage and Administration

In human studies, the most common doses of *G. sylvestre* used for blood sugar control were 400 mg to 600 mg per day. *G. sylvestre* is commonly added to many different herbal combination products, but the majority of studies used GS4150, a standardized product that contains only *G. sylvestre*. Standardization by the manufacturer should assure the same amount of active ingredient in every batch of the commercial preparation. Standardization of herbal products is not required by the U.S. Food and Drug Administration (FDA), so not every product will contain the same amounts of active ingredients. *Gymnema* Dosing: Typically, clinical studies investigating antidiabetic effects have used 200 or 400 mg of an extract standardized to contain 25% gymnemic acids administered twice daily [71].

In market, *G. sylvestre* is available in the form of crude plant, powder, extract, paste and solid in standardized form. The plant material is also available in the form of capsule or tablets in combination with other herbal plants [72]. Adult dose: In liquid form (extract), 25 to 75 ml per week is recommended. Best results of this medicine will come after 6 to 12 months of continuous use. It is also prescribed in tablet form; in this case 8 to 12 g per day of leaf

equivalent is recommended.Paediatric dose: In this case, there is insufficient evidence about its uses for paediatric population, so it cannot be recommended for them.

Suggested combination with other herbs

G. Sylvestre can be taken along with fenugreek, goat's rue and the neem leaves for the treatment of diabetes, and with artichoke or blue flag for the treatment of weight loss. In the case of hypercholestrolaemia, *G. Sylvesre* recommended with turmeric, hawhorn, silybum, globe artichoke and garlic [73].

Table: 3 phytochemical test of Gymnema Sylvestre

Sr. No.	Tests	Reagents used	Results of stem	Results of leaf
A)	**Water Extractives**			
1.	Starch	I2-KI	-ve	+ve
2.	Tannins	Acidic $FeCl_3$	+ve	-ve
3.	Saponins	H_2SO_4 + Acetic unhydride	+ve	+ve
4.	Proteins	Million's test	+ve	+ve
5.	Anthraquinones	Benzene + 10%NH_4OH	+ve	+ve
6.	Reducing sugars	Benedict's	-ve	+ve
B)	**Alcoholic Extractives**			
1.	Alkaloids	Mayre's	+ve	+ve
		Wagner's	+ve	+ve
		Dragnendorff's	+ve	+ve
2.	Flavonoides	HCl + Mg turnings	+ve	+ve
3.	Glycosides	Benzene+hot ethanol	-ve	+ve

Estimation of Different Chemical Constituents Collected From Different Localities

Table: 4 Estimation of proteins in Gymnema Sylvestre collected from different localities

	Plant Part Used		
Name of the Locality	Leaf % / g / dry weight	Stem % / g / dry weight	Mean % / g / dry weight
Amboli	O.30	2.01	2.31
Dapoli	0.19	1.55	1.74
Department Garden	O.25	2.00	2.25
Khambataki Ghat	O.58	1.O2	1.60
Mulshi	0.28	2.33	2.61

The results are mean of three different readings.

Table: 5 Estimation of alkaloid in Gymnema Sylvestre collected from different localities

	Plant Part Used		
Name of the Locality	**Leaf % / g / dry weight**	Stem % / g / dry weight	**Mean** % / g / dry weight
Amboli	1.22	O.74	1.96
Dapoli	1.85	0.93	2.78
Department Garden	1.80	1.55	3.35
Khambataki Ghat	0.67	0.84	1.15
Mulshi	1.95	1.12	3.07

The results are mean of three different readings.

Table: 6 Estimation of Gymnemic acid in Gymnema Sylvestre collected from different localities

	Plant Part Used		
Name of the Locality	**Leaf** **% / g / dry weight**	Stem % / g / dry weight	**Mean** % / g / dry weight
Amboli	1.35	0.56	0.96
Dapoli	1.64	0.68	1.16
Department Garden	2.03	0.91	1.47
Khambataki Ghat	1.67	0.75	1.21
Mulshi	2.08	1.74	1.91

The results are mean of three different readings.

Results indicated that plants growing under various ecological conditions showed histological similarities, but size and thickness of leaves shows difference in plants growing at different ecological conditions [74].

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