CHAPTER-1

GENERAL INTRODUCTION

CHEMISTRY OF GENUS ASPARAGUS

In the systematic classification, genus *Asparagus* belongs to the family Liliaceae and its position in the plant kingdom[1] is shown below.

Division	...	Trachaeophyta
Sub-division	...	Pteridopsida
Class	...	Angiospermae
Sub-class	...	Monocotyledoneae
Order	...	Liliales
Family	...	Liliaceae
Genus	...	Asparagus

The name *Asparagus*[1-8] was applied by Theophratus. The genus *Asparagus* comprises of erect climbing herbs or shrubs with slender, ribbed or grooved green stems. These have no true leaves, but small, sometimes spine-tipped, scales subtending a bunch of narrow green needle-like spiny or flattened branchlets. (cladodes). Plants of genus *Asparagus* are found in India, Ceylon, Burma, Java, Africa and Europe.

The species coming under the genus *Asparagus* are of medicinal value. The leaves and the roots are usually used for a number of diseases. They contain carbohydrates, sapogenins, saponins, proteins, vitamins, amino acids, lipids and inorganic materials like Mg, Fe, K, Na P, P_2O_5, K_2O etc.

The genus Asparagus covers over a hundred species. The following species are more frequently met with.

(1) A. racemosus Willd.
(2) A. officinalis Linn.
(3) A. asparagoides Wight.
(4) A. sprengeri Regel.
(5) A. filicinus Buch-Ham.
(6) A. acutifolius Linn.
(7) A. adscendens Roxb.
(8) A. gonoclados Baker.
(9) A. umbellatus Linn.
(10) A. stipularis Forsk.
(11) A. curillus Ham.
(12) A. cochinchinensis (Loureio) Merill.

1. A. racemosus Willd

This is a tall spinuous climbing, excessively branched under-shrub with small white flowers which are very fragrant. The roots are tuberous. This species is found in tropical and subtropical India, Ceylon, tropical Africa, Java and Australia.

The root of this plant is used medicinally as a refrigerant, demulcent, diuretic, aphrodisiac, antispasmodic, alterative, antidiarrhoeatic and antidysentric. It is used chiefly as a demulcent in veterinary medicine.

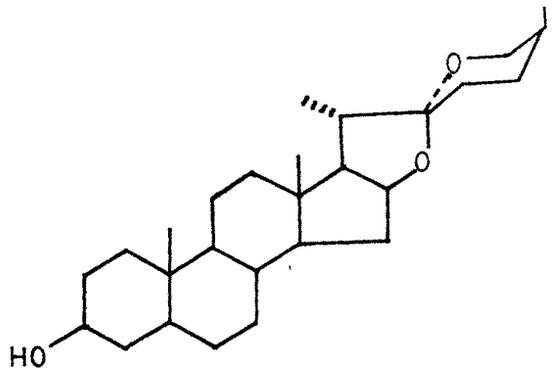
It prevents confluence of small-pox. It is considered to be a galactogogue. The native physicians used the root as a stimulant and restrorative.

Rao[9] et al. reported that the root powder has the following composition.

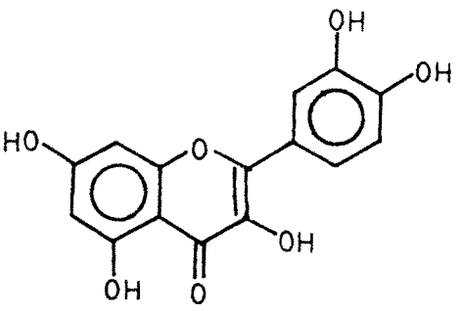
Moisture	...	13.42%
Lipids	...	3.19%
Proteins	...	2.95%
Saponins	...	5.44%
Carbohydrates including uronic acids and free sugars	...	52.89%
Crude fibre	...	17.93%
Ash	...	3.92%

The quantitative analysis of the ash revealed the presence of Na, K, Ca, Mg, Fe, $CO_3^{''}$, $SO_4^{''}$, $PO^{'''}$ and silica.

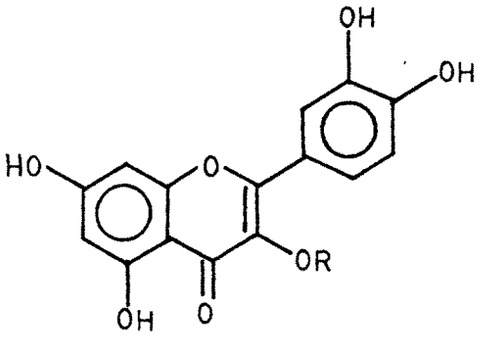
The root powder freed from saponins by treatment with ethylacetate was extracted with 70% alcohol. The extract contained both mono and oligosaccharides (37.44%). The sugars obtained after hydrolysis of the extract were identified as glucose and fructose. The mucilage [9-11] isolated after the removal of saponins and free sugars was composed of glucose and galactose in the proportion of 3:2.



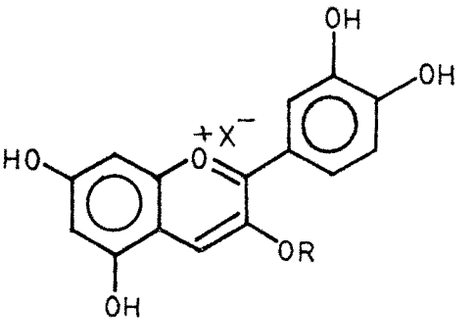
I



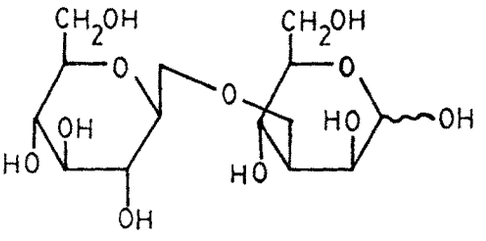
II



III R= $C_{12}H_{21}O_9$
= 6-(∝-L-rhamnosyl)-D- glucoside



IV R= galactosyl group ($C_6H_{11}O_5$)
R_1= glucosyl rhamnoside
($C_{12}H_{21}O_9$)



VI

FIG. I

Rao[12] isolated sarsasapogenin (I) from the acid hydrolysate of the alcohol extract of defatted root powder.

Subramanian[13] et al. isolated quercetin (II), rutin (III) and hyperoside from the flowers. No quercetin was found in the fruits. In fully ripe fruits cyanidin-3-galactoside (IV) and cyanidin-3-glucorhamnoside (V) were shown to be present.

From the ethanolic extract D-glucose, D-mannose and a disaccharide (VI) m.p. 164-5°, were isolated[14]. Subramanian[15] et al. obtained diosgenin (VII), m.p. 204-5° and quercetin-3-glucuronide from leaves.

2. A. officinalis Linn.

This is the commonly known Asparagus. This species is usually erect, much branched herb with yellowish green flowers. The berries are red and the roots fleshy.

Berries are used[6] by Hakims in debility of the stomach and also in liver, spleen and renal disorders. It is a tonic and an aphrodisiac. The leaves, berries and the roots are used as demulcent and diuretic. It is also used in cardiac dropsy and chronic gout[16]. Also the branched lower stems are excessively eaten as a vegetable all over

the world. The plant[17] is diuretic, laxative, cardiac and sedative. The infusion made from the roots will help against jaundice and congestive torpor of the liver.

In England, amedicinal tincture is made from the whole plant which allays minory irritation and does good against rheumatic gout. A syrup of asparagus is employed medicinally in France. The water in which asparagus has been boiled is beneficial against rheumatism. In U.S.A. asparagus is thought to be undeniably sedative and a palliative in all heart affections attended with excited action of the pulse.

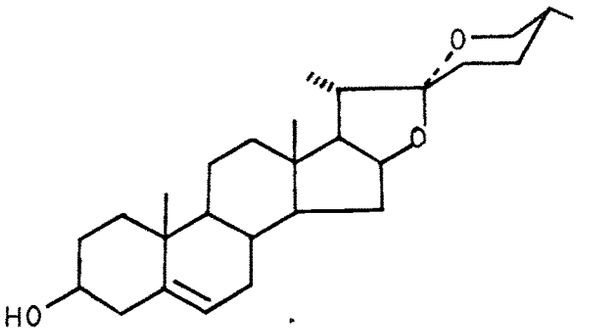
Asparagus officinalis is one of the most widely studied species. It is rich in vitamins. It contains[16]:

Moisture	...	93%
Protein	...	2.2%
Fat	...	0.2%
Carbohydrates	...	3.2%
Fibre	...	0.7%
Ash	...	0.7%
Ca	...	0.025%
P	...	0.039%

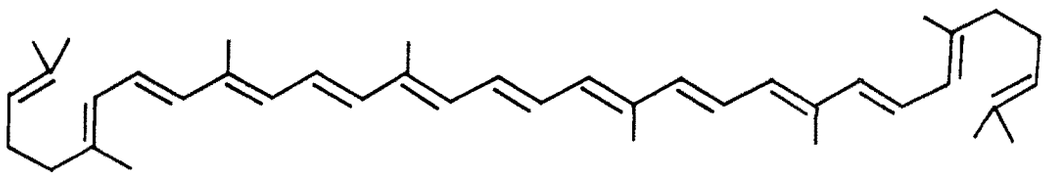
Fe, 0.96 mg, Cu, 0.14 mg.

Vitamins - A, 1400 I.U.; B_1, 180 g.; B_2, 130 g.; C, 40 mg/100 g. (Heinz Co. Nutrit. Charts. 1942, 21).

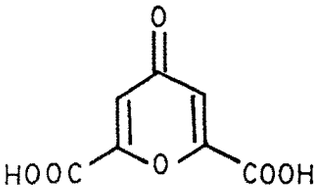
Tollens[18] reported the following composition from the analysis of the plant.



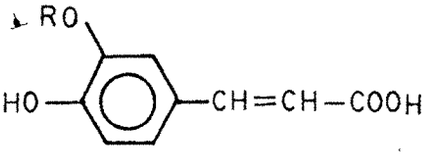
VII



VIII

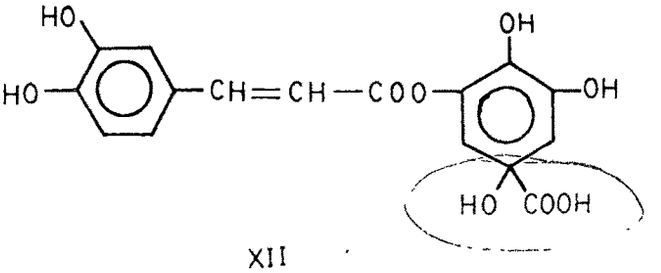


IX



X R= CH_3

XI R= H



XII

Water	...	4.4%
Fat	...	1.5%
Fibre	...	12.4%
Sugars	...	31.5%
Pentosans	...	8.6%
P_2O_5	...	1.0%
K_2O	...	3.0%

Tollens[19] further showed that roots contained fructose and glucose. An oil containing mainly palmitic acid was isolated[20] from the root. The mucilage isolated from the roots was composed of glucuronic acid, glucose, fructose and mannose in the ratio of 1:8:2:10[21].

A white crystalline powder, Asparagin[22] $C_4H_8O_3N_2 \cdot H_2O$ was found to be present in all parts of the plant. Goldberg[23] isolated a hemicellulose, made of β-glucose and β-mannose $(1 \rightarrow 4)$ with α-galactose as the terminal group.

From the fruit, Hehner[24] obtained carbohydrates, organic acids such as maleic and citric acids, and an ash which on partial analysis, showed SiO_2, Al_2O_3, Fe_2O_3, CaO, Mg, K_2O, Na_2O, P_2O_5. Bartlett[25] et al. reported the presence of glucose, fructose, galactose and mannose in

the hydrolysate of hemicellulose, isolated from the seeds. Lycopine (VIII) was also reported[26] in the berries.

Tanret[27] isolated two carbohydrates (Asparagose, $(C_6H_{10}O_5)_n$, m.p. 198-200°; pseudo-asparagose - both composed of glucose and levulose). Mannitol was reported[28] to be present in the juice of the plant.

Chelidonic acid[29] (IX) and β,β'-dimercaptoisobutyric acid[30], ferulic acid[31] (X), caffeic acid[31] (XI) and chlorogenic acid[31] (XII) were also reported to be present.

Flavonoids[32] such as quercetin (II), rutin (III) anthocyanins[33], like cyanidin-3-rhamnoglucosyl glucoside (XIII), cyanidin-3-rhamnosyl glucoside (XIV), peonidin-3-glucosyl rhamnosyl glucoside (XV) and peonidin-3-rhamnosyl glucoside (XVI) were isolated.

Eight oligosaccharides[34] were isolated from purified oligosaccharide fractions of the roots. The roots contained 9 steroid glycosides[35] (TLC, column and paper chromatography) which are named asparagosides A, B, C, D, E, F, G, H and I. From methanol extract of the roots -sitosterol, sarsasapogenin and 9 glycosides were isolated[36]. Asparagoside A, C, D and F contained spirostanol[37] as their aglycone, whereas asparagosides B, E, G, H and I contained (25 S)-5β-furostan-3β, 22α,

26-triol[37,38] as their aglycone. Asparagosides A, E and G contained glucose as their only sugar whereas asparagosides F, H and I had xylose alongwith glucose.

The species also contained glycoside of 22-spirostan-3β-ol, rhamnose, xylose and glucose and 22-isospirostan-3β-ol[39].

From the edible part Held[40] et al. isolated diosgenin (VII) and yamogenin (XVII).

The other components reported to be present in the species are the following: inorganic matter[41], such as Na, K, Ca, Fe, Mg, Cu, P, ascorbic acid[42], thiamine[42], riboflavin[42], Carotene[42], folic acid[41], choline[41], nicotinic acid[41], pantothanic acid[41], inositol[41], fumaric acid[43], succinic acid[43], α-ketoglutaric acid[43], pyrrolidone carboxylic acid[43], glycolic acid[43], maleic acid and citric acid[43] and amino acids[44] such as valine, leucine, isoleucine, threonine, arginine, histidine, lysine, phenyl alanine, tryptophan and methionine.

A water soluble[45] galactoglucomannan was isolated from endosperm of A. officinalis. It contains residues of glucose, mannose and galactose, in the ratio of 43:49:7.

3. A. asparagoides Wight.

This species is a tall, slender, glaberous twiner. It is much branched. The flowers are greenish white and the berries dark purple. These are grown much for florists' use in decoration.

Diosgenin (VII) and pennogenin (XVIII) were isolated[46] from the rhizomes of this species.

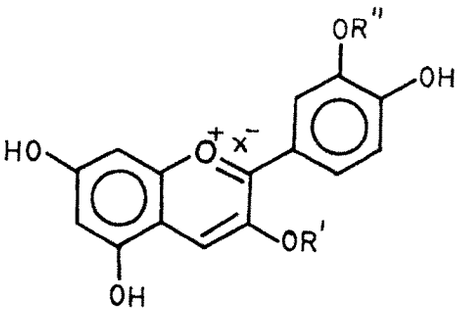
4. A. sprengeri Regel.

This is a climbing and much branched species with small prickles. The flowers are small white pink and fragrant. Berries are bright coral red. It is a good room plant. The roots are tuberous.

Elze[47] had isolated an oil from the flowers by solvent extraction. The oil had strong aldehydic odour and yielded a semicarbazone. Held[40] et al. isolated diosgenin (VII) and yamogenin (XVII) from the hydrolysate of the methanol extract.

5. A. filicinus Buch-Ham.

This species is a tall, erect herb. It is highly branched, smooth unarmed with the lower branches spreading.

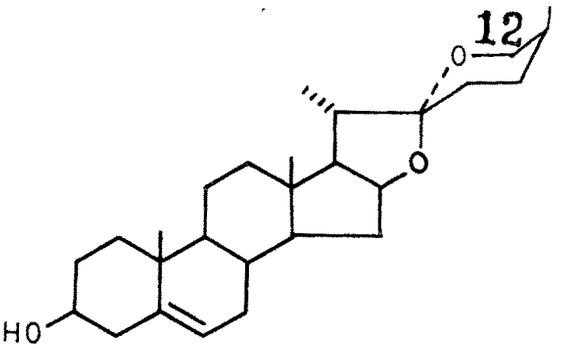


XIII R′= rhamno glucosyl glucoside group
R″= H

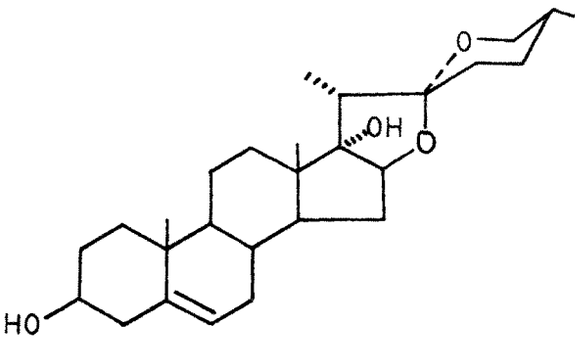
XIV R′= rhamnosyl glucoside group
R″= H

XV R′= glucosyl rhamnosyl glucoside group
R″= CH_3

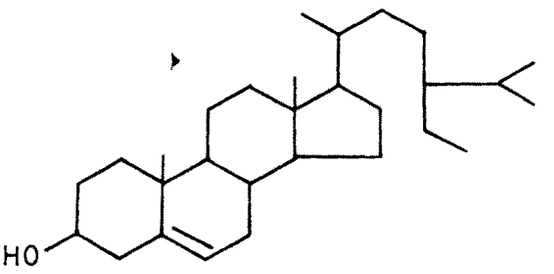
XVI R′= rhamnosyl glucoside group
R″= CH_3



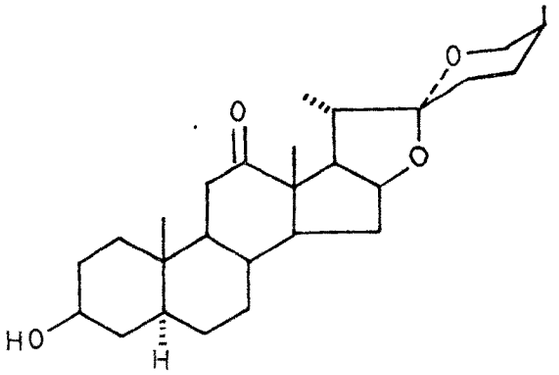
XVII



XVIII



XIX



XX

The flowers are green and the berries black. Roots are tuberous and are densely clustered. It is found in Kashmir, Bhutan, The Khasia Hills, Assam, Burma and China.

The root is considered[6] as a tonic and astringent. A spring of this plant is put in the hands of small-pox patients as a curative measure. It is aphrodisiac. The root[48] is considered vermifuge and taeniafuge in Annam. It is given in cholera and acts as a powerful diuretic. It is also used as a cure for rheumatism due to dampness.

Rao[49,50] et al. isolated an unidentified colouring matter, glucose, fructose and a mucilage composed of mannose, fructose, glucose (5:4:1) and a uronic acid (mannoglucuronic acid) from the powder.

6. A. Acuitifolius Linn.

It is a woody shrub with zigzag branching and yellow flowers. The berries are waxy olive-green. It is found in Mediterranean region.

From roots and rhizomes, sarsasapogenin (I) has been isolated[51-53].

7. A. adscendens Roxb.

The species is a tall, stout, excessively branched shrub. The branchlets are grooved ascending and angled. The flowers are white. It is found in Western Himalaya, Punjab, Murre, the Dieu and Sal forests.

It is sometimes used as a vegetable[16]. The white tubers are hairy and mucilagenous and swell up with water. They are reported to possess cooling and demulcent properties. They are used as tonic and also as a substituent for Salep. They are useful in diarrhoea, dysentry and general debility.

The powdered roots contain essential oil which smells like Khus oil. Rao[54] et al. analysed the tuber powder and found the following.

Moisture	...	11.40%
Fat	...	0.87%
Saponins	...	5.02%
Proteins	...	5.44%
Carbohydrates including free sugars and uronic acids	...	46.84%
Crude fibre	...	23.42%
Ash	...	6.28%

Analysis of the ash showed the presence of K, Na, Fe, CO_3'', SO_4'', PO_4''' and silica.

The mucilage isolated, constituted of glucose, mannose, xylose and glucuronic acid.

Two hemicelluloses were isolated by Rao[55] et al. one of which was named as A_2, was shown to contain xylose, glucose and glucuronic acid in the ratio of 2:1:1 while the other one, B_2 was shown to have the same sugars in the ratio of 1:1:2.

Sitosterol, sarsasapogenin and diosgenin have been reported[56] from the fruits of this plant. Two furostanol and two spirostanol glycosides are reported from the methanol extract of the fruits[56] on acid hydrolysis they gave sarsasapogenin. Three of them had glucose as the only sugar, whereas one contained glucose and rhamnose.

The methanol extract of the defatted roots of this plant yeilded[57] β-sitosterol-β-D-glucoside, two new spirostanol glycosides named as asparanin C and asparanin D, and two new furostanol glycosides asparoside C and asparoside D.

8. A. gonoclados Baker.

This is a much branched undershrub. Flowers are white. The green branches are curved and strongly angled. It is found in Konkan, Kanara, Western Ghats of Madras State, Ceylon etc.

The root is considered as nourishing and aphrodisiac. Boiled with oil, it is applied to cutaneous diseases. It is given in gonorrhoea in 15 grains per dose. The root is used as an adulterant or as a substitute for Aconitum heterophyllum.

The plant contains saponins. Sarsasapogenin (I) was isolated from the acid hydrolysis of the alcohol extract[12].

9. A. umbellus Link.

This is a spreading climber or undershrub with branches and twigs reflexed and pendulous. The flowers are white and the berries yellow to dark red. The plant is used by florists for decorative purpose.

From the rhizomes, A. Gonazalez[58] et al. isolated β-sitosterol (m.p. 134-8°, XIX), tigogenin (m.p. 213-4°), hecogenin (m.p. 267°, XX) and hispidogenin.

10. A. stipularis Forsk.

This species is a climbing and much branched one. The branches are angled and grooved with prickles. The flowers are white. It is abundantly found in Mediterranean region.

Panizo[53] et al. isolated sarsasapogenin (I) from rhizomes.

11. A. curillus Ham.

This is an excessively branched undershrub. It is widely occuring in subtropical Himalaya from Kumaon to Nepal region.

Sharma[59] and his coworkers reported two spirostanol and two furostanol glycosides from the fruits of this plant. From methanol extract of the roots, Sharma[60] et al. isolated three spirostanol and two furostanol glycosides.

12. A. cochinchinensis (Loureio) Merill.[61]

The dried fruits of this plant are known as Asparagi radix. The plant occures widely in Japan and China. Tuberous roots of this plant have been used in Chinese crude drug for the purpose of analeptic, diuretic and cough medicine. It is also used as a tonic and exhibits antifebrile, antitussive and diuretic activities.

β-Sitosterol, glucose, and fructose have been reported from this plant[62]. From the roots, eight oligosaccharides[63] constituted of glucose and fructose have been isolated.

Okanishi Tameo[64] et al. reported sarsasapogenin (I) from roots of the plant. Four Ehrlich - positive[65] furostanol oligosides have been reported by Tenji Konishi and Junzo Shoji[66].

Tomoda[67] et al. isolated citrulline, asparagin, serine, threonine, proline, glycine, alanine, valine, methionine, leucine, isoleucine, phenyl alanine, tyrosine, asparatic acid, glutamic acid, arginine, histidine, lysine and an unidentified acidic amino acid.

SHATAVRI IN AYURVEDA

The roots of shatavri are used as a medicine in Ayurvedic system for last several centuries, as is described in Charaka Samhita, Sushrut Samhita and other books of Ayurveda.

In Ayurvedic system shatavri is a well known drug having a number of properties. In ayurvedic literature it is referred to as by different synonames, the names are characteristic and indicative of its properties. In Ayurveda Saukhyam of Todarananda[68] it is described as satavari, bhirupatri, dvipika, adharkantaki, narayani, satapadi, satahva and vahuputrika. The synonames used are shatamooli, sheetvirya, bahusutaa, atirasa, abhiru,

maha purusa, dantika, sahastra virya, kesi, tungini and suksmapatrika. In ayurved literature its actions are described[69] as balya (promoter), vedanasthapana, rasayana (rejuvenation) and stanyakari.

Shatavari is either used singly[70-72] or as an ingredient in the kalp[70-72]. The root is highly mucilagenous, anti-diarrhoeatic, refrigerant, diuretic, antidysentric, nutritive tonic, demulcent, galactogogue, aphrodisiac and anti-spasmodic[73]. In addition shatavari is laxative, and expectorant[74]. It is given[75] in billiousness, rheumatism, dyspepsia, in combination with other diuretics, it is given in scanty urine. As a tonic it is given in sexual debility and respiratory complaints. It is used[76] as a cardiac tonic and it increases intellectual power, also used in chronic colitis and hemorrhoids. Sushruta recommends the use of shatavari in internal piles. Arya Bhishaka, Charakadatta, Bhavaprakash recommended it in hyperacidity, bilinary colic, burning syndrom and hemorrhagic diseases. Bhavaprakash and Charaka recommended it as nervine sedative and in epilepsy. Charakadatta has recommended it for gout. It is useful in urinary calculus, in the diseases of blood and the eye, throat complaints, tuberculosis, leprosy and night blindness. It is used as an ingredient in a mixture which cures rakta-pitta, anorexia, suppression of the power of digetion,

vomitting, anemia, jaundice, syphilis, erysipelas and chronic fever[77]. It is also used in scalding urine, gleet and gonorrhoea. The root of this plant is used as a demulcent in veterinary medicine. Combined with other ayurvedic drugs, it cures oedema, chronic tuberculosis, immobility of arm and facial paralysis, asthama, hiccup, cough, insanity, syncope, ascitis, chlorosis and constipation. Also it is antiabortive and increases virility and promotes fertility.

BOTANICAL IDENTIFICATION AND PHARMACOGNOSTIC STUDIES

The drug has been equated with various species of Asparagus by many authors. However, A. racemosus Willd. of the family of liliaceae resembled most with shatavari. The taxonomical characters prescribed for A. racemosus are the characters of spines, size of clusters and the length of the cladodes.

Kanitkar et al.[78-79] made a detailed pharmacognostic and microscopic study of the authentic A. racemosus Willd. which were obtained from different parts. They found that there are a number of discripancies in respect of character of spines, size of clusters and the length of the cladodes. According to their study, the classification based on the characters like length of cladodes, size of cladode clusters and size of spines are subject to change according to their

position on the plant and growth of the plant in different soils and climate is inadequate for comparison. They suggested pith/stele ratio as a distinct character of shatavari materials.

PHARMACOLOGICAL SCREENING OF DIFFERENT EXTRACTS OF SHATAVARI

Various extracts of shatavari were prepared by extracting the material with ethyl alcohol, ethyl acetate, petroleum ether and acetone. The alcohol extract was found to contain saponins and free sugars. The extraction procedure was modified. The roots were first extracted with hot acetone and then with hot alcohol in a soxhlet unit. The alcohol extract, after removal of solvent, was dissolved in water and extracted with n-Butyl alcohol saturated with water. The butanol extract contained glycosides - i.e. saponin fraction.

Gaitonde[80-83] et al. carried out the pharmacological screening of various extracts and found that the alcohol extract had the antioxytocic activity.

TABLE - 1 PHARMACOLOGICAL SCREENING OF VARIOUS EXTRACTS OF SHATAVARI[84]

Extract	Diuretic	Anabolic	Anti-ADH activity	Antioxy-toxic activity	Mamma-rotropic activity	Human toxicity study
Alcohol	-	-	-	Present	Present	-
Ethylacetate	-	-	-	Present	Present	-
Acetone	-	-	-	Present	Present	-
Petroleum ether	-	-	-	Absent	Present	-
Saponin mixture	-	Absent	-	Present	Present	-
Saponin A_4 (Shatavarin I)	-	-	Present	Present	Absent	No Toxicity

Roy[85] et al. reported that the crude alcohol extract of A. racemosus caused an initial increase in force and rate of contraction in isolated frog's heart but a higher dose of crude alcohol extract produced a fall in the blood pressure and depression in the respiration of cat. The extract also caused an increase in bleeding time in the rabbit and slight diuretic effect in rat[86].

The alcohol extract of aerial parts of A. racemosus showed anti-cancer activity[87].

The aqueous extract of bath fresh and dried roots were found to have amylase and lypase activities[88].

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SUMMARY

The chemistry of genus Asparagus is reviewed. These species contain carbohydrates, saponins, sapogenins, amino acids, colouring matter, inorganic materials etc. Sarsasapogenin is the most commonly occuring aglycone.

Also background work on Asparagus racemosus Willd, is described. The pharmacognostic identification, various extracts of shatavari and their pharmacological screening are described.