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Carbohydrate and Derived Products – An Overview

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***Abstract:** Carbohydrate and derived products –an overview find the properties types of carbohydrates and the presence of carbohydrate containing crude drugs details. Some of the examples of derived products like Indian gum, Isabgol, agar, tragacanth, and honey*

***Keywords:** Carbohydrate, aldehyde, Isabgol, tragacanth, honey*

1.0 Introduction:

The word carbohydrate can be traced back to Germans, who called them 'kohlenhydrates'. It was then termed carbohydrates in English. The definition did not remain valid as it was misleading with a few compounds like (1) acetic acid expressed as CH3COOH (i.e. C2H4O2) and lactic acid as CH3-CHOHCOOH (i.e. C3H6O3), which are not carbohydrates and (2) sugars like rhamnose and fucose represented by the formula C6H12O5. The carbohydrates are defined as polyhydroxy aldehydes or polyhydroxy ketones or compounds that on hydrolysis produce either of the above. They are substances of universal occurrence and are much abundant in plants, rather than in animals.

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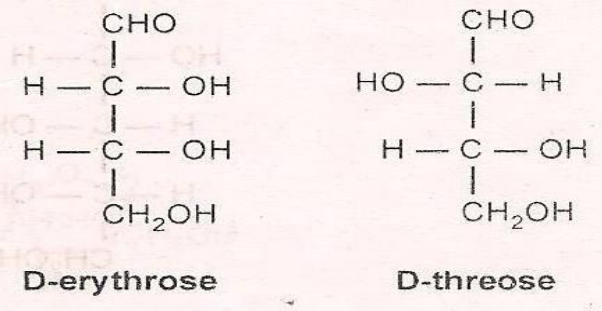
Carbohydrates are grouped into two major classes: simple sugars (saccharides) and polysaccharides. Low molecular weight carbohydrates are crystalline, soluble in water and sweet in taste; e.g. glucose, fructose, and sucrose. The high molecular weight carbohydrates (polymers) are amorphous, tasteless and relatively less soluble in water e.g. starch, cellulose, gums, pectins, inulin, etc. depending upon the chemical structure, saccharides are subdivided as monosaccharides, disaccharides and trisaccharides.

[A] MONOSACCHARIDES

Monosaccharides are sugars, which cannot be further hydrolysed to simple sugars. However, they are classified according to the number of carbon atoms in sugar molecules.

1. **Bioses:** They contain two carbon atoms. They do not occur free in nature.
2. **Trioses:** They contain three carbon atoms, but in the form of phosphoric ester, e.g. glyceraldehyde.
3. **Tetroses (C4H8O4):** They contain four carbon atoms, e.g. erythrose and threose.



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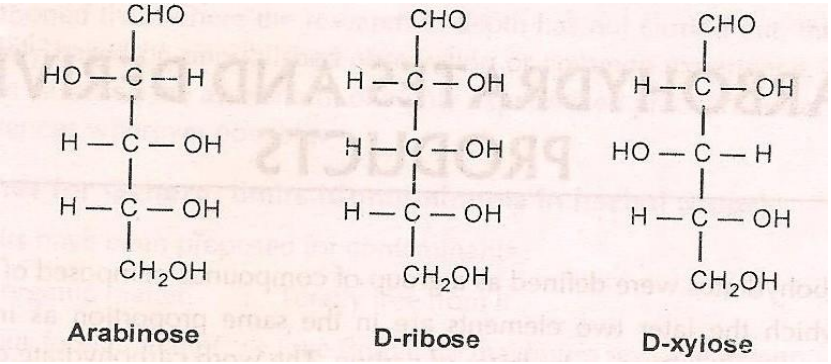
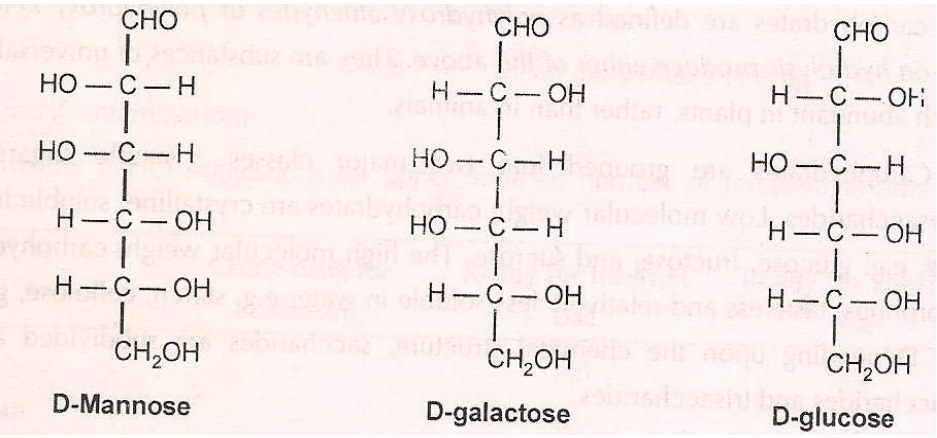
4. **Pentoses (C5H10O5):** They are very common in plants and are the products of hydrolysis of polysaccharides like himecellulose, mucilage and gums, e.g. arabinose, ribose and xylose.



5. **Hexoses:** They are the monosaccharides containing six carbon atoms and are abundantly available carbohydrates of plant kingdom. They are further divided into two types – aldoses and ketoses. They may be obtained by the hydrolysis of polysaccharides like starch, inulin, etc.

   Aldoses : Glucose, mannose, galactose



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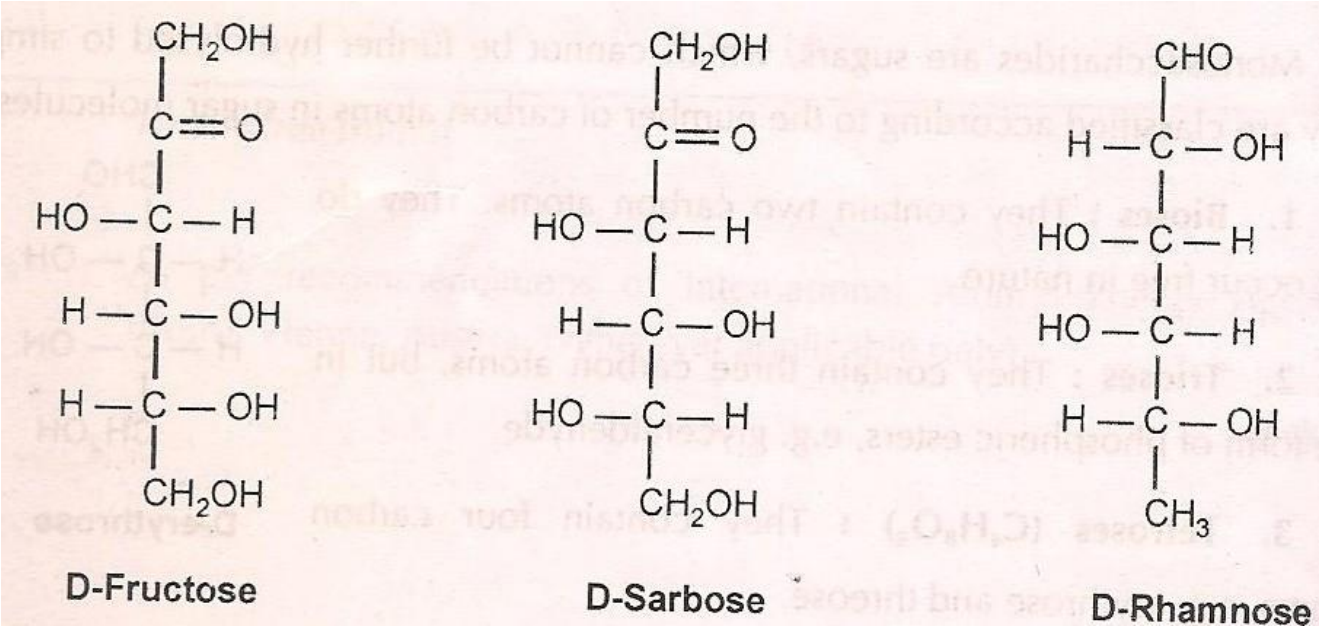
Ketoses : Fructose and sorbose



6. **Heptoses:** They contain 7 carbon atoms, vitally important in the photosynthesis of plant and glucose metabolism of animals and are rarely found accumulated in plants, e.g. glucoheptose and mannoheptose.

[B] DISACCHARIDES

Carbohydrates, which upon hydrolysis yield two molecules of monosaccharides are called as disaccharides.

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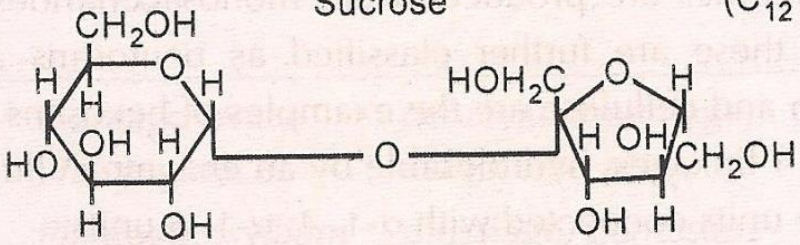
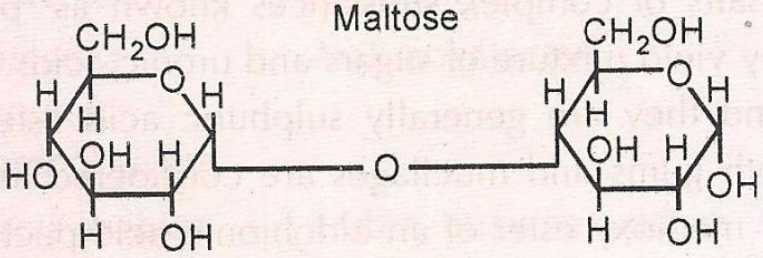
Sucrose (Cane-sugar) —Hydrolysis→ glucose + fructose

Sucrose ($C_{12}H_{22}O_{11}$)



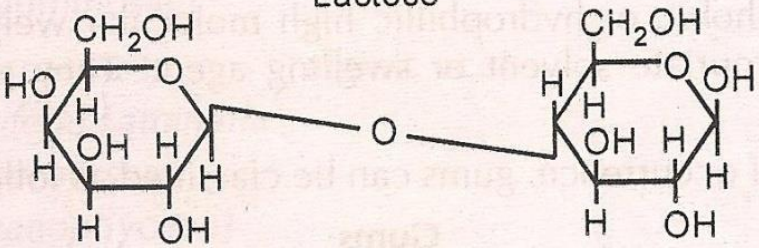
Maltose (Malt-sugar) —Hydrolysis→ glucose + glucose

Maltose



Lactose (Milk-sugar) —Hydrolysis→ glucose + galactose

Lactose



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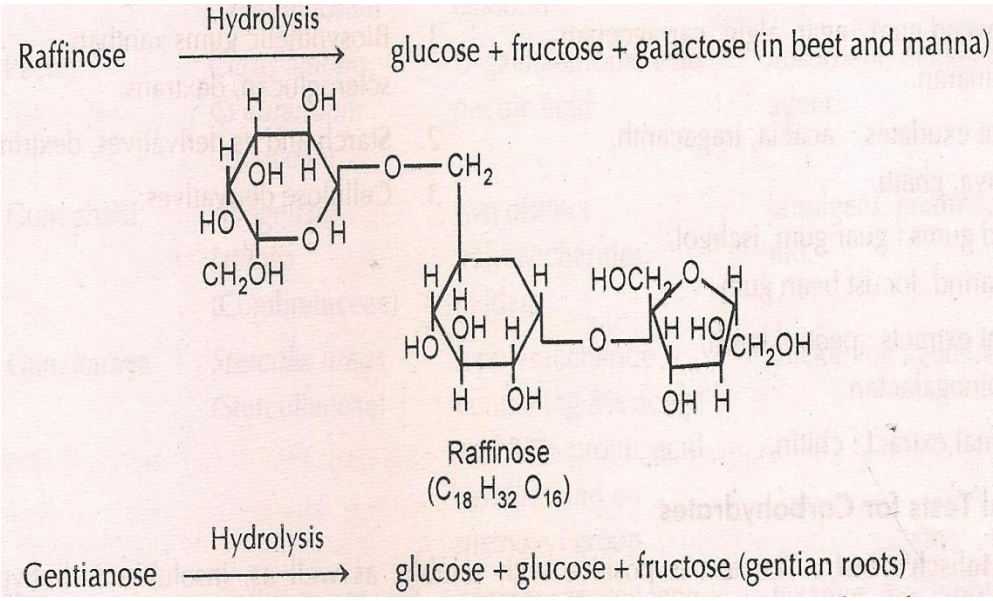
[C] TRISACCHARIDES

As the name indicates, these liberate three molecules of monosaccharides on hydrolysis.



Scillatrise (squill), mannotriose (manna) and phanteose (psyllium) are the other examples of trisaccharides.

[D] TETRASACCHARIDES

Stachyose, a tetrasaccharide, yields on hydrolysis, four molecules of monosaccharide.

[E] POLYSACCHARIDES

On hydrolysis, they give an indefinite number of monosaccharides. By condensation, with the elimination of water, polysaccharides are produced from monosaccharides. Depending upon the

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type of product of hydrolysis these are further classified as pentosans and hexosan. Xylan is pentosan, whereas starch, inulin and cellulose are the examples of hexosans.

Gums:

a. Natural gums

1. Seaweed gum: agar, algin, carrageenan,laminaran
2. Plant euxdates: acacia, tragacant, karaya, ghatti.
3. Seed gums: guar gum, isabgol, tamarind, locust bean gum.
4. Plant extracts: pectin, larch, arabinogalactan.
5. Animal extract: chitin

b. Prepared gums

1. Biosynthetic gums xanthan, scleroglucan, dextrans.
2. starch and itsderivatives, dextrins.
3. Cellulose derivatives.

Chemical Tests for Carbohydrates

1. **Molishc's test:** The test is positive with soluble, as well as, insoluble carbohydrate. It consists of treating the compounds with α-naphthol and concentrated sulphuric acid which gives purple colour.
2. **Fehling's test:** To the solution of test sample with equal quantity of Fehling's solutions A and B is added. After heating, brick red precipitate is obtained.

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Table No: 1 Carbohydrates and Related Drugs

Sr. No.	Name of drug & Synonym	Biological Source	Constituents	Uses
1.	Isapgol	Plantago ovate (Plantaginaceae)	Pentosan, mucilage, aldobionic acid	Demulcent, laxative, pharmaceutical aid.
2.	Psyllium	Plantago psyllium (Plantaginaceae)	Mucilage, pentosans	Laxative, pharmaceutical aid.
3.	Bael	Aegle marmelos	Marmelosin and furocoumarin	Digestive, antidiarrhoeal
4.	Echinacea	Echinacea purpurea		Immunostimulant
5.	Acacia (Indian gum)	Acacia Arabica (leguminosae)	Arabinogalactan	Emulsifying and suspending agent.
6.	Guar gum	Cyamopsis tetragonolobus (Leguminosae)	Arabin, enzyme oxidase	Binding agent, emulgent, disintegrating agent.
7.	Algin (Alginic acid)	Macrocystis pyrifera, Laminaria hyperborsea	Guaran	

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8.	Tragacanth	(phaeophyceae)		
		Astragalus gummifer (Leguminosae)	Alginic acid	Thickening agent and suspending agent.
9.	Pectin	Citrus limonis, C.aurantium (Rutaceae)	Tragacanthin, tragacanthic acid, bassorin	Thickening agent, demulcent.
10.	Gum ghatti	Anogeissus latifolia (Combretaceae)		
		Sterculia urens (sterculiaceae)	D-galactouronic acid pectric acid	Adsorbent, thickening agent.
11.	Gum karaya			
			Two distinct polysaccharides, oxidase	Emulgent, pharmaceutical aid.
12.	Agar (Agar agar)	Gelidium amansii (Gelidaceae)	A polysaccharide containing 8%	Thickening agent, emulgent.
		Chondrus cryspus		

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13.	Carrageenan (Irish moss)	Rhodophyceae	acetyl and 37% uronic acid residues and no methoxyl group.	
14.	Manna	Fraxinus ornus (Oleaceae)		Laxative, bacteriological cultures.
15.	Inulin	Inulahelenium (Compositae)	Agarose, agaropectin	
16.	Locust bean	Ceratonia siliqua (leguminosae)		Demulcent, antidiarrhoeal, pharmaceutical aid.
17.	Starch	Zae mays, Oryza sativa (Gramineae)	Kappa-carrageenan lambda carrageenan.	laxative.
18.	Arrow-root starch	Maranta arundinaceae (Marantaceae)	Mannitol, mannotriose	Source of fructose in foods and drinks.
19.	Liquid glucose	Partial hydrolysis of starch Controlled hydrolysis of starch By heating sucrose Enzymic fermentation of	Mannitol, mannotriose	Thickener, pharmaceutical aid.

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20.	Dextrin	sucrose Fermentation of glucose	Fructo-furanose unit	Disintegrating agent, demulcent, nutritive.
21.	Caramel	Apis species (Apidae)	88% D-galacto-D-manoglycon	Pharmaceutical aid
22.	Dextran	Shells of Lobster crab, cell walls of lower plants Disaccharide from mammalian milk	Amylase, and amylopectin	Sweetening agent, non-crystallizing agent.
23.	Xanthan gum			Adhesive in paper, textile and food industries.
24.	Honey			
25.	Chitin		Dextrose, maltose	Colouring agent.
26.	Lactose		Polysaccharide	Binding, suspending and stabilizing agent, blood plasma extender.
			Burnt sugar	Emulsifying agent, stabilizer.

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			α – D – glucopyranosyl units mannose, glucose, glucuronic acid natural invert sugar 2-acetamide-2-deoxy-cellulose Disaccharide containing galactose and glucose	Demulcent, sweetening agent. Wound healing, adhesive to glass and plastics, sizing of rayon. Diluents in tablets and pharmaceuticals.

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1.0 ISAPGOL

1.1 Synonyms: Ispaghula, Isabgul, Indian Psyllium, Isabgol.

The origin of the word isapgol lies in the Persian words ISAP (the horse) and GHOL (the ear). Thus, the literal meaning of word isapgol is the ear of the horse. The seeds, as well as, husk of the seeds, are used in medicine since 18th century. About 10 species of the drugs are available in India. Seeds are very small in size. One thousand seeds weigh about 105g. Isapgol has high export potential.

1.2 Biological source

Isapgol consists of dried seeds of the plant known as Plantago ovate (Syn: Plantago indica; Plantago afra) Forskal, family Plantaginaceae. In the pharmaceutical field, seeds, as well as, the dried seed coats, known as isapgol husk, are used.

1.3 Geographical Source

Gujarat, Punjab and South Rajasthan.

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1.4 Cultivation and Collection

India is producing 48000 tonnes of seeds annually at present. The world demand for psyllium and isapgol seeds and husk is increasing (approx. 50,000 tonnes) and the main markets are in U.S.A., France, West Germany, and U.K. The export of isapgol husk and seeds together during 1995-96 was Rs. 155 crores and during 1996-97 it was Rs. 137 crores.

1.5 Macroscopic Characters

Colour – Pinkish-grey to brown

Odour – None

Size – 10-35 mm in length and 1-1.75 mm in width

Shape – It is ovate cymbiform

1.7 Macroscopical characters

Colour is pale buff ovate flakes with more or less lanceolate shape. The pieces are 1 to 2 mm in size, flakes are odourless, smooth and free flowing.

Indian psyllium or Isapgol seeds are preferred in the world market for the following reasons.

1. Indian psyllum seeds are available at a lower price.
2. The mucilage content of this species is more.
3. It yields practically colourless mucilage.

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4. The husk of the Indian psyllum cracks off under slight mechanical pressure and even it can be easily separated from the seed.

1.8 Chemical Consituents of Seed and Husk

Mucilage is present chemically; it consists of pentosan and aldobionic cid. The products of hydrolysis are xylose, arabinose, galacturonic acid andrhamnose. Fixed oil and proteins are also present in this seed.

1.9 Chemical Tests

1. Swelling factor is the criterion for purity of the drug. Swelling factor of the drug is a quantitative swelling due to mucilage present in the drug.
2. Isapgol gives pink colour with the solution of ruthenium red.

1.10Uses

Demulcent, laxative, emolinent in the treatment of chronic constipation, amoebic and bacillary dysentery.Mucilage of the isapgol is used in the preparation of tablets and also as a stabilizer in the ice-cream industry.

The product formed by removing cations from the mucilage by treatment with cation exchange resins followed by spray drying is an acid form of polysaccharide. This finds special pharmaceutical applications as enteric coating material, tablet disintegrator and also used in the sustained release drug formulations.

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The mucilage of isapgol has a property of glairiness or stringiness, which is desired in certain cosmetic formulatins.

1.11 Substitutes

Several other species of Plantago have been investigated of which *Plantago rhodosperma* distributed in Missouri and Lonisiana and Plantago wrightiana are important. The earlier variety contains 17.5% of mucilage, while the latter contains about 23.0%. In all respects, these two varieties favourably compare-with the official drugs.

Plantago purshii and Plantago aristata are substitutes of official drug with good mucilage forming capacity. Plantago asiatica, found in Andhra Pradesh andTamilNadu is also used as a substitute for isapgol seeds.

2.0 INDIAN GUM

2.1Synonyms

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Gum acacia, Gum Arabic, Acacia

2.2 Biological source

Acacia Arabica Wild, belonging to family Leguminosae.

2.3 Geographical source

The plant is found in India, Sri Lanka, Sudan, Morocco and Africa. In India, it occurs in Punjab, Rajasthan and Western ghats. About 85% of world supply of gum acacia is from Sudan.

2.4 Cultivation and Collection

It is a common member of dry monsoon forests of India. It is an evergreen tree with short trunk. It is not cultivated on commercial scale. Gum is collected from wild grown plants, made free of bark and foreign organic matter, dried in sun, which also results-in partial bleaching of gum.

2.5 Description

Colour – Tears are cream-brown to red in colour, while powder is light brown in colour.

Odour – Odourless

Taste – Bland and mucilaginous

Size and Shape – Irregular brown tears of varying size

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2.6 Extra Features

The tears are glossy and marked with minute fissurss and are brittle in nature. The pieces of broken tears are with angular fragments and glistering surfaces, breaking with difficulty, and with conchoidal fracture.

2.7 Solubility

It is soluble in water, the watery solution is viscous and acidic. It is insoluble in alcohol.

2.8 Standard

It should contain not more than 15% of moisture and 5% of ash Indian gum should not contain tannin, starch and dextrin.

2.9 Chemical Constituents

Arabin, which is a complex mixture of calcium, magnesium and potassium salts of Arabic acid.

2.10 Identification

1. Solution of lead subacetate gelatinizes the aqueous solution of Indian gum.
2. It does not produce a pink colour with the solution of ruthenium red.
3. On addition of solutions of hydrogen peroxide and benzidine in alcohol to aqueous solution of gum, blue colour is produced due to oxidase enzyme.

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2.11 Uses

Acacia is a demulcent. It is also administered intravenously in haemolysis. It is a gum of choice, as it is compatible with other plant hydrocolloids, as well as, starches and carbohydrates. In combination with gelatin, it is used to form coacervates for microencapsulation of drugs.

2.12 Tests for Purity of Indian Acacia

1. Dilute 1 ml. of the solution of gum with 10 ml. of water and keep for few hours. No sedimentation should take place.
2. To 1ml. of solution, add 4ml. of water, boil, cool and add 2 drops of N/10 iodine. Brown colour indicates presence of dextrin, whereas blue colour is due to starch. This test should be negative with authentic drug.
3. To the gum acacia solution, add a drop of hydrogen peroxide and tincture of guaiacum blue colour is produced.
4. With few drops of 0.1% ferric chloride to 1ml. of the solution, blue or black colour (due to tannins) is produced.

2.13 Substitutes and adulterants

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B.P. variety consists of gum obtained from Acacia Senegal Wild, (Leguminosae), a plant of African origin and grown in Africa. The tears are rounded or ovoid and about 5-40 mm in diameter. Tears are yellowish white in colour. It can be used as –a substitute to Indian gum.

Indian gum is adulterated with gum ghatti, obtained from Anokgeissus latifolia (Combretaceae), which is distinguished from the genuine drug by the next characters. Its outer surface is dull and without fissures. It shows very slight precipitate with lead subacetate solution and its aqueous solution is highly viscous. Starch, tragacanth, dextrin and sterculia gum are the other adulterants of acacia.

2.14 Storage

Acacia or powdered acacia should be stored in cool dry place in air-tight containers.

3. TRAGACANTH

3.1 Synonym

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Gum Tragacanth, Tragacantha.

3.2 Biological source

Astragalus gummifer Labill and other species of Astragalus, family Leguminosae.

3.3 Geographical source

Iran, Greece, Turkey, Iraq and Syria. In India, Garhwal, Kumaon and Central Punjab are the areas where few species of tragacanth are found. North Syria and Iran supply Persian tragacanth.

3.4 Collection

Most of the shrubs from which tragacanth is collected grow at an altitude of 1000-3000 m. the shrubs are thorny. The mode of formation of tragacanth is entirely different from that of acacia, the gum exuding out immediately after an injury.

Most of the drug comes from Persian source only.

3.5 Description

Colour – white or pale yellowish white

Odour – Odourless

Taste – Mucilagenous

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Shape – Tragacanth occurs in the form of thin, flattened ribbon lie flakes, more or less curved

Size – Flakes are approximately 25 x12 x2 mm in size.

The gum is horny, translucent with transverse and longitudinal ridges. Fracture of the drug is short.

It is partly soluble in water, in which it swells to homogeneous, adhesive and gelatinous mass. It is insoluble in alcohol.

3.6 Chemical Consituents

Tragacanth contains two fractions of which one is soluble in water. The water-soluble portion of the tragacanth is known as tragacathin, constituting about 8-10% of the gum. Water – insoluble portion is known as bassorin (60-70%). Tragacanth contains about 15% of methoxy group which swells in water. It is the constituent of the gum responsible for its high viscosity. Normally, 1.0% solution of tragaanth has a viscosity of not less than 250 centipoises. The products of hydrolysis of tragcanth are galactouronic acid, D-galactopyranose, L-arabino-rhamnose and D-xylopyranose.

3.7 Standards

Foreign organic matter – Not more than 1.0%

Sulphated ash – Not more than 4.0%

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Moisture content – Not more than 15.0%

3.8 Identification tests

1. Tragacanth is boiled with few drops of 10% aqueous ferric chloride solution, deep yellow precipitate is formed.
2. The tragacanth is produced the stringly precipitate with copper oxide and ammonium hydroxide.
3. When it is warmed with sodium hydroxide solution, canary yellow colour is developed with strong iodine solution, it gives green colour.

3.9 Uses

It is used as a demulcent and as an emollient in cosmetics. Tragacanth is used as a thickening, suspending and as an emulsifying agent.

AGAR

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4.1 Synonyms

Agar-agar, Japanese-isinglass, Vegetable gelatin.

4.2 Biological Soure

Gelidium amansii (Gelidaceae) and several other species of red algae like, Gracilaria (Gracilariaceae) and Pterocladia (Gelidaceae).

4.3 Geographical Source

Agar is produced commercially in Jpan, Australia, New Zealand, U.S.A., and India. In India, it is produced in the coastal regions of Bay of Bengal.

4.4 Preparation

In Japan, the red-algae is grown on the bamboos spread in the ocean. The collection of the material is done in May and October. The sea-weeds are scrapped from the bamboos, dried and shaken. This is necessary to bleach the product to some extent and even to remove and foreign material like shells, sand, etc. the entire material is then taken to the high altitudes where it is washed and bleached by exposing to sun. it is boiled for 5 – 6 hours with large quantity of dilute acidified water (about 1 part of algae with 60 parts of water). The extract is then strained while hot through the cloth and transferred to wooden troughs. On coolin, jelly is produced. These rectangular solid pieces of jelly are then passed through the netting under pressure. Narrow strips, thus formed, are allowed to melt during the day time in the sun, which removes the excess

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of water. This operation is continued for several days to remove the excess of water. The manufacture of agar takes place in the winter, and moisture is removed by successively freezing, thawing and drying at about 35oC. Japan is taking the advantage of natural climatic conditions since centuries for the preparation of agar. In America, the modern method of deep-freezing is being utilized for the same purpose.

4.5 Description

Colour – Depending upon the shape and the for, it is yellowish-grey or white to nearly colourless.

Odour – odourless

Taste – Mucilaginous

Shape – It is found in various forms like strips , sheets, flakes or coarse powder.

Size – Sheets are 45 – 60 cm long and 10-15 cm wide. Bands are about 4 cm. wide, while strips are 4 mm in width. Strips are translucent, lustrous and slender, while the flakes are grayish-white in colour.

In India, the raw material being used is known as Galidiella accrosa and indigenous production of agar is estimated to be about 200 tones. In India, the process has been developed for the extraction of agar from the speices of Hypnea.

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It is unsolvable in cold water, but forms a gelatinous collection after cooling hot solution. It is soluble in boiling water and insoluble in organic solvents.

4.6 Standards

Acid-insoluble ash – Not more than 1.0%

Sulphated ash – Not more than 5.0%

Foreign organic matter – Not more than 1.0%

Loss on drying – Not more than 18.0%

Starch – Negative with iodine solution

4.7 Chemical Constituents

Agar consists of two different polysaccharide named as agarose and agaropectin. Agarose is responsible for gel strength of agar and is composed of D-galactose and 3.6 anhydro L-galactose units.

4.8 Identification

1. 1.5 g agar with 100 ml. water. Then boil and cool the solution to room temperature. It forms a stiff jelly.
2. When mounted in the solution of ruthenium red and examined under microscope, the mounted particles acquire pink colour.

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3. To 0.2% solution of agar in water, add solution of tannic acid; no precipitate is produced.

4.9 Uses

Agar is used as an emulsifying agent and bulk laxative. It is used in the preparation of jellies, confectionery items and in microbiology; it is employed in preparation of bacteriological culture medium.

5. HONEY

5.1 Synonyms: Madhu, Honey Puridied, Mel

5.2 Biological Source

Apis mellifera, Apis dorsata, and other species of Apis, belonging to family Apidae,

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5.3 Geographical Source

Africa, Australia, New Zealand, Clifornia and India.

5.4 Preparation for the Market

The nectar of the flowers is a watered-down solution containing 25% sucrose and 75% water. The worker bee sucks this nectar through its hollow tube of mouth (proboscis) and deposits in honey-sac located in abdomen. The enzyme invertase in attendance in saliva of the bee convert nectar into invert sugar, which is partially utilized by the bee and the remaining, is deposited into honey comb. Honey comb is smoked to eliminate the bees and honey is obtained by applying the pressure to it or allowing it to drain naturally. The honey of commerce is heated to 80oc and allowed to stand. The impurities which float over the surface are skimmed off and liquid diluted with water to produce honey of 1.35 density. Natural honey has the density of 1.47. Many –a-time, honey is extracted from the comb by centrifugation. It must be free from foreign substances. Honey is liable to fermentation, unless it is suitably processed. Honey is heated to 80oc before it is sent to the market, so as to avoid fermentation. It should be cooled rapidly or else it darkens in colour on keeping. If necessary (and if not prepared by centrifugation method), honey is required to be filtered through wet cloth or flannel.

5.5 Description

Colour – Pale yellow to yellowish-brown

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Odour – Characteristic, pleasant

Taste – Sweet and faintly acid

5.6 Standards

Weight per ml. – 1.35 – 1.35 g.

Specific rotation - +3o to -10o

Total ash – 0.1 – 0.8%

It has to pass limit tests for chloride and sulphate.

It is syrupy thick liquid, translucent when fresh and on keeping it becomes opaque and granular due to the crystallization of glucose.

It is soluble in water and insoluble in alcohol.

5.7 Chemical constituents

Honey having the constituents of Glucose 35% (+- 5%) and sucrose about 2%. Small quantities of vitamins. Proteins and pollen grains from various flowers are also found in honey.

Since, honey is a saturated solution of sugar, on keeping, it starts crystallizing. A product which contains crystallized dextrose is called as Granulated honey. Heating of honey serves the purpose of minimizing the granulation.

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Artificial invert sugar, an adulterant of honey contains furfural which is detected by Fiehe's test. It gives instant red colour with resorcinol in hydrochloric acid.

5.8 Uses

India has only exploited 10% of its honey potential. India is producing 11000 tones of honey per annum. Per capital consumption of honey in India is only 8.0 gms while in Germany is 1800gms.

According to Khadi and Village Industries Commission, absence of modern technology inadequate marketing and infrastructure for manufacture of honey are the reasons for poor development.

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