Module Title	Plant Products and Primary Metabolites
Subject /Course	Pharmacognosy & Phytochemistry-1
Subject/Course ID	BP405T
Semester	IV
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Learning Outcome of Module 05

LO	**Learning Outcome**	**Course outcome**
LO1.	Student will learn about basics of various plant products like fibers, Hallucinogens, natural allergens and Teratogens.	BP405.4
LO2.	Student will know about Biological source, properties, chemistry and uses of Carbohydrate drugs like Honey, Acacia, Tragacanth and Agar.	BP405.4
LO3.	Student will know about Biological source, properties, chemistry and uses of Protein drugs like Gelatin and Casein.	BP405.4
LO4.	Student will know about Biological source, properties, chemistry and uses of various enzymes.	BP405.4
LO5.	Student will know about Biological source, properties, chemistry and uses of Lipids drugs like Castor oil, wool fat, Bees wax and chaulmoogra oil.	BP405.4
LO6	Student will know about various novel medicinal agents from marine sources.	BP405.4

Content Table

Topic
• Plant Fibers- Cotton, Jute and Hemp • Hallucinogens • Natural Allergens • Teratogens • Carbohydrate drugs- Acacia, Tragacanth, Agar and Honey • Protein drugs- Gelatin and Casein • Enzyme- Papain, Bromelain, Serropeptidase, Urokinase, Streptokinase and Pepsin • Lipid drugs- Castor oil, Chaulmoogra oil, Wool fat and Bees wax • Marine drugs

FIBERS

Long strands of molecules interwoven to form a linear, string-like structure are known as **‘Fibers’**. Fibers are natural or man-made such as cotton, silk, jute, etc.

Fibers were discovered when early people realized the need to cover and protect their own hair and skin from the weather. Since early people would live in cold climate they hunted animals with skins (fur and food) that kept them warm. When used continuously this skin becomes harder and made it hard for the early men to hunt and hence later they started to treat this skin to maintain its softness. In a much later time, they started using the bones of animals as needle and nerves as the thread to stitch. And now decades later we finally know how to grow our own fibres and make clothes or fabrics out of them.

Characteristics of Fibers

Fibers used in clothing are used to cover the body, to protect our body, etc. Everyone wears clothes for different reasons. Some of the other characteristics of fibres are:

- Fibers can be repeatedly stretched more than 500% of its original size and can also recover back; immediately to its original size and shape once the tension is relaxed.
- In comparison to rubber, it is stronger and more durable.
- It is lightweight.

Natural Fibers

Fibers obtained from plants and animals that can be spun into filament, thread or rope are termed as ‘Natural fibers’. They may be woven, knitted, matted or bonded.

Decades later even though the methods used to make fabrics_from fibers may have changed greatly, their functions remain the same:

- Most natural fibers are still used to make clothing and containers.
- To insulate, soften and decorate our spaces. Ex. Cotton and wool

COTTON

Synonym- Raw cotton, Cotton wool, Purified cotton, Absorbent cotton

Biological source- Cotton consists of the epidermal trichomes or hairs of the seeds of cultivated species of the *Gossypium barbadense*, belonging to the family Malvaceae.

Purified cotton or absorbent cotton is prepared by removing the fatty matter and adhering impurities from raw cotton. It is also bleached and sterilized.

Geographical source- Cotton is produced commercially in USA, Egypt and India. Also cultivated in Africa and South America.

Preparation of Absorbent cotton- Cotton plant after flowering , bears capsule fruits which are 3-5 celled and contains numerous seeds. The seeds are covered with hairs (trichomes) and also called as Bolls. These bolls are collected dried and taken to ginning press, where the trichomes are separated from the seeds using various devices. The short and long hairs are separated. The short length hairs are known as Linters and used for preparation of cloth. After collection, the raw cotton is purified to remove impurities, finally packed in wrappers and sterlised by gamma radiation.

Description- Colour- White (due to bleaching), odour- None, taste- None, Size- 2.5-4.5 cm in length, 25-35 micrometer in diameter.

Chemical constituents- Raw cotton contains about 90% of cellulose, 7-8% of moisture, wax, fat and some protoplasm. Purified or absorbent cotton is entirely cellulose with 6-7% moisture.

Chemical tests-

1. Soak cotton fibres in iodine water, then dried, add few ml of 80% Sulphuric acid. It gives purple-blue or blue-green colour (Distinction from Jute and Hemp).
2. With Ammonical Copper oxide solution (Cuoxam reagent)- Raw cotton dissolves with formation of balloons. Absorbent cotton dissolves completely with uniform swelling.
3. Cotton is insoluble in dil NaOH and HCl and soluble in 66 % Sulphuric acid.

Uses-

1. As filtering medium
2. In surgical dressings
3. As insulating material
4. Absorbent cotton absorbs blood, mucus, pus and prevents from infections.

Applications of Cotton

1. Poplins, voiles are made by using Cotton.
2. Cotton is used in great quantity as a fabric for hot weather wear.
3. The absorbency of cotton makes it an excellent material for household fabrics such as sheets and towels.
4. Cotton is widely used in making rainwear fabrics. It can be woven tightly to keep out the driving wind arid rain, yet the fabric will allow perspiration to escape.

5. Ventile fabrics, for example, are close-woven cotton materials of this sort which are given additional water resistance by a chemical proofing.
6. It goes into clothing (shirts, T-shirts, trousers, denim, etc.), undergarments, boots and shoes, carpets and curtains, hats, etc.
7. Heavy cotton yarns and materials are used for tyre cords and marquees, tarpaulins and industrial fabrics of all descriptions.
8. Cotton can be blended with other fibres like polyester, rayon to manufacture fabric for different applications.

JUTE

Synonym- Gunny

Biological source- It consists of phloem fibersof the stem of various species of the *Corchorus olitorius* and *Corchorus capsularis*, family Tiliaceae

Preparation-Phloem fibers are separated from stem by a process called Retting. After it, fibers are cleaned, dried and bleached by hanging in sun light. The jute is graded according to colour, glossiness and length.

Geographical source- Cultivated in West Bengal, Assam and Delta regions of Ganga.

Description- Colour- yellow-green, no odour and no taste, individual fiber length 0.8-5 mm, diameter 10-25 micrometer, great tensile strength and hygroscopic.

Chemical constituents- Cellulose 53%, Hemicellulose 20-22%, Lignin 10-11%

Chemical test- with phloroglucinol and HCl- give red colour due to Lignin.

Uses-

1. As filtering and straining medium
2. Manufacturing of padding splints
3. Preparation of gunny bags

HEMP

Biological source- Hemp is prepared from pericyclic fibers of the stems of *Cannabis sativa*, family- Cannabinaceae

Geographical source- In Russia, USA, Italy and France.

Preparation- By retting process

Description- Average length- 35-40 mm, average diameter- 22 micrometer, the fibers ends are bluntly rounded and some are forked due to injuries to stem.

Constituents- Mainly composed of cellulose, and some Lignin is present.

Uses- For manufacture of rope, twin and sail- cloths etc.

HALLUCINOGENS

Hallucinogens are the substance that produces psychological effects that tend to be associated with phenomena such as dreams or religious exaltation or with mental disorders such as schizophrenia. Hallucinogens produce changes in perception, thought, and feeling, ranging from distortions of what is sensed (illusions) to sensing objects where none exist (hallucinations). Hallucinogens heighten sensory signals, but this is often accompanied by loss of control over what is experienced.

Psychopharmacological Drugs

The psychopharmacological drugs that have aroused widespread interest and controversy are those that produce marked aberrations in behaviour or perception. Among the most prevalent of these are D-lysergic acid diethylamide, or LSD-25, which originally was derived from ergot (*Claviceps purpurea*), a fungus on rye and wheat; mescaline, the active principle of the peyote cactus (*Lophophora williamsii*), which grows in the southwestern United States and Mexico; and psilocybin and psilocin, which come from certain mushrooms (notably two Mexican species, *Psilocybe mexicana* and *P. cubensis*).

Other hallucinogens include bufotenine, originally isolated from the skin of toads; harmine, from the seed coats of a plant of the Middle East and Mediterranean region; and the synthetic compounds methylenedioxyamphetamine (MDA), methylenedioxymethamphetamine (MDMA), and phencyclidine (PCP). Tetrahydrocannabinol (THC), the active ingredient in cannabis, or marijuana, obtained from the leaves and tops of plants in the genus *Cannabis*, is also sometimes classified as a hallucinogen.

Potential Side Effects of Hallucinogen Abuse

Hallucinogenic drugs can be highly unpredictable, sometimes offering individuals a pleasant sensation and other times a “bad trip,” characterized by psychosis, high levels of anxiety, paranoia (A type of mental illness in which you wrongly believe that other people want to harm you), and fear. The “trip” from a hallucinogenic drug can last for several hours, with no relief or control over the symptoms. Adding alcohol or other drugs can increase the possible risks and dangers as well.

Individuals can overdose on a hallucinogen when toxic levels build up in the body, resulting in hyperthermia, high blood pressure, impaired respiratory levels, and a racing heart rate. Seizures, extreme confusion, delirium, nausea, vomiting, and a loss of consciousness may be the result of a hallucinogenic drug overdose, which may lead to coma or even death.

Accidents due to poor motor control, lack of depth perception, distortion of the size and shape of objects, and feelings of invincibility (Too strong or powerful to be defeated), fear, or aggression brought on by a hallucinogenic drug are significant risks when taking these kind of drugs.

Increased libido and sexual arousal may lead to potentially hazardous sexual liaisons that may have long-reaching side effects, like unwanted pregnancy or the transmission of a sexually transmitted disease.

Hallucinogenic drugs may also have long-lasting side effects, especially when they are used regularly. Individuals may suffer from “flashbacks” days, months, or even years after using a hallucinogenic drug, and some may even develop hallucinogen persisting perception disorder (HPPD). Hallucinogenic drugs impact levels of dopamine and serotonin in the brain, which can alter moods and the ability to regulate emotions.

Allergy and Allergens

Allergies are hypersensitive responses from the immune system to substances that either enter or come into contact with the body.

These substances commonly include materials such as pet dander, pollen, or bee venom. Anything can be an allergen if the immune system has an adverse reaction.

A substance that causes an allergic reaction is called an **allergen**. Allergens can be found in food, drinks, or the environment.

Many allergens are harmless and do not affect most people.

If a person is allergic to a substance, such as pollen, their immune system reacts to the substance as if it was foreign and harmful, and tries to destroy it.

Research indicates that 30 percent of adults and 40 percent of children in the United States have allergies.

Fast facts on allergies

1. Allergies are the result of an inappropriate immune response to a normally harmless substance.
2. Some of the most common allergens are dust, pollen, and nuts. They can cause sneezing, peeling skin, and vomiting.
3. Anaphylaxis is a serious allergic reaction that can be life-threatening.
4. To diagnose an allergy, a clinician may take a blood sample.

5. The symptoms of an allergy can be treated with drugs. However, the allergy itself requires desensitization.
6. Anaphylaxis requires emergency treatment. Epinephrine injectors can help reduce the severity of an anaphylactic reaction.

What is an allergy?

Allergies occur when the immune system overreacts to ordinarily harmless substances.

Allergies are a very common overreaction of the immune system to usually harmless substances. When a person with an allergy comes into contact with an allergen, the allergic reaction is not immediate. The immune system gradually builds up sensitivity to the substance before overreacting.

Symptoms

An allergic reaction causes inflammation and irritation. The signs and symptoms depend on the type of allergen. Allergic reactions may occur in the gut, skin, sinuses, airways, eyes, and nasal passages.

Allergic reactions may be confused for other conditions. Hay fever, for example, creates similar irritations to the common cold but the causes are different. Recognizing these symptoms can be crucial to receive timely treatment.

Causes

A particular antibody called immunoglobin (IgE) causes allergic reactions. Antibodies are released to combat foreign and potentially harmful substances in the body. IgE is released to destroy the allergen and causes the production of chemicals that trigger the allergic reaction.

One of these chemicals is called histamine. Histamine causes tightening of the muscles in the airways and the walls of blood vessels. It also instructs the lining of the nose to produce more mucus.

Risk factors

The following can be risk factors for developing allergies:

- a family history of asthma or allergies
- being a child
- having asthma
- not being exposed to enough sunlight
- having a different allergy
- birth by Caesarean section

The most common allergens

Animal dander is a very common allergen. Potential allergens can appear almost anywhere.

Any food can theoretically cause an allergy. Specific components of food can also trigger allergic reactions, such as gluten, the protein found in wheat. The eight foods most likely to cause allergies are: eggs, especially egg-white, fish, milk, nuts from trees, peanuts, wheat, soy and shellfish.

Other allergens include:

- Animal materials, such as dust mite excrement, wool, fur, dander, or skin flakes, a protein found in cat saliva
- Medications, such as penicillin, salicylates, and sulfonamides
- Foods such as corn, celery, pumpkin, sesame, and beans
- Insect stings, including wasp and bee sting venom, mosquito stings, and fire ants.
- Insect bites from horseflies, blackflies, fleas, and kissing bugs
- Cockroaches, caddis and lake flies, midges, and moths
- Plant pollens from grass, trees, and weeds
- Household chemicals
- Metals, such as nickel, cobalt, chromium, and zinc
- Latex

Diagnosis

The doctor will ask the patient questions regarding symptoms, when they occur, how often, and what seems to cause them. They will also ask the person with symptoms whether there is a family history of allergies, and if other household members have allergies.

The doctor will either recommend some tests to find out which allergen is causing symptoms or refer the patient to a specialist.

Below are some examples of allergy tests:

- **Blood test**: This measures the level of IgE antibodies released by the immune system. This test is sometimes called the radioallergosorbent test (RAST)
- **Skin prick test**: This is also known as puncture testing or prick testing. The skin is pricked with a small amount of a possible allergen. If the skin reacts and becomes itchy, red, and swollen, it may mean an allergy is present.

- **Patch test**: A patch test can identify eczema. Special metal discs with very small amounts of a suspected allergen are taped onto the individual's back. The doctor checks for a skin reaction 48 hours later, and then again after a couple of days.

Treatment

The most effective treatment and management of an allergy is avoidance of the allergen. However, sometimes it is not possible to completely avoid an allergen. Pollen, for example, is constantly floating in the air, especially during hay fever season.

Medications

Drugs can help treat the symptoms of an allergic reaction, but they will not cure the allergy. The majority of allergy medications are over-the-counter (OTC). Before taking a particular type of medication, speak to a pharmacist or doctor.

- **Antihistamines**: These block the action of histamine. Caution is recommended, as some antihistamines are not suitable for children.
- **Decongestants**: These can help with a blocked nose in cases of hay fever, pet allergy, or dust allergy. Decongestants are short-term medications.
- **Leukotriene receptor antagonists, or anti-leukotrienes**: When other asthma treatments have not worked, anti-leukotrienes can block the effects of leukotrienes. These are the chemicals that cause swelling. The body releases leukotrienes during an allergic reaction.
- **Steroid sprays**: Applied to the inside lining of the nose, corticosteroid sprays help reduce nasal congestion.

Various types of natural allergens-

1. **Infestant Allergens**: Parasitic microorganisms in or on the body.
2. **Infectant Allergens**: Represented by the metabolic wastes and growth products of pathogenic microorganisms.
3. **Contactant Allergens**: Those that come into direct contact with epithelium.
4. **Injectant Allergens**: Those that may be present in the solutions intended for parenteral administration are known as injectants.
5. **Ingestant Allergens**: Those that occur in the foodstuffs and are swallowed are known as ingestants.
6. **Inhalant Allergens**: Substances that are distributed in the atmosphere and contact the nasal or buccal mucosa during respiration are called inhalant allergens.

TERATOGENS

A teratogen is a substance known to cause birth defects following exposure during pregnancy. Some teratogens can be drugs (e.g., prescription drugs such as lithium or epilepsy medication or recreational drugs). Certain infections, such as rubella (German Measles) or chicken pox can also be teratogens. The mother can also unknowingly introduce the fetus to teratogens in the womb.

Alcohol is a common teratogen. Alcohol use during pregnancy can adversely affect the unborn baby. There are many factors that influence this effect, including the amount of alcohol ingested over time and differences in the way the mother metabolizes alcohol. There is also evidence that variations in a person's genetic makeup can affect the baby's susceptibility to alcohol while in utero.

Teratogenicity or reproductive toxicity broadly refers to the occurrence of biologically adverse effects on the reproductive system that may result from chemical exposure to several environmental agents. The adverse effects may be alterations to female or male reproductive organs related to endocrine system or pregnancy outcomes. Teratogenesis signifies the structural malformations during fetal development.

Teratogenic substances when ingested by the mother, can cause abnormalities in the developing fetus. The human teratogen is a chemical drug, metabolic state, physical agent or psychological alteration during development that produces a permanent pathologic or pathophysiologic alteration in fetus.

Teratogens generally have the ability to inhibit cell division and kill embryo during cell dividion.

Various types and examples of teratogens are-

Drugs- Angiotensin converting enzyme inhibitor, antiepileptics, penicillamine, warfarin, thalidomide, caffeine, pesticides, etc..

Chemicals- Alcohol, Cocaine, Methyl mercury Physical agents- Cigarette smoke, ionizing radiations Biological agents- Rubella infection

Maternal disease- Diabetes, Epilepsy Phytochemicals- various alkaloids Examples of plant teratogens are-

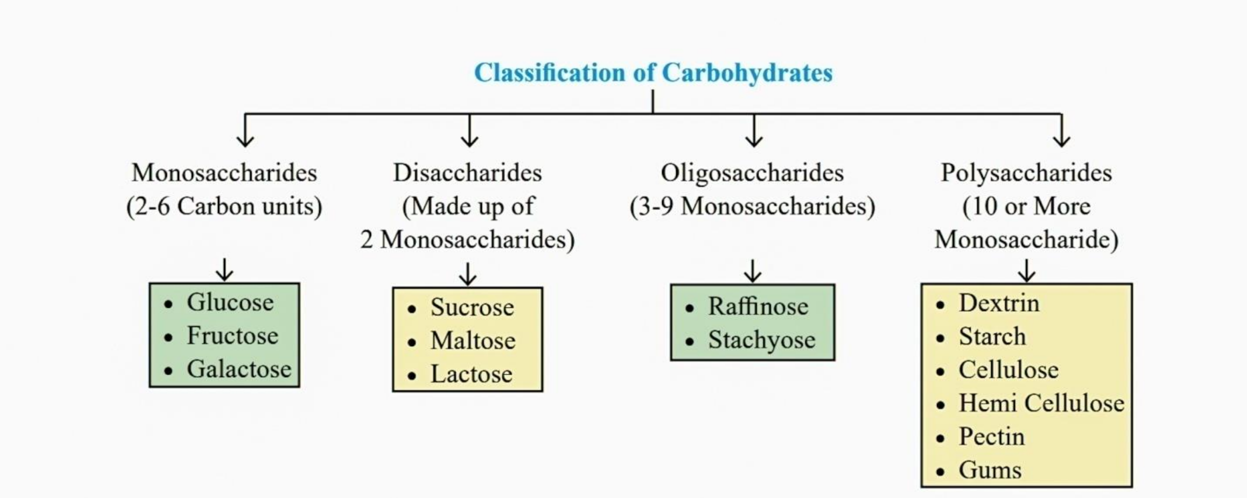
1. Pyrrolozidine alkaloids- Senecio sp from Compositae family
2. Pyridine alkaloids from Nicotiana sp Solanaceae and Lobelia sp Campanulaceae family
3. Quinolozidine alkaloids- from Lupinus sp Leguminosae
4. Steroidal alkaloid from Veratrum sp Liliaceae

5. Purine alkaloid- Caffeine from Coffea Arabica family Rubiaceae

CARBOHYDRATES

It is a class of naturally occurring compounds and derivatives formed from them. In the early part of the 19th century, substances such as wood, starch, and linen were found to be composed mainly of molecules containing atoms of carbon (C), hydrogen (H), and oxygen (O) and to have the general formula $C_6H_{12}O_6$; other organic molecules with similar formulas were found to have a similar ratio of hydrogen to oxygen. The general formula $C_x(H_2O)_y$ is commonly used to represent many carbohydrates, which means “watered carbon” or “Hydrates of Carbon”.

Chemically, carbohydrates are defined as *“optically active polyhydroxy aldehydes or ketones or the compounds which produce units of such type on hydrolysis”*.



Carbohydrates are also called saccharide which is a Greek word and it means sugar because almost all the carbohydrates have a sweet taste. Carbohydrates are probably the most abundant and widespread organic substances in nature, and they are essential constituents of all living things. Carbohydrates are formed by green plants from carbon dioxide and water during the process of photosynthesis. Carbohydrates serve as energy sources and as essential structural components in organisms; in addition, part of the structure of nucleic acids, which contain genetic information, consists of carbohydrate. Although a number of classification schemes have been devised for carbohydrates, the division into four major groups—monosaccharides, disaccharides, oligosaccharides, and polysaccharides—used here is among the most common.

Chemical tests-

Molisch’s test

Molisch’s reagent is 10% alcoholic solution of α-naphthol. This is a common chemical test to detect the presence of carbohydrates. Carbohydrates undergo dehydration by sulphuric acid to form furfural (furfuraldehyde) that reacts with α-naphthol to form a violet coloured product.

Fehling's test

This is an important test to detect the presence of reducing sugars. Fehling’s solution A is copper sulphate solution and Fehling’s solution B is potassium sodium tartrate. On heating, carbohydrate reduces deep blue solution of copper (II) ions to red precipitate of insoluble copper oxide.

Benedict's test

Benedict’s test distinguishes reducing sugar from non-reducing sugar. Benedict’s reagent contains blue copper (II) ions (Cu^{2+}, cupric ions) that are reduced to copper (I) ions (Cu^{+}, cuprous ions) by carbohydrates. These ions form precipitate as red coloured cuprous (copper (I) oxide.

Tollen’s test

Tollen’s reagent is ammoniacal silver nitrate solution. On reacting with carbohydrate elemental silver is precipitating out of the solution, occasionally onto the inner surface of the reaction vessel. This produces silver mirror on the inner wall of the reaction vessel.

Iodine test

Iodine test is used to detect the presence of starch. Iodine is not much soluble in water so iodine solution is prepared by dissolving iodine in water in presence of potassium iodide. Iodine dissolved in an aqueous solution of potassium iodide reacts with starch to form a starch/iodine complex which gives characteristics blue black colour to the reaction mixture.

GUM ACACIA

Synonyms Indian Gum; Gum Acacia; Gum Arabic.

Biological Source According to the USP, acacia is the dried gummy exudation from the stems and branches of *Acacia senegal* (L.) Willd; family; Leguminoseae, or other species of Acacia.

It is also found in the stems and branches of *Acacia arabica*, Willd.

Geographical Source The plant is extensively found in India, Arabia, Sudan and Kordofan (North- East Africa), Sri Lanka, Morocco, and Senegal (West Africa). Sudan is the major producer of this gum and caters for about 85% of the world supply.

Cultivation and Collection Acacia is recovered from wild as well as duly cultivated plants in the following manner, such as:

(a) From Wild Plants: The Gum after collection is freed from small bits of bark and other foreign organic matter, dried in the sun directly that helps in the bleaching of the natural gum to a certain extent, and

(b) From Cultivated Plants: Usually, transverse incisions are inflicted on the bark which is subsequently peeled both above and below the incision to a distance 2-3 feet in length and 2-3 inches in breadth. Upon oxidation, the gum gets solidified in the form of small translucent beads, sometimes referred to as ‘tears’. Tears of gum normally become apparent in 2-3 weeks, which is subsequently hand-picked, bleached in the sun, garbled, graded and packed.

Description

Colour: Tears are usually white, pale-yellow and sometimes creamish-brown to red in colour.

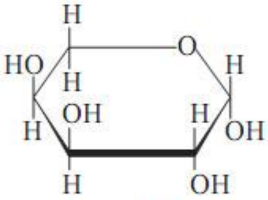
Odour: Odourless.

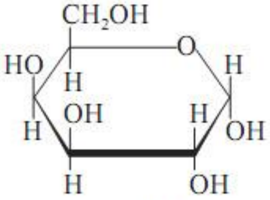
Taste: Bland and mucillagenous.

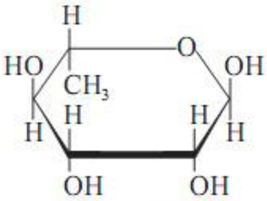
Shape & Size: Tears are mostly spheroidal or ovoid in shape and having a diameter of about 2.5-3.0 cm.

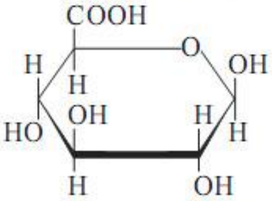
Appearance: Tears are invariably opaque either due to the presence of cracks or fissures produced on the outer surface during the process or ripening. The fracture is usually very brittle in nature and the exposed surface appears to be glossy.

Chemical Constituents Acacia was originally thought to be composed only of four chemical constituents, namely : (–) arabinose; (+) – galactose; (–)–rhamnose and (+) glucuronic acid.

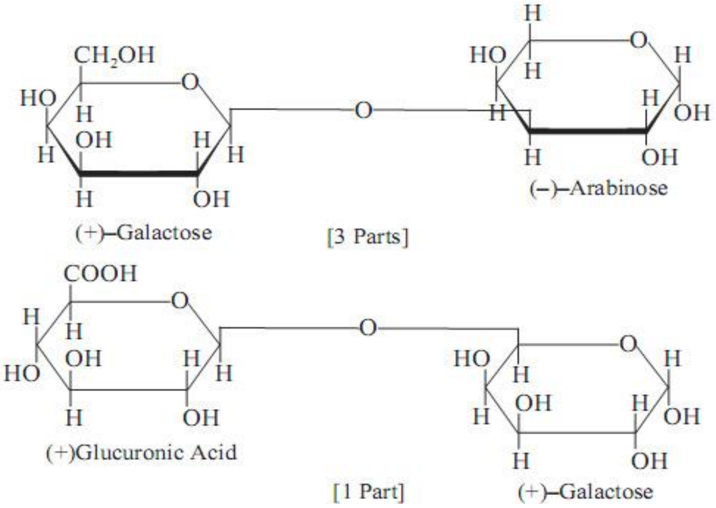

(−)–Arabinose


(+)–Galactose


(−)–Rhamnose


(+)–Glucuronic Acid

On subjecting the gum acacia to hydrolysis with 0.01N H_2SO_4 helps in removing the combined product of (–) – arabinose and (+) – galactose, whereas the residue consists of the product (+) – galactose and (+) – glucuronic acid. These two products are formed in the ratio of 3:1.



It also contains a peroxidase enzyme.

Chemical Tests

1. Lead Acetate Test: An aqueous solution of acacia when treated with lead-acetate solution it yields a heavy white precipitate.

2. Borax Test: An aqueous solution of acacia affords a stiff translucent mass on treatment with borax.

3. Blue Coloration due to Enzyme: When the aqueous solution of acacia is treated with benzidine in alcohol together with a few drops of hydrogen peroxide (H_2O_2), it gives rise to a distinct–blue colour indicating the presence of enzyme.

4. Reducing Sugars Test: Hydrolysis of an aqueous solution of acacia with dilute HCl yields reducing sugars whose presence are ascertained by boiling with Fehling's solution to give a brick-red precipitate of cuprous oxide.

5. Specific Test: A 10% aqueous solution of acacia fails to produce any precipitate with dilute solution of lead acetate (a clear distinction from Agar and Tragacanth); it does not give any colour change with Iodine solution (a marked distinction from starch and dextrin); and it never produces a bluish-black colour with $FeCl_3$ solution (an apparent distinction from tannins).

Uses

1. The mucilage of acacia is employed as a demulcent.

2. It is used extensively as a vital pharmaceutical aid for emulsification and to serve as a thickening agent.

3. It finds its enormous application as a binding agent for tablets e.g., cough lozenges.

4. It is used in the process of 'granulation' for the manufacture of tablets. It is considered to be the gum of choice by virtue of the fact that it is quite compatible with other plant hydrocolloids as well as starches, carbohydrates and proteins.

5. It is used in conjuction with gelatin to form conservates for microencapsulation of drugs.

6. It is employed as colloidal stabilizer.

7. It is used extensively in making of candy and other food products.

8. It is skillfully used in the manufacture of spray – dried 'fixed' flavors – stable, powdered flavors employed in packaged dry-mix products (puddings, desserts, cake mixes) where flavor stability and long shelf-life are important.

TRAGACANTH

Synonym Gum Tragacanth

Biological Source The dried gummy exudation from *Astragalus gummifer* Labill. (white gavan) or other species of *Astragalus* belonging to the family of *Leguminoseae*.

Geographical Source It is naturally found in various countries, *viz.*, Iran, Iraq, Armenia, Syria, Greece and Turkey. A few species of *Astragalous* are located in India, *viz.*, Kumaon, Garhwal and Punjab. *Persian tragacanth* is exported from Iran and North Syria, whereas the *Smyrna tragacanth* from the Smyrna port in Asiatic Turkey.

Collection The thorny shrubs of ***tragacanth*** normally grow at an altitude of 1000-3000 meters. As an usual practice transverse incisions are inflicted just at the base of the stem, whereby the gum is given out both in the pith and medullary rays. Thus, the absorption of water helps the gum to swell-up and subsequently exude through the incisions. The gummy exudates are duly collected and dried rapidly to yield the best quality white product. It usually takes about a week to collect the gum exudates right from the day the incisions are made; and this process continues thereafter periodically.

Description

Colour: White or pale

Odour: Odourless

Taste: Tasteless

Shape: Curved or twisted ribbon –like flakes marked with concentric ridges that are indicative of successive exudation and solidification. Fracture is normally short and horny.

Size: Flakes are usually 25 × 12 × 12 mm.

Appearance: Translucent

Chemical Constituents Interestingly, tragacanth comprises of two vital fractions: *first*, being water soluble and is termed as **'tragacanthin'** and the *second*, being water-insoluble and is known as **'bassorin'.** Both are not soluble in alcohol. The said two components may be separated by carrying out the simple filtration of a very dilute mucilage of tragacanth and are found to be present in concentrations ranging from 60-70% for bassorin and 30-40% for tragacanthin. Bassorin actually gets swelled up in water to form a gel, whereas tragacanthin forms an instant colloidal solution. It has been established that no methoxyl groups are present in the tragacanthin fraction, whereas the bassorin fraction comprised of approximately 5.38% methoxyl moieties. Rowson (1937) suggested that the gums having higher methoxyl content *i.e.*, possessing higher bassorin contents, yielded the most viscous mucilages.

Chemical Test

1. An aqueous solution of tragacanth on boiling with conc. HCl does not develop a red colour.
2. Ruthenim Red solution (0.1% in H_2O) on being added to powdered gum tragacanth whereby the particles will not either acquire a pink colour or are merely stained lightly.
3. When a solution of tragacanth is boiled with few drops of $FeCl_3$ [aqueous 10% (w/v)] it produces a deep-yellow precipitate.
4. It gives a heavy precipitate with lead acetate.

Substituents/Adulterants- Karaya gum which is sometimes known as **sterculia gum** or **Indian tragacanth** and is invariably used as a substitute for gum tragacanth.

Uses

1. It is used as a demulcent in throat preparations.

2. It is employed as an emolient in cosmetics (*e.g.*, hand lotions).

3. It is used as a pharmaceutical aid as a suspending agent for insoluble and heavy powders in mixtures.

4. It is effectively employed as a binding agent for the preparation of tablets and pills.

5. It is also used as an emulsifying agent for oils and waxes.

6. It is used in making medicinal jellies *e.g.*, spermicidal jelly.

7. A 0.2-0.3% concentration is frequently used as a stabilizer for making ice-creams and various types of sauces *e.g.*, tomato sauce, mustard sauce.

8. The mucilages and pastes find their usage as adhesives.

Agar

Synonyms Agar-agar; Gelose; Japan-agar; Chinese-isinglass; Bengal isinglass; Ceylon isinglass; Layor carang; Vegetable gelatin.

Biological Source Agar is the dried hydrophilic colloidal polysaccharide complex extracted from the agarocytes of algae belonging to the class *Rhodophyceae*. It is also obtained as the dried gelatinous substance from *Gelidium amansii* belonging to the family *Gelidaceae* and several other species of red algae, such as *Gracilaria* (family: *Gracilariaceae)* and *Pterocladia (Gelidaceae)*. The predominant agar-producing genera are, namely; *Gelidium; Gracilaria; Acanthopeltis; Ceramium and Pterocladia.*

Geographical Source Agar is largely produced in Japan, Australia, India, New Zealand, and USA. It is also found in Korea, Spain, South Africa and in the Coastal regions of Bay of Bengal (India) together with Atlantic and Specific Coast of USA.

Preparation It is an usual practice in Japan where the **red-algae** is cultivated by placing poles or bamboos spread in the ocean which will serve as a support and shall augment the growth of algae on them. During the months of May and October the poles are removed and the algae are carefully stripped off from them. The fresh seaweed thus collected is washed thoroughly in water and subsequently extracted in digestors containing hot solution of dilute acid (1 portion of algae to 60 portions of diluted acid). The mucilagenous extract is filtered through linen while hot and collected in large wooden troughs to cool down to ambient temperature so as to form solid gel. The gel is mechanically cut into bars and passed through a wire netting to form strips. The moisture from the strips is removed by successive **freezing and thawing (**To bring down to room temperature from –20 to –30^{o}C**)** and finally sun dried and stored as thin agar strips.

Alternatively, the mass of gel if frozen and subsequently thawed and the dried agar is obtained by vaccum filtration. The crude agar is usually formed as flakes which can be powdered and stored accordingly.

Description

Colour : Yellowish white or Yellowish grey

Odour : Odourless

Taste : Bland and mucilaginous

Shape : It is available in different shapes, such as: bands, strips, flakes, sheets and coarse powder

Size : Bands: width = 4cm; Length = 40 to 50 cms

Sheets: Width = 10-15cm; Length = 45 to 60 cms

Strips: Width = 4mm; Length = 12 to 15 cms

It is insoluble in cold water in organic solvents. It readily dissolves in hot solutions and it forms a translucent solid mass which characteristic is very useful in microbiology for carrying out the *Standard Plate Count.*

Chemical Constituents Agar can be separated into two major fractions, namely: (*a*) *Agarose*-a neutral gelling fraction; and (*b*) *Agaropectin*—a sulphated non-gelling fraction. The former is solely responsible for the *gel-strength of agar* and consists of (+) –galactose and 3,6-anhydro-(–)-galactose moieties; whereas the latter is responsible for the *viscosity of agar solutions* and comprises of sulphonated polysaccharide wherein both uronic acid and galactose moieties are partially esterified with sulphuric acid. In short, it is believed to be a complex range of polysaccharide chains having alternating α–(1→3) and β–(1-4) linkages and varying *total charge content.*

Chemical Tests

1. It gives a pink colouration with Ruthenium Red solution.
2. A 1.5-2.0% (w/v) solution of agar when boiled and cooled produces a *stiff-jelly.*
3. Prepare a 0.5%(w/v) solution of agar and add to 5 ml of it 0.5 ml of HCl, boil gently for 30 minutes and divide into two equal portions:

(*a*) To one portion add $BaCl_2$ solution and observe a slight whitish precipitate due to the formation of $BaS0_4$ (distinction from Tragacanth), and (*b*) To the other portion add dilute KOH solution for neutralization, add 2 ml of Fehling's solution and heat on a water bath. The appearance of a brick red precipitate confirms the presence of galactose.

Substituents/Adulterants- Gelatin and isinglass are usually used as substituents for agar.

Uses

1. It is used in making photographic emulsions.
2. It is also employed as a bulk laxative.
3. It is extensively used in preparing gels in cosmetics.
4. It is widely used as thickening agent in confectionaries and dairy products.
5. It is used in the production of ointments and medicinal encapsulations.
6. In microbiology, it is employed in the preparation of bacteriological culture media.
7. It is used for sizing silks and paper.
8. It finds its enormous usage in the dyeing and printing of fabrics and textiles.
9. It is also used as dental impression mould base.
10. It is employed as corrosion inhibitor.

HONEY

Synonyms Madhu, Honey (English);

Biological Source Honey is a viscid and sweet secretion stored in the honey comb by various species of bees, such as: *Apis dorsata*, *Apis florea*, *Apis indica*, *Apis mellifica*, belonging the natural order *Hymenotera* (Family: *Apideae*).

Geographical Source Honey is available in abudance in Africa, India, Jamaica, Australia, California, Chili, Great Britain and New Zealand.

Preparation Generally, honey bees are matched with social insects that reside in colonies and produce honey and beeswax. Every colony esentially has one *'queen'* or *'mother bee'*, under whose command a huge number of *'employees'* exist which could be mostly sterile females and in certain seasons male bees. The *'employees'* are entrusted to collect nector from sweet smelling flowers from far and near that mostly contains aqueous solution of sucrose (ie; approximately 25% sucrose and 75% water) and pollens. Invertase, an enzyme present in the saliva of bees converts the nector into the invert sugar, which is partly consumed by the bee for its survival and the balance is carefully stored into the honey comb. With the passage of time the water gets evaporated thereby producing honey(ie; approximately 80% invert sugar and 20% water). As soon as the cell is filled up completely, the bees seal it with wax to preserve it for off-season utility.

The honey is collected by removing the wax-seal by the help of a sterilized sharp knife. The pure honey is obtained by centrifugation and filtering through a moistened cheese-cloth. Invariably, the professional honey collectors smoke away the bees at night, drain-out honey, and warm the separated combs to recover the beeswax.

Description

Appearances : Pale yellow to reddish brown viscid fluid,

Odour : Pleasant and characteristic,

Taste: : Sweet, Slightly acrid,

Specific gravity : 1.35-1.36

Specific rotation : $+3^o$ to -15^o

Total Ash : 0.1-0.8%

However, the taste and odour of honey solely depends upon the availability of surrounding flowers from which nector is collected. On prolonged storage it usually turns opaque and granular due to the crystallisation of dextrose and is termed as **'granular honey'.**

Chemical Constituents The average composition of honey ranges as follows: Moisture 14-24%, Dextrose 23-36%, Levulose (Fructose) 30-47%, Sucrose 0.4-6%, Dextrin and Gums 0-7% and Ash 0.1-0.8%. Besides, it is found to contain small amounts of essential oil, beeswax, pollen grains, formic acid, acetic acid, succinic acid, maltose, dextrin, colouring pigments, vitamins and an admixture of enzymes eg; diastase, invertase and inulase. Interestingly, the sugar contents in honey varies widely from one country to another as it is exclusively governed by the source of the nector (availability of fragment flowers in the region) and also the enzymatic activity solely controlling the conversion of nector into honey.

Substituents/Adulterants Due to the relatively high price of pure honey, it is invariably adulterated either with artificial invert sugar or simply with cane-sugar syrup. These adulterants or cheaper substituents not only alter the optical property of honey but also its natural aroma and fragrance.

Uses

1. It is used as a sweetening agent in confectionaries.
2. Being a demulcent, it helps to relieve dryness and is, therefore, recommended for coughs, colds, sore-throats and constipation.

3. Because of its natural content of easily assimilable simple sugars, it is globally employed as a good source of nutrient for infants, elderly persons and convalescing patients.

PROTEIN DRUGS

GELATIN

Synonyms- Gelfoam; puragel; gelatinum.

Biological Source- Gelatin is a protein derivative obtained by evaporating an aqueous extract made from bones, skins, and tendons of various domestic animals. Some important sources are: Ox, *Bos taurus*, and Sheep, *Ovis aries* belonging to family Bovidae

Preparation- The process of manufacture of gelatin vary from factory to factory. However, the general outline of the process is given below.

Raw material- Bones, skins, and tendons of Bovideans is collected and subjected to liming operation.

Liming Process- The raw material is first subjected to the treatment known as ‘liming’. In this process, the skins and tendons are steeped for fifteen to twenty and sometimes for 40 days in a dilute milk of lime. During this, fleshy matter gets dis-solved, chondroproteins of connective tissues gets removed and fatty matter is saponified. The animal skin is further thoroughly washed in running water.

Defattying- In case of bones, the material is properly ground and defatted in close iron cylinders by treatment with organic solvents such as benzene. The mineral and inorganic part of the bone is removed by treatment with hydrochloric acid.

Extraction- The treated material from bones, skins and tendons is boiled with water in open pans with perforated false bottom. This process can also be carried out under reduced pressure. The clear liquid runs of again and again and is evaporated until it reaches to above 45 per cent gelatin content.

Setting- The concentrated gelatin extract is transferred to shallow metal trays or trays with glass bottom. It is allowed to set as a semisolid jelly.

Drying- The jelly is transferred to trays with a perforated wire netting bottom and passed through series of drying compartments of 30–60°C increasing each time with 10°C. About a month is taken for complete drying.

Bleaching- In case of darker colour, finished product is subjected to bleaching by sulphur dioxide. Bleaching affords a light coloured gelatin.

Characteristics

Gelatin occurs as a colourless or slightly yellow, transparent, brittle, practically odourless, tasteless sheet, flakes or course granular powder. In water it swells and absorbs 5–10 times its weight of water to form a gel in solutions below 35–40°C. It is insoluble in cold water and organic solvents, soluble in hot water, glycerol, acetic acid; and is amphoteric. In dry condition it is stable in air, but when moist or in solution, it is attacked by bacteria. The gelatinizing property of Gelatin is reduced by boiling for long time. The quality of gelatin is determined on the basis of its jelly strength (Bloom strength) with the help of a Bloom gelometer. Jelly strength is used in the preparation of suppositories and pessaries.

Commercially two types of gelatin, A and B, are avail-able. Type A has an isoelectric point between pH 7 and 9. It is incompatible with anionic compounds such as Acacia, Agar and Tragacanth. Type B has an isoelectric point between 4.7 and 5, and it is used with anionic mixtures. Gelatin is coloured with a certified colour for manufacturing capsules or for coating of tablets. It may contain various additives.

Chemical Constituents

Gelatin consists of the protein glutin which on hydrolysis gives a mixture of amino acids. The approximate amino-acid contents are: glycine (25.5%), alanine (8.7%), valine (2.5%), leucine (3.2%), isoleucine (1.4%), cystine and cysteine (0.1%), methionine (1.0%), tyrosine (0.5%), aspartic acid (6.6%), glutamic acid (11.4%), arginine (8.1%), lysine (4.1%), and histidine (0.8%). Nutritionally, gelatin is an incomplete protein lacking tryptophan. The gelatinizing compound is known as chondrin and the adhesive nature of gelatin is due to the presence of glutin.

Chemical Tests

1. Biuret reaction: To alkaline solution of a protein (2 ml), a dilute solution of copper sulphate is added. A red or violet colour is formed with peptides containing at least two peptide linkages. A dipeptide does not give this test.

2. Xanthoproteic reaction: Proteins usually form a yellow colour when warmed with concentrated nitric acid. This colour becomes orange when the solution is made alkaline.

3. Millon's reaction: Millon's reagent (mercuric nitrate in nitric acid containing a trace of nitrous acid) usually yields a white precipitate on addition to a protein solution which turns red on heating.

4. Ninhydrin test: To an aqueous solution of a protein an alcoholic solution of ninhydrin is added and then heated. Red to violet colour is formed.

5. On heating gelatin (1 g) with soda lime, smell of ammonia is produced.

6. A solution of gelatin (0.5 g) in water (10 ml) is precipitated to white buff coloured precipitate on addition of few drops of tannic acid (10%).

7. With picric acid gelatin forms yellow precipitate.

Uses

Gelatin is used to prepare pastilles, pastes, suppositories, capsules, pill-coatings, gelatin sponge; as suspending agent, tablet binder, coating agent, as stabilizer, thickener and texturizer in food; for manufacturing rubber substitutes, adhesives, cements, lithographic and printing inks, plastic compounds, artificial silk, photographic plates and films, light filters for mercury lamps, clarifying agent, in hectographic matters, sizing paper and textiles, for inhibiting crystallization in bacteriology, for preparing cultures and as a nutrient.

It forms glycerinated gelatin with glycerin which is used as vehicle and for manufacture of suppositories. Combined with zinc, it forms zinc gelatin which is employed as a topical protectant. As a nutrient, Gelatin is used as commercial food products and bacteriologic culture media.

CASEIN

Biological Source- Casein is a proteolytic enzyme obtained from the stomachs of calves. It is extracted from the proteins of the milk; in the milk, casein is structured in voluminous globules. These globules are mainly responsible for the white colour of the milk. According to various species, the casein amount within the total proteins of the milk varies.

The casein content of milk represents about 80% of milk proteins. The principal casein fractions are alpha (s1) and alpha (s2)-caseins, β-casein and κ-casein. The distinguishing property of all casein is their low solubility at pH 4.6. The common compositional factor is that caseins are conjugated proteins, most with phosphate group(s) esterified to serine residues. These phosphate groups are important to the structure of the casein micelle. Calcium binding by the individual caseins is proportional to the phosphate content.

Characteristics

The isoelectric point of casein is 4.6. The purified protein is water insoluble. While it is also insoluble in neutral salt solutions, it is readily dispersible in dilute alkalis and in salt solutions such as sodium oxalate and sodium acetate. Casein does not coagulate on heating. It is precipitated by acids and by a proteolytic enzyme (rennet).

Chemical Constituents

Milk consists of 80% of milk proteins (casein). The major constituents of casein are alpha (s1) and alpha (s2)-caseins, β-casein and kappa-casein. These caseins are conjugated proteins with phosphate group(s) which are esterified into serine residues they have a low solubility at pH 4.6.

Uses

It is used in the manufacture of binders, adhesives, protective coatings, plastics (such as for knife handles and knitting needles), fabrics, food additives, and many other products. It is commonly used by bodybuilders as a slow-digesting source of amino acids. There is growing evidence that casein may be addictive for some individuals, particularly those on the autism spectrum or having schizophrenia.

ENZYMES

UROKINASE

Synonym Uroquinase.

Biological Source Urokinase is serine protease enzyme isolated from human urine and from human kidney cells by tissue culture or by recombinant DNA technology.

Preparation

Urokinase is a fibrinolytic enzyme produced by recombinant DNA using genetically manipulated *E. coli* cells. It is produced firstly as prourokinase q.v. and then converted to active form by plasmin or kallikrein. Urokinase used medicinally is also purified directly from human urine. It binds to a range of adsorbents such as silica gel or kaolin which can be use to initially concentrate and purify the product. It can be further purified by precipitation with sodium chloride or ethanol or by chromatography. Human urokinase needs sterile filtration, a septic filling and freeze drying.

Characteristics

Urokinase enzyme occurs in two different forms as single and double polypeptide chain forms. It has a half-life of 10–16 minutes after intravenous administration. These enzymes act on an endogenous fibrinolytic system.

Chemical Constituents

Urokinase enzymes are serine proteases that occur as a single low molecular weight (33 kDa) and double, high molecular weight (54 kDa) polypeptide chain forms. They differ in molecular weight considerably. A single chain is produced by recombinant DNA technique and is known as SCUPA.

Uses

Urokinase is used in the treatment of pulmonary embolism, coronary artery thrombosis and for restoring the potency of intravenous catheters. It is generally administered intra-venously in a dose of 4,400 units/kg body weight per hour for twelve hours.

PEPSIN

Biological Source

It is the enzyme prepared from the mucous membrane of the stomach of various animals like pig, sheep, or calf. The commonly used species of pig is *Sus scrofa* Linn, belonging to family Suidae. Optimal activity of pepsin is at pH of 1.8 –3.5, depending on the isoform. They are reversibly inactivated at about pH 5 and irreversibly inactivated at pH 7–8.

Preparation

The mucous membrane is separated from the stomach either by the process of stripping or it is scrapped off, and it is placed in acidified water for autolysis at 37°C for 2 hours. The liquid obtained after autolysis consist of both pepsin and peptone. It is then filtered and sodium or ammonium salts are added to the liquid till it is half saturated. At this point only the pepsin separates out, and the peptone remains in the solution. The precipitates are collected and subjected to dialysis for the separation of salts. Remaining amount of pepsin if any in the aqueous solution is precipitated by the addition of alcohol into it. The pepsin is collected and dried at low temperature.

Description

Pepsin occurs in pale yellow colour, they are odourless or with very faint odour, translucent grains and slightly bitter in taste. It is soluble in dilute acids, water, and physiological salt (NaCl) solution. It is best active at a temperature of 40°C with pH 2–4. Pepsin is unstable above pH 6. The enzyme gets denatured at a temperature of 70°C and in the presence of alcohol and sodium chloride. Pepsin can be stored for 1–2 years at 2–8°C.

Uses

It is used in the deficiency of gastric secretion. Pepsin is also used in the laboratory analysis of various proteins; in the preparation of cheese, and other protein-containing foods.

PAPAIN

Synonyms

Papayotin, vegetable pepsin, tromasin, arbuz.

Biological Source

Papain is the dried and purified latex of the green fruits and leaves of *Carica papaya* L., belonging to family Caricaceae.

The plant is cultivated in Sri Lanka, Tanzania, Hawai, and Florida. The plant is 5–6 m in height bearing fruits of about 30 cm length and a weight up to 5 kg. The epicarp adheres to the orange-coloured, fleshy sarcocarp, which surrounds the central cavity. This cavity contains a mass of nearly black seeds.

Preparation

It is distributed throughout the plant, but mostly concentrated in the latex of the fruit. The latex is obtained by making two to four longitudinal incisions, about 1/8 inch deep, on the surface on four sides of nearly mature but green fruits while still on the tree. The incisions are made early in the morning, at intervals of three to seven days. The latex flows freely for a few seconds but soon coagulates. The exudate is collected in nonmetallic containers. The latex is dried as soon as possible after collection. Rapid drying or exposure to sun or higher temperature above 38°C produce dark colour product with weak in proteolytic activity. The use of artificial heat yields the better grade of crude papain. The final product should be creamy white and friable. It is sealed in air-tight containers to prevent loss of activity. If 10% common salt or 1% solution of formaldehyde is added before drying, the product retains its activity for many months.

Fully grown fruits give more latex of high enzyme potency than smaller or immature fruits. The yield of Papain varies from 20 to 250 g per tree. The yield of commercial Papain from latex is about 20%.

Characteristics

Papain occurs as white or greyish-white, slightly hygroscopic powder. It is incompletely soluble in water and glycerol. It may digest about 35 times its weight of lean meat. Best grades render digestion of 200–300 times their weight of coagulated egg albumin in alkaline media. A temperature range of 60–90°C is favourable for the digestive process with 65° the optimum point. Best pH is 5.0, but it functions also in neutral or alkaline media. It is activated by reduction (HCN and H_2S) and inactivated by oxidation (H_2O_2, iodoacetate).

Chemical Constituents

Papain contains several enzymes such as proteolytic enzymes peptidase I capable of converting proteins into dipeptides and polypeptides, rennin-like enzyme, clotting enzyme similar to pectase and an enzyme having a feeble activity on fats.

The enzymes, papain, papayaproteinase, and chymopapain, have been isolated in crystalline form from the latex. Papain is atypical protein digesting enzyme with isoelectric point. It contains 15.5% nitrogen and 1.2% sulphur. Crystalline papain is most stable in the pH range 5–7 and is rapidly destroyed at 30°C below pH 2.5 and above pH 12. Papain is a protein of 212 amino acids and having a molecular weight of about 23,000 daltons. It is resistant to heat, inactivated by metal ions, oxidants and reagents which react with thiols, and is an endopeptidase activated by thiols and reducing moieties, for example, cysteine, thiosulphate, and glutathione.

The leaves possess dehydrocarpaines I and II, fatty acids, carpaine, pseudocarpaine, and carotenoids.

The fruits yield lauric, myristoleic, palmitoleic and arachidic acids, malonated benzyl-p-o-glucosides, 2-phenyl ethyl glucoside, and 4-hydroxy-phenyl-2-ethyl glucoside.

Uses

Papain is used to prevent adhesions; in infected wounds; internally as protein digestant, as anathematic (nematode), to relieve the symptoms of episiotomy (incision of vulva), in meat industry for tenderizing beef, for treatment of dyspepsia, intestinal and gastric disorders, and diphtheria, for dissolving diphtheria membrane; in surgery to reduce incidence of blood clots where thromboplasma is undesirable and for local treatment of buccal, pharyngeal, and laryngeal disorders.

It is used in digestive mixtures, liver tonics, for reducing enlarged tonsils, in prevention of postoperative adhesions, curbuncles, and eschar burns. It is an allergic agent causing severe paroxysmal cough, vasomotor rhinitis and dyspnea. It is a powerful poison when injected intravenously. In industry it is used in the manufacture of proteolytic preparations of meat, lever, and casein, with dilute alcohol and lactic acid as meat tenderizer, as a substitute for rennet in cheese manufacture, in brewing industry for making chill-proof bear, for degumming natural milk, in preparation of tooth pastes and cosmetics, in tanning industry for bathing skin and hides, and as an ingredient in cleansing solutions for soft contact lenses.

Test

Papain is reacted with a gelatin solution at 80°C in the presence of an activating cysteine chloral hydrate solution for an hour. The solution is cooled to 4°C for long time. The treated solution must not regel in comparison to a blank solution under identical con-ditions.

Adulteration

Commercial papain is often adulterated with arrowroot starch, dried milk of cactus, gutta percha, rice flour, and pepsin.

BROMELIN

Synonyms

Bromelin, bromelain.

Biological Source Bromelin is a mixture of proteolytic enzymes isolated from the juice of *Ananas comosus* (pineapple), belonging to family Bromeliaceae.

Geographical Source

Pineapple is a native of tropical America. It is grown in almost all parts of the world including India, China, Thai-land, United States, Brazil, Philippines, Mexico, Hawaii, and Taiwan.

Cultivation, Collection, and Preparation

Bromelin is found in pineapple fruit juice and stem. Pine-apple is perennial, and it does not have a natural period of dormancy. It is propagated through suckers, slips, and crowns. In India it is planted in August, the plant generally flowers in February–March, and the fruit ripens during July–October.

The fruits must be left on the plant to ripen for the full flavour to develop. Dark green unripe fruits gradually change to yellow and finally to deep orange. The fruits are cut off. The enzyme bromelin does not disappear as the fruit ripens. The enzyme from fruit and stem are known as fruit bromelin and stem bromelin, respectively. It is isolated from pineapple juice by precipitation with acetone and also with ammonium sulphide

Characteristics

The optimum pH of bromelain is 5.0–8.0. In solution pH below 3.0 and above 9.5 inactivates the enzyme. The optimum temperature is between 50 and 60°C, still it is effective between 20 and

65°C too. The moisture content should not exceed 6%. It is obtained in light brown-coloured powder.

Chemical Constituents

Bromelain is not a single substance, but rather a collection of enzymes and other compounds. It is a mixture of sulphur-containing protein-digesting enzymes, called proteolytic enzymes or proteases. It also contains several other substances in smaller quantities, including peroxidase, acid phosphatase, protease inhibitors, and calcium.

Uses

Bromelain is an effective fibrinolytic agent; bromelain inhibits platelet aggregation and seems to have both direct as well as indirect actions involving other enzyme systems. It can modify the permeability of organs and tissues to different drugs. The potentiation of antibiotics and other medicines by bromelain may be due to enhanced absorption, as well as increased permeability of the diseased tissue which enhances the access of the antibiotic to the site of the infection.

It is also thought that the use of bromelain may provide a similar access to specific and nonspecific components of the immune system, therefore, enhancing the body’s utilization of its own healing resources. Bro-melain has been used successfully as a digestive enzyme following pancreatectomy, in cases of exocrine pancreas insufficiency and in other intestinal disorders. Research has indicated that bromelain prevents or minimizes the severity of angina pectoris and transient ischemic attacks (TIA); it is useful in the prevention and treatment of thrombosis and thrombophlebitis. If administered for prolonged time periods, bromelain also exerts an antihypertensive effect in experimental animals. It may even be useful in the treatment of AIDS to stop the spread of HIV. It has no major side effects, except for possible allergic reactions.

STREPTOKINASE

Synonym

Estreptokinase, plasminokinase.

Biological Source

Estreptokinase, plasminokinase is a purified bacterial protein produced from the strains of group C β-haemolytic *Streptococcus griseus.*

Preparation

Streptokinase is a bacterial derived enzyme of serine pro-tease group. The ancestral protease activity lies within the first 230 amino-acid residues at the N-terminal part of the protein that evolves from serine protease due to the replacement of histamine at 57th amino acid by glycine. The amino terminal residue polypeptide chain shows sequence homology to serine protease. Duplication and fusion of gene generate an ancestral streptokinase gene. Streptokinase is produced by fermentation using streptococcal culture and is isolated from the culture filtrate. It is produced in the form of a lyophilized powder in sterile vials containing 2,50,000 to 7,50,000 IUs.

Characteristics

Streptokinase is a bacterial protein with half-life of 23 minutes. Its anisolylated plasminogen activator complex (APSAC) has a higher half-life of six hours.

Chemical Constituents

Streptokinase is the purified bacterial protein with about 484 amino-acid residues.

Uses

Streptokinase is the first available agent for dissolving blood clots. It binds to plasminogen in a 1:1 ratio and changes molecular conformation. Thus, the complex formed becomes an active enzyme and promotes the activity of fibrinolytic enzyme plasmin. Plasmin breaks fibrin clots. Anistreptase or the anisolylated plasminogen streptokinase activator complex (APSAC) can also be used in a similar way for degrading blood clots. Streptokinase and anistreptase are both used in the treatment of pulmonary embolism, venous, and arterial thrombosis and coronary artery thrombosis. It is also sometimes administered along with heparin to counter act a paradoxical increase in local thrombin.

SERRATIOPEPTIDASE/ SERROPEPTIDASE

Synonym

Serrapeptase, serratiopeptidase.

Biological Source

Serratiopeptidase is a proteolytic enzyme isolated from nonpathogenic enterobacteria *Serratia* E 15. It is also produced by the larval form of the silk moth.

Preparation

Serratiopeptidase is produced by fermentation technology by using nonpathogenic enterobacteria species such as *Serratia* E 15. The larvae of silk moth produce this enzyme in their intestine to break down cocoon walls. It can thus be obtained from the silk moth larvae.

Serratiopeptidase **Characteristics**

is very much vulnerable to degradation in the acidic pH. When consumed in unprotected tablet or capsule, it is destroyed by acid in stomach. However enteric coated tablets facilitate its absorption through intestine. One unit of the enzyme hydrolyses casein to produce colour equivalent to 1.0 µmol of tyrosine per minute at pH 7.5 and 35°C.

Chemical Constituents

Serratiopeptidase is a proteolytic enzyme of protease type XXVI. The preparation contains 7.1 units/mg solid.

Uses

Serratiopeptidase is the most widely prescribed anti-inflammatory enzyme in developed countries and also in India. It eliminates inflammatory oedema and swelling, accelerate liquefaction of pus and sputum, and enhance the action of antibodies. It is also used as a fast wound healing agent. It is proving to be a superior alternative to the nonsteroidal anti-inflammatory drugs traditionally used to treat rheumatoid arthritis and osteoarthritis. It has wide ranging applications in trauma surgery, plastic surgery, respiratory medicine, obstetrics and gynaecology.

LIPID DRUGS

Lipids are the substances of animal or plant origin and comprise of fixed oils, fats and waxes. The basic function of fat and oil is energy storage. These are obtained by expression or extraction methods.

LANOLIN (Wool fat)

Synonyms

Wool fat; Oesipos; Agnin; Alapurin; Anhydrous lanolin; Adeps lanae; Laniol.

Biological Source

Lanolin is the fat-like purified secretion of the sebaceous glands which is deposited into the wool fibres of sheep, *Ovis aries* Linn., belonging to family Bovidae.

Preparation

Wool is cut and washed with a soap or alkali. An emulsion of wool fat, called as wool grease, takes place in water. Raw lanolin is separated by cracking the emulsion with sulphuric acid. Wool grease floats on the upper layer and fatty acids are dissolved in the lower layer. Lanolin is purified by treating with sodium peroxide and bleaching with reagents.

Characteristics

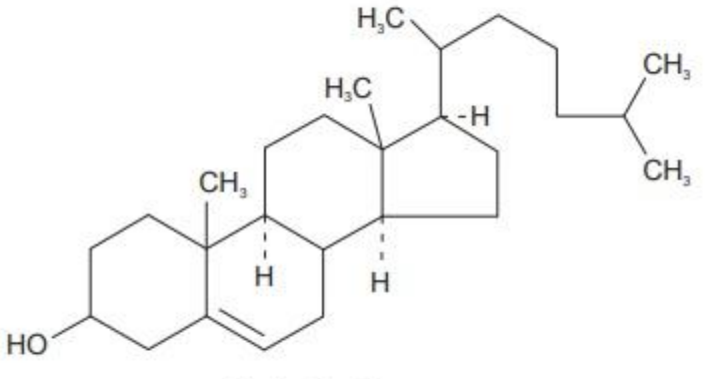
Lanolin is a yellowish white, tenacious, unctuous mass; odour is slight and characteristic. Practically, it is insoluble in water, but soluble in chloroform or ether with the separation of the water. It melts in between 34 and 40°C. On heating it forms two layers in the beginning, continuous heating removes water. Lanolin is not saponified by an aqueous alkali. However, saponification takes place with alcoholic solution of alkali.

Anhydrous lanolin is a yellowish tenacious, semisolid fat with slight odour. Practically it is insoluble in water but mixes with about twice its weight of water without separation. It is sparingly soluble in cold, more in hot alcohol, freely soluble in benzene, chloroform, ether, carbon disulphide, acetone, and petroleum ether.

Chemical Constituents

Lanolin is a complex mixture of esters and polyesters of 33 high molecular weight alcohols, and 36 fatty acids. The alcohols are of three types; aliphatic alcohols, steroid alcohols, and triterpenoid alcohols. The acids are also of three types: saturated nonhydroxylated acids, unsaturated nonhydroxylated acids, and hydroxylated acids. Liquid lanolin is rich in low molecular weight, branched aliphatic acids, and alcohols, whereas waxy lanolin is rich in high molecular weight, straight-chain acids, and alcohols.

The chief constituents of lanolin are cholesterol, iso-cholesterol, unsaturated monohydric alcohols of the formula $C_{27}H_{45}OH$, both free and combined with lanoceric ($C_{30}H_{60}O_4$), lanopalmitic ($C_{16}H_{22}O_3$), carnaubic, and other fatty acids. Lanolin also contains esters of oleic and myristic acids, aliphatic alcohols, such as cetyl, ceryl and carnaubyl alcohols, lanosterol, and agnosterol.



Cholesterol

Identification Tests

Dissolve 0.5 g of lanolin in chloroform, and to it add 1 ml of acetic anhydride and two drops of sulphuric acid. A deep green colour is produced, indicating the presence of cholesterol.

Uses

Lanolin is used as an emollient, as water absorbable ointment base in many skin creams and cosmetic and for hoof dressing. Wool fat is readily absorbed through skin and helps in increasing the absorption of active ingredients incorporated in the ointment. However, it may act as an allergenic contactant in hypersensitive persons.

BEESWAX

Synonyms White beeswax, yellow beeswax, cera alba, and cera flava.

Biological Source Beeswax is the purified wax obtained from honeycomb of hive bee, *Apis mellifera* Linn and other species of Apis, belonging to family Apidae.

Geographical Source It is mainly found in Jamaica, Egypt, Africa, India, France, Italy, California etc.

Preparation The worker bee secretes the wax due to the ability of maintaining a high temperature and the wax is secreted in the last four segments of abdomen on the ventral surface. Just below the sterna it has a smooth layer of cells form the chitinous area that secretes the wax. The chitinous area has small pores through, which the wax exudes out. The wax is passed to the front leg and later to the mouth; in the mouth it gets mixed with the saliva, which is then built on the comb. This wax forms a capping on the honey cells. Wax forms about 1/8th part of the honeycomb. After removal of honey, honeycomb or the capping is melted in boiling water. On cooling the melted wax gets solidified and floats on the surface of water while the impurities settle below and honey leftovers get dissolved in water. The pure wax is then poured into earthen vessels wiped with damp cloth and the wax so obtained is yellow beeswax.

White beeswax is obtained from yellow beeswax. The yellow beeswax is runned on a thin stream of spinning wet drum, from which long ribbon like strips are scrapped off. The ribbon strips are placed on cloth in thin layers, rotated from time to time and bleached in sunlight till the outer layer becomes white. White beeswax is obtained by treating yellow beeswax chemically with potassium permanganate, chromic acid or chlorine or charcoal.

Characteristics

Yellow wax or Cera flava is yellowish to greyish brown coloured solid, with agreeable, honey-like odour and a faint, characteristic taste. When cold, it is somewhat brittle and when broken, shows presence of a dull, granular, noncrystalline fracture. Yellow wax is insoluble in water and sparingly soluble in cold alcohol. It is completely soluble in chloroform, ether, and in fixed or volatile oils, partly soluble in cold benzene or in carbon disulphide and completely soluble in these liquids at about 30°C.

White wax is less unctuous to the touch; it is yellow, soft, and ductile at 35°C and fusible at 65°C. A yellowish-white solid, somewhat translucent in thin layers. It has a faint, characteristic odour which is free from rancidity and tasteless. It is insoluble in water, soluble in chloroform, ether, fixed oil, and volatile oils (hot turpentine oil) and sparingly soluble in alcohol. It is not affected by the acids at ordinary temperatures, but is converted into a black mass when boiled with concentrated sulphuric acid.

Chemical Constituents

Beeswax contains myricin, which is melissyl palmitate; melting point 64°C, free cerotic acid ($C_{26}H_{52}O_2$), myricyl alcohol ($C_{30}H_{61}OH$) is liberated when myricyl palmitate is saponified. Melissic acid, some unsaturated acids of the oleic series, ceryl alcohol, and 12 to 13% higher hydrocarbons are present.

Uses Beeswax is used in the preparation of ointments, plaster, and polishes.

Adulterants

Beeswax is adulterated by solid paraffin, ceresin, carnauba wax, or other fats and waxes of animal or mineral origin. Spermaceti and lard render wax softer and less cohesive, of a smoother and less granular fracture and different odour when heated. The melting point and specific gravity are lowered by tallow, suet, lard, and especially by paraffin. Ceresin, a principle obtained from ozokerite is also employed as an adulterant. In yellow wax the iodine value is also of use as a test for detection of adulterants but in white wax the bleaching process has altered the bodies which absorb the iodine.

Marketed Products

It is one of the ingredients of the preparations known as Saaf Organic Eraser Body Oil and Jatyadi tail (Dabur).

CASTOR OIL

Synonyms Castor bean oil, castor oil seed, oleum ricini, ricinus oil, oil of palma christi, cold-drawn castor oil.

Biological Source Castor oil is the fixed oil obtained by cold expression of the seeds of *Ricinus communis* Linn., belonging to family Euphorbiaceae.

Geographical Source It is mainly found in India, Brazil, America, China, Thai-land; in India it is cultivated in Gujarat, Andhra Pradesh, and Karnataka.

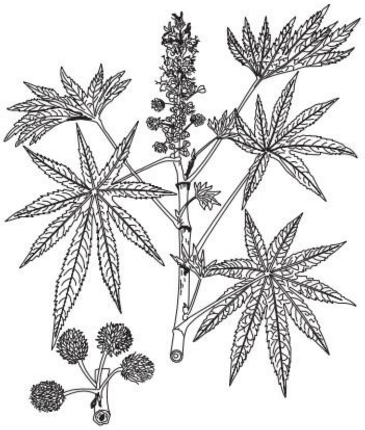
Preparation Castor oil is obtained from castor seeds. The oil is obtained by two ways; either after the removal of the seed coat or with the seed coat. Seed coats are removed by crushing the seeds under the grooved rollers and then they are subjected to a current of air to blow the testas. The kernels are fed in oil expellers and at room temperature they are expressed with 1 to 2 tons pressure per square inch till about 30% oil is obtained. The oil is filtered, steamed 80–100°C to facilitate the coagulation and precipitation of poisonous principle ricin, proteins and enzyme lipase present in it. Oil is then filtered and this oil with 1% acidity is used for medical purpose.

The oil cake which remains contains of ricin, lipase and about 20% oil. The cake is grounded, steamed to 40° to 80°C, and a pressure of 3 tons pressure per sq. inch is applied. This yields the second quality of oil with 5% acidity and is used for industrial purpose.

The residual cake which remains after the expression of the second quality oil still contains about 8 to 10% oil. This oil is obtained by subjecting it to extraction in soxhlet with lipid solvents. This oil obtained is also used in industry. The residual cake is used as manure and not fed to animal due to the presence of ricin. The cake is also used for the production of lipase.

Characteristics Medicinal or the first grade or Pale pressed castor oil is colourless or slightly yellow coloured. It is a viscid liquid which has slight odour with slightly acrid taste. Castor oil is soluble in absolute alcohol in all proportions; Specific gravity is 0.958 to 0.969, refractive index at 40°C is 1.4695 to 1.4730, acid value not more than 2, saponification value 177 to 187, and acetyl value is about 150.

Chemical Constituents Castor oil consists of glyceride of ricinoleic acid, isoricinoleic, stearic, and dihydroxy stearic acids. Ricinoleic acid is responsible for laxative property. Castor oil also contains vitamin F. 90% of the fatty acid content is ricinoleic acid. The ricinoleic acid is an 18-carbon acid having a double bond in the 9–10 position and a hydroxyl group on the 12th carbon. This combination of hydroxyl group and unsaturation occurs only in castor oil.



Ricinus communis

Identification Tests- About 5 ml of light petroleum (50° to 60°) when mixed with 10 ml of castor oil at 15.5° shows a clear solution, but if the amount of light petroleum is increased to 15 ml, the mixture becomes turbid. This test is not shown by other oils.

Uses

Castor oil is mild purgative, fungistatic, used as an ointment base, as plasticizer, wetting agents, as a lubricating agent. Ricinoleic acid is used in contraceptive creams and jellies; it is also used as an emollient in the preparation of lipsticks, in tooth formulation, as an ingredient in hair oil. The dehydrated oil is used in the manufacture of linoleum and alkyl resin. The main use of castor oil is the industrial production of coatings, also employed to make pharmaceuticals and cosmetics in the textile and leather industries and for manufacturing plastics and fibres.

Marketed Products

It is one of the ingredients of the preparations known as Lip balm and Muscle and joint rub (Himalaya Drug Company).

CHAULMOOGRA OIL

Synonyms Hydnocarpus oil; gynocardia oil.

Biological Source

Chaulmoogra oil is the fixed oil obtained by cold expression from ripe seeds of *Taraktogenos kurzii* King, (syn. *Hydnocarpus kurzii* (King) Warb.), *Hydnocarpus wightiana* Blume, *H. anthelminticta* Pierre, *H. heterophylla*, and other species of Hydnocarpus, belonging to family Flacourtiaceae.

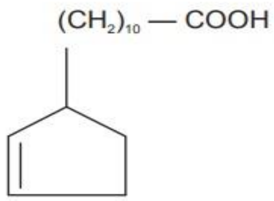
Geographical Source The plants are tall trees, up to 17 m high, with narrow crown of hanging branches; native to Burma, Thailand, eastern India, and Indo-China.

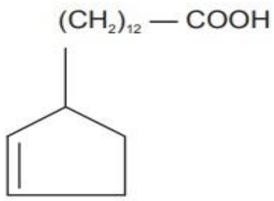
Characteristics The oil is yellow or brownish yellow. Below 25°C it is a soft solid. It has peculiar odour and sharp taste. It is soluble in benzene, chloroform, ether, petrol; slightly soluble in cold alcohol; almost entirely soluble in hot alcohol and carbon disulphide.

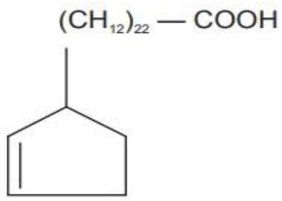
Chemical Constituents

Chaulmoogra oil contains glycerides of cyclopentenyl fatty acids like hydnocarpic acid (48%), chaulmoogric acid (27%), gorlic acid with small amounts of glycerides of palmitic acid (6%), and oleic acid (12%). The cyclic acids are formed during last 3–4 months of maturation of the fruit and are strongly bactericidal towards the Micrococcus of leprosy.

The seeds of H. wightiana contain a flavonolignan hydnocarpin; isohydnocarpin, methoxy hydnocarpin, apigenin, luteolin, chrysoeriol, hydnowightin, epivolkenin, and cyclopentenoid cyanohydrin glycosides.


Hydnocarpic acid


Chaulmoogric acid


Gorlic acid

Uses

The oil is useful in leprosy and many other skin diseases. The cyclopentenyl fatty acids of the oil exhibit specific toxicity for Mycobaeterium leprae and M. tuberculosis. The oil has now been replaced by the ethyl esters and salts of hydnocarpic and chlumoogric acids. At present organic sulphones have replaced Chaulmoogra oil in therapeutic use.

MARINE DRUGS

INTRODUCTION - Marine drugs are the drugs obtained from marine organisms which are being conventionally used like shark and cod-liver oils, sodium alginate, agar-agar, chitin etc.

Importance of Marine Drugs –

Marine organisms are potential source for drug discovery. Life has originated from the oceans that cover over 70% of the surface of earth and contain highly ecological, chemical and biological diversity starting from micro-organisms to vertebrates. This diversity has been the source of unique chemical compounds, which hold tremendous pharmaceutical potential. Because of the highly chemical and physical harsh conditions in marine environment, the organisms produce a variety of molecules with unique structural features and exhibit various types of biological activities. Majority of the marine natural products have been isolated from sponges, coelenterates (sea whips, sea fans and soft corals), tunicates, echinoderms (starfish, sea cucumbers, etc) and bryozoans and a wide variety of marine micro-organisms in their tissues.

Classification of drugs from marine organisms-

The enormous quantum of newer and potent drug molecules derived from the wide spectrum of marine organisms across the world has been classified based on their specific pharmacologic actions as stated below:

1. Cytotoxic/antineoplastic agents
2. Cardiovascular active drugs
3. Marine toxins
4. Antimicrobial drugs
5. Antibiotic substances
6. Anti-inflammatory and antispasmodic agents
7. Miscellaneous pharmacologically active substances

ANTIMICROBIAL

(1)**ZONAROL AND ISO - ZORANOL Biosource:** Zonarol and Iso-zonarol are both obtained from *Dictyopteris zonaroides* (Brown algae).

Chemistry - Flavonoid Use : Antimicrobial

(2)TETRABROMO-2-HEPTANONE

Biosource: It is obtained from another species of Bonnemaisonia hemifera. (Red algae)

Use – Antimicrobial   Chemistry – Bromophenol compound

(3) 2-CYANO-4,5-DIBROMOPYRROLE

It is perhaps one of the rarest examples of a chemical entity isolated from a marine organism which contains a cyano(-CN) function group.

Biosource: It is obtained from Agelas oroides, a specific type of sponge found in marine sources.

Use -Antimicrobial

(4) EUNICIN

Biosource: It is obtained from Gorgonian corals, Eunicia mammosa.

Chemistry – Diterpene Use – Antimicrobial

ANTICANCER

Simularin

Source – Soft coral Sinularia fleibilis

Chemistry – Cembranoids (14 C cyclic diterpenoid with eocyclic lactone)

Use – Anticancer

Asperdiol

Source – From gorgonian coral Eunicea knighti

Use - Leukemiaυ Chemistry - Non lactone cembranoid

Geranyl Hydro –Quinone

Source – Aplidium species

Use - Anticancerυ Chemistry – Quinone

ANTIBIOTICS

Cycloedudesmol

Bio source – Red algae Chondria oppositiclada

Use - Antibiotic Chemistry – Eudesmol (Sesquiterpenoid)

Variabilin

Bio source - Sponge , Ircinia oros

Use - Antibiotic Chemistry – Furanose ester terpene

ANTICOAGULANT

Organism- Iridae laminarioides

Chemical compound- Galaxtan sulphuric acid

Use- Anticoagulant

Organism - Codium fragile ssp. leo mentosides

Chemical compound -associated with an unknown plasma factor.

Use- Antithrombin activity

Organism- C.fragile ssp. Atlanticum

Chemical compound-High molecular wt. proteoglycans;

Use-Anticoagulant activity.

ANTIPARASITIC

Organism - Digenia simplex (Red algae)

Chemical compound -alpha-kainic acid

Use- Broad spectrum anthelmintic. Effective against parasitic round worms, whipworm and tapeworm.

Organism- Laminaria angustala

Chemical compound -Laminine

Use- Anthelmintic as well as smooth muscle relaxant and hypotensive;

Organism- Sea cucumber

Chemical compound- Cucumechinoside F.

Use-Antiprotozoal.

CARDIOVASCULAR AGENS

EPTATRETIN

Bio-source – It is found in the bronchial hearts of pacific hogfish i.e. Eptatretus stoutii

Use – It is a potent Cardiac stimulant with direct stimulant action on mammalian myocardium.

LAMININE

Biosource- It is obtained from Marine algae, Laminaria angustata

Use – Hypotensive agent

ANTHOPLEURINS

Biosource – It is obtained from Coelenterates- Anthropleura xanthogrammica Use – Cardiotonic (35 times more potent as compared to digitoin)

MARINE TOXINS

CIGUATOXIN

Biosource – It is found in red tide dinoflagellate i.e. Gambier discus-toxicus

Toxic Symptoms – Neurological, cardiovascular, G.I.T disorders

PALYTOXIN

Biosource - It is present in Palythoa species

Toxic Symptoms – On coronary arteries

ANTISPASMODIC AGENTS

AGELASIDINE A

Biosource – It is obtained from Okinawa sea sponge Agelas spp

Chemical compound – Agelasidine A is the first marine natural products containing Guanine and sulfone units.

Use – Antispasmodic agent

ANTI-INFLAMMATORY

BIO-INDOL

Biosource – It is obtained from marine cyanobacterium Rivularia firma

Chemical compound – Bio Indole derivative

– Anti-inflammatory agent

BUTANOLIDE

Biosource - It is obtained from marine Euplexaura flava

Chemical compound – Butanolide derivative

Use – Anti-inflammatory agent

For 2 marks-

1. Define Lipids with example of drugs.
2. Define Carbohydrates with example of drugs.
3. Define Proteins with example of drugs.
4. Define Fibers with example.
5. Define Hallucinogens with example.
6. Define Natural allergens with example.
7. Give biological source and uses of Acacia.
8. Give biological source and uses of Castor oil.
9. Give biological source and uses of Gelatin.

10. Give biological source and uses of Papain.
11. Give biological source and uses of Honey.
12. Give biological source and uses of Bees wax.
13. Give biological source and uses of Jute fiber.
14. Give biological source and uses of Streptokinase.
15. Give biological source and uses of Casein.
16. Give biological source and uses of Tragacanth.
17. Give biological source and uses of Wool fat.
18. G Give biological source and uses of Chaulmoogra oil.
19. Give biological source and uses of Agar.
20. Give biological source and uses of Cotton.
21. Give example of marine drugs used as anti-inflammatory and anticancer drug.

For 5 marks-

1. Write a short note on any one carbohydrate drug.
2. Explain properties, side effects and examples of Hallucinogens.
3. Write about properties, chemical tests and uses of Wool fat.
4. Write a note on various proteolytic enzymes.
5. Explain the types of natural allergens.

For 10 marks-

1. Write a detailed note on Castor oil.
2. Write in detail about novel medicinal agents from marine sources.
3. Write a detailed note on Cotton.