SHAMBHUNATH INSTITUTE OF PHARMACY

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IMPORTANT QUESTIONS BASED ON PREVIOUS QUESTION PAPER

NAME OF SUBJECT: **PHARMACOGNOSY AND PHYTOCHEMISTRY- II**
SUBJECT CODE: **(BP-504T)**
COURSE AND SEMESTER: **B. PHARM & 5TH SEMESTER**

UNIT-I

Short questions:

1. **Define radiotracer technique. Enlist various detectors used in tracer techniques.**
   Answer: It can be defined as a technique which utilizes a labeled compound to find out / to trace different intermediates and various steps in biosynthetic pathways in plants at a rate and time.
   a) Geiger – Muller counter
   b) Liquid Scintillation counter.
   c) Gas ionization chamber.
   d) Autoradiography.
   e) Radio paper chromatography
   f) Mass spectroscopy
   g) NMR spectroscopy
   a) Geiger – Muller counter: A Geiger counter (Geiger-Muller tube) is a device used for the detection andmeasurement of all types of radiation: alpha, beta and gamma radiation.
2. **Discriminate primary and secondary metabolites with example**.
   Answer: Primary Metabolites are a type of metabolite that is closely engaged in the growth, development, and reproduction of an organism. Eg. **amino acid, lactic acid, vitamins, carbohydrates, lipids, etc.**
   Secondary Metabolites are compounds that are not directly engaged in normal growth and development but do have some ecological functions within the body.Eg. **Steroids, alkaloids, essential oils, phenolic, etc.**
3. **What are applications of amino acid pathway?**
   Answer: Amino acids, often referred to as the building blocks of proteins, are compounds that play many critical roles in your body. You need them for vital processes such as **building proteins, hormones, and neurotransmitters**.
   The three applications are:
   (1) Food Industry Application
   (2) Pharmaceutical Industry Application
   (3) Chemical Industry Application.

UNIT-II

Short questions:

1. **Differentiate hydrolysable and condensed tannins with example.**

   Answer:

Hydrolysable tannins	Condense tannins (Non-hydrolysable)
1. They are known as pyrogallol tannins.	1. They are known as catechol tannins.
2. They became hydrolysed with the help of acid or enzyme.	2. They are resistance to hydrolysis because glucose moiety is absent.
3. With 5% $FeCl_3$ solution, it gives bluish black colour.	3. With 5% $FeCl_3$ solution, it gives brownish green colour.
4. With bromine water it do not form precipitate.	4. With bromine water it forms buff coloured precipitate.
5. Examples: Arjuna, Tannic acid, Amla, Myrobalan.	5. Examples: Ashoka, Black and Pale catechu.

2. **Write the bio-sources and medicinal uses of Benzoin and Clove.**

   Answer: Benzoin resin is a balsamic resin obtained from **the bark of several species of trees in the genus Styrax**. Famiy- Styrax.

   Benzoin benefits the skin in many ways. It is **antimicrobial, antiseptic, anti-inflammatory and astringent**. It accelerates the healing of wounds, ulcers

   clove, (Syzygium aromaticum), tropical evergreen tree of the **family Myrtaceae** and its small reddish brown flower buds used as a spice. Clove is **used as an antiseptic, stimulant, carminative, aromatic, and as a flavouring agent**. It is also used as anodyne, antiemetic. Dentists use clove oil as an oral anesthetic and to disinfect the root canal.

3. **Define tannin. Write chemical test of tannins.**

   Answer: Tannin is **a yellow or brown chemical that is found in plants such as tea**. It is used in the process of making leather and in dyeing.

4. **Write biological source and chemical constituents of Tea and Taxol.**

   Answer: Tea. It contains the prepared leaves and leaf buds of *Thea sinensis* (Linne) kuntz., belonging to family Theaceae. The leaves are a rich source of caffeine (1–5%). It also contains theobromine and theophylline in minor quantities. The colour of tea leaves is due to tannin (10–20% gallotannic acid).

   Taxol. It is obtained from the bark of the Pacific Yew tree, Taxus brevifolia Nutt belonging to the family Taxaceae.

5. **Bio-source of catechu and Asafoetida**.

   Answer: It is an oleo gum resin obtained from the roots of Ferula foetida Regel, F. Rubricaulis Boissier. **Family**:-. Umbelliferae.

   It is an aqueous extract prepared from the leaves and young shoots of Uncaria gambier Roxburgh. Family: Rubiaceae

6. **Write composition and therapeutic uses of gentian and benzoin.**

   Answer: Gentian is used for digestion problems such as loss of appetite, fullness, intestinal gas, diarrhea, gastritis, heartburn, and vomiting. People take benzoin by mouth for **swelling (inflammation) of the throat and breathing passages**. Some people apply it directly to the skin to kill germs, reduce swelling, and stop bleeding from small cuts.

   Benzoin is also used topically for skin ulcers, bedsores, and cracked skin.

7. Enlist various different species of senna.

Answer:

No.	Species	Voucher specimens
1	*Senna alata* (L.) Roxb.	Dhaka: Dhaka University campus, 23.12.2011, Ayesa 65 (DUSH)
2	*S. auriculata* (L.) Roxb.	Dhaka: Sher-e-Bangla Agricultural University compound, 26.1.2011, Ayesa 07 (DUSH)
3	*S. hirsuta* (L.) Irwin & Barneby	Gazipur: Gazipur, 30.6.2011, Ayesa 40 (DACB)
4	*S. obtusifolia* (L.) Irwin & Barneby	Cox's Bazar: Teknaf, Mouchuni, 24.4.2011, Ayesa 32 (DUSH)
5	*S. occidentalis* (L.) Link	Dhaka: Dhaka University campus, 26.12.2010, Ayesa 02 (DUSH)
6	*S. siamea* (Lam.) Irwin & Barneby	Dhaka: Tejgaon, Old Airport, 27.12.2011, Ayesa 74 (DUSH)
7	*S. sophera* (L.) Roxb.	Dhaka: Dhaka University Campus, 30.4.11, Aeysa 33 (DUSH)
8	*S. surattensis* (Burm. f.) Irwin & Barneby	Dhaka: Dhaka University campus, 20.12.2011, Ayesa 47 (DUSH)
9	*S. timoriensis* (DC.) Irwin & Barneby	Chittagong Hill Tracts: Ruma P.S., Changnakra, 25.1.1965, M. S. Khan 1166 (DACB).
10	*S. tora* (L.) Roxb.	Dhaka: Dhaka University Botanical garden, 26.12.2011, Ayesa 69 (DUSH)

8. Differentiate between cardenolides and bufadienolides.

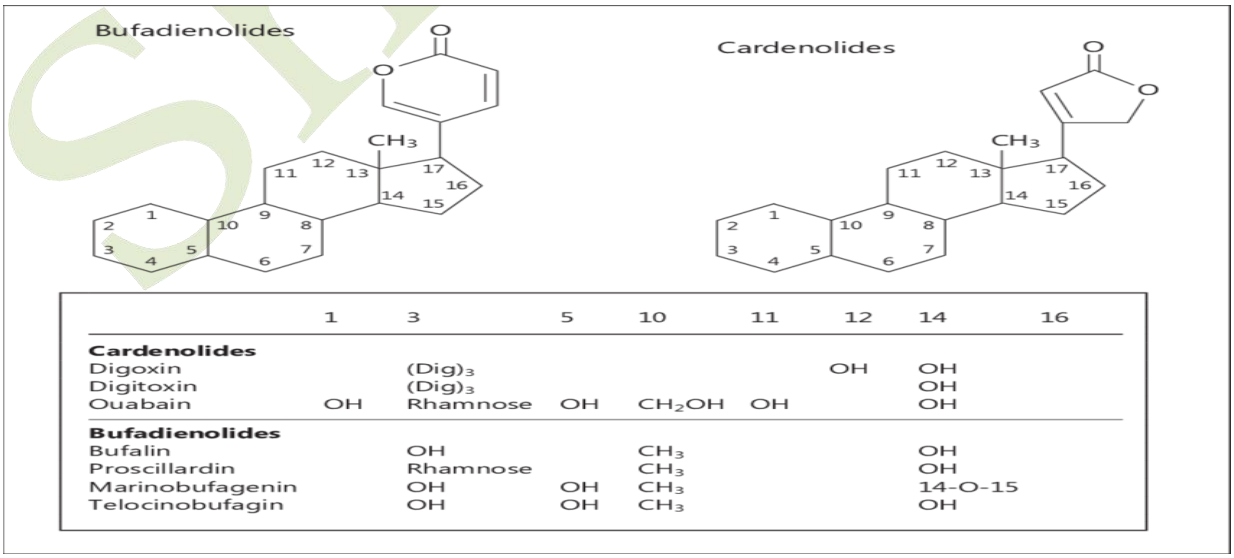
Answer: Cardenolides and bufadienolides constitute **an attractive class of biologically active steroid derivatives** which have been used for the treatment of heart disease in traditional remedies as well as in modern medicinal therapy.

Cardenolides:

They are C_{23} steroids that have a 17-β side chain and α, unsaturated β-membered lactone ring. **Example:**Digitalis, Quabain, Strophanthin, etc

Bufadienolide:

The bufadienolides are C_{24} homologues of the cardenolides and carry a doubly unsaturated 6-membered lactone ring at the 17-position. The bufadienolides derived their name from the genetic name for the toad, Bufo (the prototype compound bufalin was isolated from the skin of toads). **Example:** Squill, etc



	1	3	5	10	11	12	14	16
Cardenolides								
Digoxin		$(Dig)_3$				OH	OH	
Digitoxin		$(Dig)_3$					OH	
Ouabain	OH	Rhamnose	OH	CH_2OH	OH		OH	
Bufadienolides								
Bufalin		OH		CH_3			OH	
Proscillardin		Rhamnose		CH_3			OH	
Marinobufagenin		OH	OH	CH_3			14-O-15	
Telocinobufagin		OH	OH	CH_3			OH	

9. Give the Biological Source of Squill.

Answer: **Squill** consists of the dried slices of the bulb of white variety of **Urginea maritima** (Linn.) Baker, belonging to family **Liliaceae**.

10. Define pseudotannins.

Answer: Pseudo tannins are low molecular weight compounds associated with other compounds. They do not change color during the Goldbeater's skin test, unlike hydrolysable and condensed tannins, and cannot be used as tanning compounds. Some examples of pseudo tannins and their sources are:

Pseudo tannin	**Source(s)**
Gallic acid	Rhubarb
Flavan-3-ols (*Catechins*)	Tea, acacia, catechu, cocoa, guarana
Chlorogenic acid	Nux-vomica, coffee, mate
Ipecacuanhic acid	*Carapichea ipecacuanha*

11. Give the examples of Isoquinolenes and Imidazole alkaloids.

Answer: **Morphine and codeine** are the major and widely studied isoquinoline alkaloids. They are derived from tyrosine or phenylalanine. They are made from a predecessor of dopamine (3,4-dihydroxytryptamine) associated with a ketone or aldehyde.

Pilocarpine, the only naturally occurring imidazole alkaloid, is used in clinical medicines for the treatment of glaucoma. It is isolated from the leaves of Pilocarpus microphyllus.

12. How to differentiate C- glycosides from O- glycosides.

Answer: **O-glycosides** are formed by attaching sugar to hydroxyl oxygen. Example- : Hesperidin (aglycone: hesperetin, glycone: rutinose) Naringin (aglycone: naringenin, glycone: rutinose) Rutin (aglycone: quercetin, glycone: rutinose)While **C-glycosides** are sugar moieties combined directly to flavonoid backbone as C–C covalent bondsexample- Carminic acid, Aloin, Scoparin, Saponarin, and more recently Cucumerins (flavonoid phytoalexins) and C-glucosylxanthones and complex benzoquinone Altromycin B

13. What is cynogenetic glycoside?

Answer: the aglycone contains a cyanohydrin group. Plants that make cyanogenic glycosides store them in the vacuole, but, if the plant is attacked, they are released and become activated by enzymes in the cytoplasm. These remove the sugar part of the molecule, allowing the cyanohydrin structure to collapse and release toxic hydrogen cyanide. Storing them in inactive forms in the vacuole prevents them from damaging the plant under normal conditions.

UNIT-III

Short questions:

1. **Write down in detail about identification tests for Alkaloids.**

Answer:

Table 1: Qualitative identification of alkaloids.

Test	Reagent Composition	Positive Colour Change
Dragendorffs Reagent	Potassium bismuth iodide	Reddish-brown
Mayer's Reagent	Potassio mercuric iodide	White or pale yellow ppt
Hager's Reagent	Picric acid	Yellow
Wagner's Reagent	Solution of iodine in potassium iodide	Yellow or brown ppt.
Murexide Test (for Caffeine and Other Purine Derived Alkaloids)	Potassium chlorate + drops of HCl. Expose the resultant to NH_3	Purple colouration

Distribution of Alkaloids

2. **Chemical tests of Saponin glycosides.**

Answer:

(i) Haemolysis test : A drop of blood on slide + few drops of aq. saponin solution → appearance of ruptured red blood cells →the presence of sapnonin glycoside.

(ii) Foam test : 1 gm of sample drug + 10 to 20 ml of water →well shaked →generation of froths → the presence of saponins.

3. **What is Borntrager's test?**

Answer: Borntrager's test :

boil on waterbath and filter + extract of filterate with CCl_4 or benzene + equal amount of ammonia solution to filterate + shake → appearance of pink to red colour → indicate presence of anthraquinone moiety.

4. **Enlist general chemical tests for terpenoids.**

Answer: Salkowski test was used to detect terpenoids. Extract (5 ml) was mixed with chloroform (2 ml), and concentrated sulphuric acid (3 ml) was carefully added to form a layer. A reddish brown coloration of the inter face was formed to show positive results for the presence of terpenoids.

Liebermann – Burchard Test: 1ml of extract was treated with chloroform, acetic anhydride and few drops of H_2SO_4 was added and observed the formation of dark green color indicates of the presence of terpenoids.

5. **Write specific identification test for caffeine**

Answer: Murexide test: In this test the alkaloids are mixed with a tiny amount of potassium chlorate and a drop of hydrochloric acid. The sample is then evaporated to dryness and the resulting residue is exposed to ammonia vapour. Purine alkaloids produce a pink color in this test.

6. **Write a short note on chemical tests for resins.**

Answer: Solubility test: Resin dissolves when treated with organic solvents like alcohol, ether or chloroform etc.

Ignition test: They produces smoky flame upon burning.

HCl test: The drug is treated with hydrochloric acid which forms pink colour, ensuring the presence of resins.

Ferric chloride test: The greenish-blue colour develops when the drug is treated with ferric chloride solution. This indicates the presence of resins.

7. **Write a short note on chemical tests for Tanins.**

Answer: a. ***Goldbeater's skin test*:** Goldbeater's skin is a membrane produced from the intestine of Ox. It behaves just like untanned animal hide. A piece of goldbeaters skin previously soaked in 2% hydrochloric acid and washed with distilled water is placed in a solution of tannin for 5 minutes. It is then washed with distilled water and transferred to 1% ferrous sulphate solution. A change of the colour of the goldbeater's skin to brown or black indicates the presence of tannin.

Hydrolysable and condensed tannins both give the positive goldbeater's test, whereas pseudotannins show very little colour or negative test.

b. Phenazone Test: To 5 ml of aqueous solution of tannin containing drug, add 0.5 g of sodium acid phosphate. Warm the solution, cool, and filter. Add 2% phenazone solution to the filtrate. All tannins are precipitated as bulky, coloured precipitate.

c. **Gelatin Test**: To a 1% gelatine solution, add little 10% sodium chloride. If a 1% solution of tannin is added to the gelatine solution, tannins cause precipitation of gelatine from solution.

d. **Test for Catechin (Matchstick Test)**: Catechin test is the modification of the well-known phloroglucinol test for lignin. Matchstick contains lignin. Dip a matchstick in the dilute extract of the drug, dry, moisten it with concentrated hydrochloric acid, and warm it near a flame. Catechin in the presence of acid produces phloroglucinol which stains the lignified wood pink or red.

e. Test for chlorogenic acid: A dilute solution of chlorogenic acid containing extract, if treated with aqueous ammonia and exposed to air, slowly turns green indicating the presence of chlorogenic acid.

f. **Vanillin-hydrochloric acid test**: Drug shows pink or red colour with a mixture of vanillin: alcohol : dilute HCl in the ratio 1:10:10. The reaction produces phloroglucinol which along with vanillin gives pink or red colour.

8. **Write a note on gold-beater skin test.**

Answer: ***Goldbeater's skin test***: Goldbeater's skin is a membrane produced from the intestine of Ox. It behaves just like untanned animal hide. A piece of goldbeaters skin previously soaked in 2% hydrochloric acid and washed with distilled water is placed in a solution of tannin for 5 minutes. It is then washed with distilled water and transferred to 1% ferrous sulphate solution. A change of the colour of the goldbeater's skin to brown or black indicates the presence of tannin.

9. **Write chemical test used to identify Cardiac glycosides.**

Answer: Chemical tests for cardiac glycosides:

1. Raymond's test:

To the drug, add a few ml of 50% ethanol and 0.1 ml of 1 % solution of m- dinitrobenzene in ethanol. To this solution, add 2-3 drops of 20% sodium hydroxide solution. Violet colors appears, this is due to presence of active methylene group.

2. Legal test:

To the drug, add few ml of pyridine and 2drops of nitroprusside and a drop of 20% sodium hydroxide solution. A deep red colour is produced.

3. Killer killiani test:

Glycoside is dissolved in a mixture of 1 % ferric sulphate solution in (5%) glacial acetic acid. Add one or two drop of concentrated sulphuric acid. A blue colour develops due to the presence of deoxy sugar.

4. **Xanthydrol test:**

The crude is heated with 0.1 to 5% solution of Xanthydrol in glacial acetic acid containing 1% hydrochloric acid. A red colour is produced due to the presence of 2-deoxysugar.

5. **Baljet test:**

Take a piece of lamina or thick section of the leaf and add sodium picrate reagent. If glycoside is present yellow to orange colour will be seen.

6. **Kedde test:**

A solution of glycosides is treated with a small amount of Kedde reagent (Mix equal volumes of a 2% solution of 3, 5 dinitrobenzoic acid in menthol and a 7.5% aqueous solution of KOH). Development of a blue or violet colour that faded out in l to 2 hrs shows it presence of cardinoloids.

7. **Antimony trichloride test:**

To a solution of glycoside add a solution of antimony tri-chloride and tri-chloroacetic acid, and then heat the mixture. Appearance of blue or violet colour show presence of cardenolides and bufanolides

UNIT-IV

Short questions:

1. **Write a short note on estimation of sennosides.**

Answer: Estimation: Column- C18 8 Mobile phase- 1% acetic acid in water: Acetonitrile (82:18) Flow rate- 1ml/min Detection- 350 nm \

Utilization: 1. Treatment of constipation

2. In skin diseases

3. As an anthelmintic

4. Useful in loss of appetite, dysentry, indigestion, malaria, jaundice, gout, rheumatism & anaemia.

2. Enlist therapeutic and commercial applications of senna and vinca.

Answer:Therapeutic and commercial applications of senna

- Senna has purgative property.
- It helps to increase peristalsis movement which also causes reduction in water absorption.
- It has cathartic property.
- It is used to treat chronic constipation.
- It also has laxative property and senna is FDA- approved over –the- counter(OTC) laxative.
- It is used to treat irritable bowel syndrome (IBS) and anal or rectal surgery.
- It is used to treat hemorrhoids and weight loss.
- It is an effective laxative in the condition of pregnancy and lactation.

Therapeutic and commercial applications of vinca.

- It is used to treat lymphomas
- The Hodgkin's disease is treated by vinca because it contains vinblastin as a chemical constituent.
- Also it helps to treat non-Hodgkin's lymphomas .
- Acute lymphocytic leukemia is treated by the help of vincristine part of vinca herb.

UNIT-V

Short questions:

1. **Define chromatography with suitable example.**

Answer: **Chromatography** (Greek : Khromatos – Colour and graphos wtiting) a relatively new separation technique , was discovered by Dr.Michael Tswett (1906) in Warsaw for the separation of complex mixtures by the process of adsorption. a process in which a chemical mixture carried by a liquid or gas is separated into components as a result of differential distribution of the solutes as they flow around or over a stationary liquid or solid phase — affinity chromatography, column chromatography, electrochromatography, gas chromatography etc.

CLASSIFICATION OF CHROMATOGRAPHIC METHOD

Paper chromatography: substances are applied as a small♣ spot on filter paper dipped in an organic solvent. The mixtures are partitioned between paper(stationary phase) organic solvent (mobile phase).

Partition column chromatography: The column is packed♣ with a porous solid of high surface area The components of a mixture are separated by passing an organic solvent(mobile phase)through the column.

Ion exchange chromatography: Ionised compounds are♣ separated in aqueous solutions differences in affinity for ionised compounds

Thin layer chromatography: The adsorbent (stationary♣ phase) is spread over a glass plate in a thin film of even thickness. The solvent(mobile phase) moves up the plate by capillary action and thus affects separation .

HIGH PERFORMANCE LIQUIQ CHROMATOGRAPHY ALL forms of liquid chromatography (LC) are differential migration.LC covers a variety of separation techniques, such as liquid-solid, liquid-liquid, ion-exchange and exclusion chromatography. The technique of high pressure liquid chromatography or high speed liquid chromatography, later termed high performance chromatography (HPLC) attained greater significance in separation science. The technique of HPLC was developed by Csaba Horvath(1964) Kirkland and Huber in 1969. The first mixture to be separated Horvath group were nucleic acid components associated with thyroid function.

2. **Differentiate TLC and HPTLC.**

Answer:

PARAMETER	TLC	HPTLC
Technique	Manual	Instrumental
Efficiency	Less	High (Due to smaller particle size)
Layer	Lab Made/ Pre-Coated	Pre-coated
Mean particle size	10-12 um	5-6 um
Layer Thickness	250 um	100 um
Plate Height	30 um	12 um
Solid Support	Silica Gel, Alumina, Kiesulguhr	Silica Gel- Normal Phase C8 and C18- Reverse phase
Sample Spotting	Manual Spotting (Capillary/	Auto sampler (Syringe)

3. **Application of chromatography in the identification of the crude drugs.**

Answer: Applications of HPLC

In inorganic chemistry: (i)The chromatographic separation of anions can be effectively carried out by using ion pair chromatography (ii)For the separation of cations ,sulphonated inert polymer resins have been used.

In organic chemistry: (i) Separationof lipids:Lipids range from hydrocarbons and wax esters to highly polar sugar of phosphoric acid conataining glycol and phospholipids.The polar head group interact with a polar stationary phase

Pharmaceutical Applications♣ 1. To control drug stability. 2. Tablet dissolution study of pharmaceutical dosages form. 3. Pharmaceutical quality control.

Environmental Applications♣ 1. Detection of phenolic compounds in drinking water. 2. Bio-monitoring of pollutants.

Applications in Forensics♣ 1. Quantification of drugs in biological samples. 2. Identification of steroids in blood, urine etc. 3. Forensic analysis of textile dyes. 4. Determination of cocaine and other drugs of abuse in blood, urine etc.

Food and Flavour♣ 1. Measurement of Quality of soft drinks and water. 2. Sugar analysis in fruit juices. 3. Analysis of polycyclic compounds in vegetables. 4. Preservative analysis.

Applications in Clinical Tests♣ 1. Urine analysis, antibiotics analysis in blood. 2. Analysis of bilirubin, biliverdin in hepatic disorders. 3. Detection of endogenous Neuropeptides in extracellular fluid of brain etc.

4. Enlist various modern methods used for extraction.

Answer: Extraction is the first step to separate the desired natural products from the raw materials. Extraction methods include solvent extraction, distillation method, pressing and sublimation according to the extraction principle. Solvent extraction is the most widely used method.

The extraction of natural products progresses through the following stages:

(1) the solvent penetrates into the solid matrix;

(2) the solute dissolves in the solvents;

(3) the solute is diffused out of the solid matrix;

(4) the extracted solutes are collected.

Maceration

This is a very simple extraction method with the disadvantage of long extraction time and low extraction efficiency. It could be used for the extraction of thermolabile components.

Percolation

Percolation is more efficient than maceration because it is a continuous process in which the saturated solvent is constantly being replaced by fresh solvent.

Decoction

The extract from decoction contains a large amount of water-soluble impurities. Decoction cannot be used for the extraction of thermolabile or volatile components.

Reflux extraction

Reflux extraction is more efficient than percolation or maceration and requires less extraction time and solvent. It cannot be used for the extraction of thermolabile natural products.

Soxhlet extraction

The Soxhlet extraction method integrates the advantages of the reflux extraction and percolation, which utilizes the principle of reflux and siphoning to continuously extract the herb with fresh solvent. The Soxhlet extraction is an automatic continuous extraction method with high extraction efficiency that

requires less time and solvent consumption than maceration or percolation. The high temperature and long extraction time in the Soxhlet extraction will increase the possibilities of thermal degradation.

Pressurized liquid extraction (PLE)

Pressurized liquid extraction (PLE) has also been described as accelerated solvent extraction, enhanced solvent extraction, pressurized fluid extraction, accelerated fluid extraction, and high pressure solvent extraction by different research groups. PLE applies high pressure in extraction. High pressure keeps solvents in a liquid state above their boiling point resulting in a high solubility and high diffusion rate of lipid solutes in the solvent, and a high penetration of the solvent in the matrix. PLE dramatically decreased the consumption of extraction time and solvent and had better repeatability compared to other methods.

Supercritical fluid extraction (SFE)

Supercritical fluid extraction (SFE) uses supercritical fluid (SF) as the extraction solvent. SF has similar solubility to liquid and similar diffusivity to gas, and can dissolve a wide variety of natural products. Their solvating properties dramatically changed near their critical points due to small pressure and temperature changes. Supercritical carbon dioxide (S-CO_2) was widely used in SFE because of its attractive merits such as low critical temperature (31 °C), selectivity, inertness, low cost, non-toxicity, and capability to extract thermally labile compounds. The low polarity of S-CO_2 makes it ideal for the extraction of non-polar natural products such as lipid and volatile oil. A modifier may be added to S-CO_2 to enhance its solvating properties significantly.

Ultrasound assisted extraction (UAE)

Ultrasonic-assisted extraction (UAE), also called ultrasonic extraction or sonication, uses ultrasonic wave energy in the extraction. Ultrasound in the solvent producing cavitation accelerates the dissolution and diffusion of the solute as well as the heat transfer, which improves the extraction efficiency. The other advantage of UAE includes low solvent and energy consumption, and the reduction of extraction temperature and time. UAE is applicable for the extraction of thermolabile and unstable compounds. UAE is commonly employed in the extraction of many types of natural products

Microwave assisted extraction (MAE)

Microwaves generate heat by interacting with polar compounds such as water and some organic components in the plant matrix following the ionic conduction and dipole rotation mechanisms. The transfers of heat and mass are in the same direction in MAE, which generates a synergistic effect to accelerate extraction and improve extraction yield. The application of MAE provides many advantages, such as increasing the extract yield, decreasing the thermal degradation and selective heating of vegetal material. MAE is also regraded as a green technology because it reduces the usage of organic solvent. There are two types of MAE methods: solvent-free extraction (usually for volatile compounds) and solvent extraction (usually for non-volatile compounds)

Pulsed electric field (PEF) extraction

Pulsed electric field extraction significantly increases the extraction yield and decreased the extraction time because it can increase mass transfer during extraction by destroying membrane structures. The effectiveness of PEF treatment depends on several parameters including field strength, specific energy input, pulse number and treatment temperature. PEF extraction is a non-thermal method and minimizes the degradation of the thermolabile compounds.

Enzyme assisted extraction (EAE)

The structure of the cell membrane and cell wall, micelles formed by macromolecules such polysaccharides and protein, and the coagulation and denaturation of proteins at high temperatures during extraction are the main barriers to the extraction of natural products. The extraction efficiency will be enhanced by EAE due to the hydrolytic action of the enzymes on the components of the cell wall and membrane and the macromolecules inside the cell which facilitate the release of the natural product. Cellulose, α-amylase and pectinase are generally employed in EAE.

Hydro distillation and steam distillation

Hydro distillation (HD) and steam distillation (SD) are commonly used methods for the extraction of volatile oil. Some natural compounds encounter decomposition in HD and SD.