

**Extraction process**

**Pharmaceutics-I (Physical pharmacy)**



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# **EXTRACTION PROCESSES**

**INTRODUCTION & DEFINITIONS:**

Extraction is a process of separation or isolation of pharmaceutical active ingredients from plant or animal drugs with the help of suitable solvent.

or

Extraction may be defined as the removal of soluble constituents from a solid or liquid or semi-solid with means of suitable solvent.

Or

It may be defined as the treatment of the plant or animal tissues with appropriate solvent, which would dissolve the medicinally active constituents.

Or

Extraction is the method of removal of a soluble fraction in the form of a solution from an insoluble matrix with the help of a suitable solvent.

The soluble components may be present either as a solid or liquid.

Insoluble matrix may be in powder form, openly porous or nonporous or cellular with selective permeable cell walls as in case of vegetable.

**Example:** Boiling tea, Tannins, Theobromine, Caffeine

**DEFINITIONS**: Extraction involves the separation of medicinally active portions of plant or animal tissues from the inactive components through the use of selective solvents and standard extraction process.

**Menstrum:** Solvent used for extraction process. (E.g. water, alcohol, ether, acetone, ethyl acetate)

**Marc:** The inert fibrous and other insoluble materials remaining after extraction.

**Extractives**: Concentrated preparations of vegetable or animal drugs obtained by removal of the active constituents of the respective drug with suitable menstrum, evaporation of all or nearly all solvent.

**Tinctures:** are alcoholic or hydroalcoholic solutions prepared from vegetable material or from chemical substances. E.g. belladona tincture.

**Menstrum: Polar and non-polar**

**Polarmenstrum:**

It includes; water (Di-electric constant: 80), Methanol: 33,

Acetone: 21)

**Non-polarmenstrum:**

It includes; Chloroform (4.81), Hexane (1.88), Benzene (2.3), toluene (2.38), diethyl-ether (4.3), Solvents with a dielectric constant of less than 15 are generally considered to be non-polar.

**Fluid Extract:** are liquid preparations of vegetable drugs containing alcohol as a solvent or as preservative or both.

It made in such a way that 1ml of extract contains the therapeutic constituents of 1g of standard drug. E.g. Cascara sagrada Fluid extract.

**Expression:** is a method of fragrance extraction where raw materials are pressed, squeezed or compressed and the oils are collected.

**Galanicals**: the extract initially obtained by leaching the vegetable or animal tissue with the suitable solvent, is converted into concentrated and converted into a dry extract, a viscous extracts, liquid extracts. These crude extracts, when standardized, are known as galenicals.

**Some of the products that are obtained after extraction process may be summarized as:**

1. Extraction of fixed oils from seeds.
2. Preparation of alkaloid as strychnine from nux- vomica, quinine from chincona bark.
3. Isolation of enzymes as renin and hormones as insulin from animal sources.
4. Extraction of morphine from opium.
5. Reserpine from Rauwolfiaserpentina.
6. Gelatin that is used for making capsule shell is produced by conversion of skin and bone collagen by treatment with lime or dilute acid and is further extracted with warm water.

**IMPORTANCE OF EXTRACTION**:

* For Quantitative description of dug present.
* Potency of drug can be controlled in extract than in crude drug and can be used accordingly.
* More Stable form separation
* Deterioration by enzyme action is diminished due to separation from bulk.
* Enhanced organoleptic characteristic.
* More palatable, and more elegant.
* Easy formulation
* Tableting of crude material may not be possible.
* Preparation of the drug are more easily formulated, more stable, palatable and elegant after extraction.
* Different route of drug administration
* Injection of crude material may be undesirable and dangerous
* Storage and transport feasibility
* Extracts are less bulky and covers less space
* Smaller bulk facilitates storage and transport.

**CLASSIFICATION OF EXTRACTION**

1. **Solid-liquid:** extraction (leaching) The separation of soluble constituent from a solid by extraction with a solvent.

It consists of two stages

i. Contact of solute with the liquid phase

ii. Separation of the liquid phase from solid phase

1. **Liquid-liquid extraction:**

Liquid–liquid extraction, also known as solvent extraction and partitioning.

It is a method to separate compounds based on their relative solubilities in two different immiscible liquids, usually water and an organic solvent.

It is an extraction of a substance from one liquid phase into another liquid phase.

And it is a basic technique performed by using a separatory funnel.

Liquid-liquid extraction: Liquid-liquid extraction is a useful method to separate components (compounds) of a mixture RAFFINATE.

In Liquid-liquid extractiontechnique, a solvent (known as the “extractive solvent” ) is brought in contact with another solvent (termed as the “solute bearing solvent”) in order to bring about the transfer of one or more solutes into the first solvent. Separation of a substance from a mixture by preferentially dissolving that substance in a suitable solvent.

Liquid-liquid extraction for a given compound, solubility difference between solvents is quantified as Distribution Coefficient or partitioning coefficient.

**Distribution Ratio:** measure of how well a species is extracted. It is the ratio, K of the solubility of solute dissolved in the organic layer to the solubility of material dissolved in the aqueous layer. (Note that K is independent of the actual amounts of the two solvents mixed.)

K= distribution coefficient, K =solubility in organic (g/100 mL) solubility in water (g/100 ml) The constant K, is essentially the ratio of the concentrations of the solute in the two different solvents once the system reaches equilibrium. At equilibrium the molecules naturally distribute themselves in the solvent where they are more soluble. Inorganic and water soluble materials will stay in the water layer and more organic molecules will remain in the organic layer.Unless K is very large, not all of a solute will reside in the organic layer in a single extraction.

Usually two, three, or four extractions of the aqueous layer with an organic solvent are carried out in sequence in order to remove as much of the desired product from the aqueous layer as possible.

The greater the number of small extractions, the greater the quantity of solute removed. However for maximum efficiency the rule of thumb is to extract three times with 1/3 volume.

**Case 1**: Suppose a particular extraction proceeds with a distribution coefficient of 10. The system consists of 5.0g of organic compound dissolved in 100mL of water (solvent 1). In this illustration the compare the effectiveness of three 50mL extractions with diethyl ether (aka ether, solvent 2 ) and with one 150mL extraction with ether. Case one: Doing one extraction of 150 mL of ether. Case two: Doing three extractions of 50 mL of ether each time.

**Solvents used for extraction process**:

The ideal solvent for a certain pharmacologically active constituent should:

Be highly selective for the compound to be extracted.

Have a high capacity for extraction.

Not react with the extracted compound or with other compounds in the plant material.

Have a low price.

Be harmless to man and to the environment.

Be completely volatile.

**The generally used solvents includes:**  Water, ether, alcohol, chloroform.

**1-Water use as a menstruum:**

**Advantages of water as menstruum:**

• Readily available

• Cheapness

• Good solvent action for many plant constituents

• Used with other solvents

**Disadvantages of water as a solvent**

* Most active plant constituents are complex organic chemical which are less soluble in water. Plant constituents such as sugars, gums, starches, coloring agents, tannins are easily extracted by water, however are not desirable component sometimes and may interfere with clarity of the preparation.
* Aqueous preparations serve as excellent growth for molds, yeasts and bacteria. Preservatives should be added such as alcohol.
* Water causes hydrolysis of many substances.
* Maximum amount of heat is needed to concentrate the extraction than non-aqueous solvent.

2- Alcohol as a Solvents used for extraction process:

• Solvent of alkaloids, alkaloidal salts, glycosides, volatile oils and resins

• Also dissolves many forms of coloring matter, tannins, many organic acids and salts.

• Alcohol does not dissolve albuminous matter, gums, waxes, fats, fixed oils and sugars.

**Advantages:**

• No microbial contamination in alcohol solution containing 20% or more alcohol concentration. • A small amount of heat needed to concentrate the alcoholic preparations

• Non-toxic

• Dissolves selected active constituents of drugs

**Disadvantages:**

• Costly

• Flammable

**Acetone and chlorinated hydrocarbon:**

Solvents used for extraction process

* + Acetone and chlorinated hydrocarbons may also be used for leaching purpose.
  + More selective solvents used for extraction of alkaloid are petroleum ether and benzene.
  + Potassium hydroxide may be used to extract eugenol from clove.

**Theory of extraction**

**1-**Suitable size reduction

2. Penetration of drug by the solvent

3. Solution of the soluble matter within the cells

4. Escape of dissolved material through the cell walls and through the boundary layer surrounding the particles

5. Separation of the solution and exhausted drug

Size Reduction:

In order to achieve proper extraction maximum surface area of contact would be desirable. If the size of drug is reduced to individual cell size then it would be the best option. It is not feasible to reduce the size of material to cellular level as

• It may cause decomposition of constituents or may lead to loss of volatile materials.

• Very fine particles may not form good suspension as they wouldn’t sediment at the desired rate and particle size if reduced to cellular level be form sticky mass.

• Dilution of extracts may occur as breakage of cell may result in release of all cellular content

The appropriate degree of size reduction will comply with the following requirements

a). Increased surface area by distortion or breakage of cells which facilitates penetration of solvent and escape the soluble matter.

b). Decrease in radial distance will help in setting up the concentration gradient

**Disadvantages of size reduction**

a. Slow down the rate of percolation

b. Difficulty in the separation of the insoluble solid fraction after extraction

c. Poor quality of extract by extracting undesirable constituents due to breakage of cell wall which exposes other cellular materials to solvent action

**Degree of size reduction**; Depends upon botanical structure of drugs

• Sliced (for soft drugs like gentian)

• Coarse to Moderately coarse (for cascara, belladona)

• Moderately fine (for hard and woody drugs like ipecacuanha)

• Coarse powder for leafy structure

Appropriate degree of size reduction will result

* Cause some cells to be cracked or distorted
* Particle size that will not result in a very long path for solvent.
* Particle with large surface area for adequate mass transfer.

1. **Penetration of solvent into the drug**

A drug in dry state is porous due to shrinkage and pores contain air that must be displaced as the solvent enters into the pores and penetrates into the cells.

When drug is dried, micellae (cellulose in cell wall) loses its film of water.

When the drug is moistened the micellae take up a liquid film and tissue swell

Swelling continues until the pressure caused by liquid layer is equal to the cohesive forces between micellae.

Swelling may occur due to

a. Distension of cell wall

b. Bursting of thin walled cell

c. the solvent must displace air from pores in the drug.

**Solubilization of constituents**

When the solvent penetrates in the cells, dissolution of the constituents takes place and is governed by surface area, temperature, viscosity.

The most important factors which will increase the rate of extraction is elevation of temperature.

**Dissolution:**

Dissolution of a solid in a liquid involves transfer of molecules or ions (mass) from a solid state into solution.

**Escape of solution from the cells**

The dissolved material reaching the surface of the particle must pass through the boundary layer at the solid liquid interface.

The rate of diffusion will depend on the,

* Presence of suitable concentration gradient from the center of the particle, outwards and through the boundary layer
* Thickness of boundary layer
* Diffusion coefficient of the solute in the solvent

This theory suggests that the process of dissolution of solid particles in a liquid, in absence of reactive or chemical forces consist of two consecutive steps:

– Solution of the solid due to interfacial reaction to form a thin film at the solid/liquid interface called a stagnant film or diffusion layer which is saturated with the drug (Cs)

– Diffusion of the soluble solute from the stagnant layer to the bulk of the solution (Cb)

**Noyes’s Whitney equation**

• The dissolution of drugs from a single spherical particle can be described by the Noyes’s-Whitney equation which explains the rate of dissolution when the process is diffusion controlled and involves no chemical reaction.

• “The rate of mass transfer of solute molecules or ions through a static diffusion layer is directly proportional to the area available for molecular/ionic migration and concentration difference across the boundary layer and is inversely proportional to the thickness of the boundary layer”

Given as, dC/dt= DA (Cs-Cb)/h

Where, dC/dt = is the dissolution rate D = diffusion coefficient of the solute in solution S = surface area of the exposed solid h = thickness of the diffusion layer Cs = Concentration of solute particle at the boundary layer Cb = concentration of the solute in the bulk solution

**Influence of some parameter on dissolution rate of drug**

• Diffusion coefficient (D):Greater the value, faster the dissolution. Diffusion decreases as the viscosity of dissolution medium increases.

• Surface area of solid drug (A): Greater the surface area, faster the dissolution; can be increased by micronization of drug.

• Concentration gradient (Cs – Cb): Greater the concentration gradient, faster the diffusion and drug dissolution: Can be increased by increasing drug solubility and the volume of dissolution medium. • Thickness of stagnant layer (h): More the thickness, lesser the diffusion and drug dissolution; can be decreased by increasing agitation.

**Factor influencing Extraction:**

The rate of extraction can be affected in the following ways:

I. Where drug immersed in a solvent

a. By agitating the mixture occasionally, local concentration of the solution is dispersed increasing the concentration gradient.

b. By agitating the drug and solvent continuously increases the concentration gradient by dispersion of local concentration as well as reduces the thickness of the boundary layer.

c. By suspending the drug in a cloth or above a perforated plate near the surface of the liquid. As the drug dissolves, the density of the solution increases leading to the convection of the solution, increasing the concentration gradient through the boundary layers

If the drug is positioned so that the solvent flows past the particles

a. The flow replaces the solution by pure solvent causing the increase in the concentration gradient

b. Flow of the solvent between the particles reduces the boundary layer increasing the concentration gradient. This can be achieved by suspending drug in a cloth bag or above a perforated plate.

Elevated temperature’s advantages

a. Solubility of most of the material is higher at higher temperature.

b. Viscosity of the solvent gets reduced decreasing boundary layer thickness

c. Diffusion coefficient is proportional to the absolute temperature and inversely proportional to the viscosity, so raising the temperature influences the rate of diffusion considerably.

d. By setting convection current

**5-Separation of solution and exhausted drug**:

* + In the process of immersion of drug in a bulk of solvent, the solid material has to be strained off, as the drug absorbs solvent there is a residue of soluble constituents in this solvent.
  + In this case the drug is subjected to pressure to expel as much of the solution as possible.
  + Even though the extraction process uses solvent flowing through the drug, separation of solution is essential.

**Processes Used For Extraction**

* Simple Percolation
* Maceration With Adjustment
* Simple Maceration
* Multiple Maceration
* Percolation Process For Concentrated Preparations
* Continious Percolation Process
* Reserve Percolation Process
* Modified Percolation Process

**LARGE SCALE EXTRACTION PROCESS**:

* INFUSION
* DECOCTION
* MACERATION
* PERCOLATION
* DIGESTION
* CONCENTRATED INFUSION
* FRESH INFUSION

**Drug: Menstrum ratio = 1: 10**

**INFUSION**:

Infusion is the process of extracting chemical compounds or flavors from plant material in a solvent such as water, oil or alcohol, by allowing the material to remain suspended in the solvent over time (a process often called steeping).

An infusion is also the name for the resultant liquid.

Infusions are dilute solutions containing the readily-soluble constituents of crude drugs.

**Fresh infusions**: prepared by macerating the drug for a short period in cold water or boiling water were used.

Now, fresh infusions are usually prepared by diluting one volume of a concentrated infusion to ten volumes with water.

**Concentrated infusions:** are prepared by modified percolation or maceration process.

Fresh infusions are liable to fungus and bacterial growth, and it is necessary to dispense them within twelve hours of their preparation.

**Purpose:**It is used for those drugs which are soft in nature so that water may penetrate easily to the tissues and the active constituents are water soluble.

**Procedure used**: It involves pouring water over drugs and allowing it to keep in contact with water for the stated period, usually 15 minutes, with occasional stirring and finally filtering off the liquid. Marc is not pressed. Boiling water commonly used as solvent, After the specified time the liquid is filtered and dispense as drug. Short time is sufficient for extraction due to readily soluble constituent of crude drug and its constituents.

**DECOCTION:**This is another process of extraction in which the water soluble and heat stable constituents of hard and woody crude drugs are extracted out.

**Purpose:**For extraction of drugs with water soluble and non- volatile constituents, and drugs of hard and woody nature.

**Procedure**: Water is used as a solvent and the crude drug which is to be extracted is cut in to small pieces and boiled with water for the stated time, usually 10 to 15 minutes. Previously sliced drug barks or wood (5 parts) is boiled with water (100 or 120 parts) in a vessel of enameled iron or earthenware for a definite length of time (15 min.) counting from when the liquid starts to boil with occasional stirring.

To obtain highly concentrated decoction, boiling is continued until the liquid reduced to a certain volume. Allow to cool to about 40ºC, press the marc and mix the resulting liquid to the decoction. At the end of decoction time, decoction is strained through fine muslin. Then, sufficient water is passed through the strainer to produce a definite volume.

**Example:** Cinchona bark or wood (contains quinine)

**Uses:** treatment of fever, malaria and as an appetite Stimulant. Also used in anemia, indigestion, gastrointestinal disorders, general fatigue.

• Tea making is an example of decoction.

**Comparison between infusion and decoction Item**

**Infusion Decoction**

1- Plant Soft structure (ex. Senna leaves). 1-Hard woody structure (ex. Cinchona bark).

2- Menstrum Boiling or cold water. 2- Boiling water.

3-Procedure infusing the drug with cold

or hot water. 3- Boiling the drug with water.

4-Time calculated as soon as water is

added to drug. 4-Time scalculated as soon as the water begins

to boil.

5- Adjustment of final volume 5- No adjustment is necessary

6- Apparatus Infusion earthenware pot 6- Any covered apparatus

7- Storage used fresh within 12 hours 7-Used fresh and when stored in refrigerator

Used within few days 47

**DIGESTION:**

Digestion is the process in which heat as well as pressure is used for extraction.

**Purpose and process:**The equipment is like a pressure cooker or autoclave and is called digester. Extraction of non-thermolabile materials is more efficient in it because of high penetration power of solvent and solubilisation rate of soluble matters of the crude drug due to high pressure and temperature respectively.

**MACERATION:** Various types of maceration process are

1. Simple Maceration: A process for tinctures made from organized drug e.g. roots, stems, leaves etc.
2. Maceration with Adjustment: A process for tinctures made from unorganized drugs such as oleo resins and gum resins.
3. Double Maceration and Triple Maceration Process: for concentrated preparations.

Plant material (crushed or cut small or moderately coarse powder) Placed in a closed vessels Menstruum added (whole)Allowed to stand for 7 days shaking occasionally Liquid strained off Solid residue (marc)pressed (recover as much as occluded) (Strained and expressed liquids mixed) Clarified by subsidence and filtration Evaporation and concentration

**SIMPLE MACERATION:**

• Drug is placed in wide mouthed container which can be well stoppered to prevent the evaporation of menstruum which is mostly concentrated alcohol.

• The drug is placed with the whole of the menstruum in a closed vessel for 7 days

• During this period shaking is done occasionally

• After 7 days liquid is strained and marc is pressed – in filter press, hydraulic press or hand press, squeezed in muslin piece etc.

• Then filtered to make a clear liquid.

• The final volume is not adjusted.

• E.g. tincture of orange, tincture of lemon

**MACERATION WITH ADJUSTMENT**

* The unorganized drug is placed with 4/5th of menstruum in a closed vessel in a closed vessel for a period of 2-7 days
* Shaking done occasionally
* After the stated period, the liquid is filtered and the final volume is made up by passing the remaining 1/5th of the menstruum through the filter
* The marc is not pressed
* E.g. tincture of tolu, compound tincture of benzoin

**Maceration for organized and unorganized drug**

Organized: Put total menstrum, marc is pressed, vol not adjusted

Unorganized: 4/5 th of the menstrum, marc-not pressed, vol. adjusted

**MULTIPLE MACERATION**:

It is established that the maximum extraction is obtained in multiple maceration when the total quantity of menstruum to be used is divided in such a way that same quantity of menstruum is present during each maceration.

Sometime this single process of extraction is not sufficient, then double or triple maceration is also done, in which the above whole process is repeated to make the extraction process more effective. We do not have to change the process just we have to repeat it for specified times (2-4) times, all other things is same.

**DOUBLE MACERATION**: The drug is macerated twice with the menstruum which is divided into two equal volume. Where V1 is volume of menstruum required for first maceration, Vt is total volume of menstruum.Vr is volume of menstruum to be retained by drug or marc.Volume required for 2nd maceration is the difference between Vt and V1. Vr is determined by performing trial to get volume retained by known weight of drug

The whole of the drug is macerated for 48 hours with the quantity of menstruum required for first maceration.

Strain the liquid and press the marc. Macerate again for 24 hours with the remaining menstruum required for second maceration Strain the liquid and press the marc. Mix the liquids obtained from two macerations and allow it to stand for 14 days and filter. E.g. concentrated compound infusion of Chirata, concentrated compound infusion of Gentian.

**TRIPLE MACERATION**: In this process, the drug is macerated thrice by using menstruum which is divided into 3 parts in such a manner that same volume is used for each maceration. Volume of menstruum required by the first maceration= total vol. of menstruum – vol. to be retained by the drug + Vol. to be retained by drug 3. Volume of menstruum required by the second maceration= Total volume of menstruum - vol. of menstruum used in first maceration 2.

The whole of the drug is macerated for 1 hr with a part of menstruum required for first maceration and strained. Macerate again for 1 hr with a part of menstruum required for 2nd maceration and strained. Macerate again for 1 hr with a part of menstruum required for 3rd maceration and strained. Press marc lightly then combine the liquid obtained from 2nd and 3rd maceration and evaporate it to a specific extent

Mix it with the liquid obtained from 1st maceration. Add alcohol 90% equal to 1/4th of the volume of the finished product .Adjust volume with water. Allow to stand for 14 days and filter e.g. concentrated infusion of Quassia, liquid, extract of Senna

**PERCOLATION**

1. Simple percolation or percolation process for tinctures.

2. Percolation processes for concentrated preparations such as:

i. Reserve percolation process

ii. Modified percolation process

3. Continuous hot percolation or Soxhelation PERCOLATION – APPARATUS • Conical percolator • Cylindrical percolator • Steam jacketed percolator

**SIMPLE PERCOLATION**: There are three stages in the official method for preparation of tinctures by percolation process.

1. **Imbibition:** powdered drug is moistened with a sufficient quantity of menstruum and allowed to stand for 4 hours in a closed vessel. It is done inorder to allow swelling of the tissues before packing into the percolator. Dry powder if packed into percolator may cause blockage of the percolator. It allows entrapped air to escape, dry powder drug would have air entrapped within them, and this may resist the flow of menstrumm and will disturb the packing of the powdered drug.

Prior to packing of the imbibed drug into percolator uniformity of particle size is ensured by passing the moistened mass through a sieve of coarse aperture. Glass wool moistened with solvent is kept at the bottom to avoid blockage of outlet or tap. Cotton wool may not be used as after getting soaked it would also create a impermeable mass. The imbibed drug is packed in the percolator upto 2/3rd or 3/4th of the volume of percolator. Filter paper is placed above this layer and above this a layer of sand is placed inorder to prevent disturbance of top layer when the menstrumm is added into the percolator. Sufficient quantity of menstruum needs to be added to saturate the material. When the liquid starts coming out of the percolator outlet is closed and add menstrumm forming a layer of solvent above the imbibed mass.

1. **Maceration:** The moistened drug is left in contact with menstruum for 24 hrs. During this period, menstruum dissolves the active constituent of the drug and becomes almost saturated with it.
2. **Percolation:**It consists of the downward displacement of the saturated solution formed in maceration and extraction of the remaining active constituents present in the drug by the slow passage of the menstruum through the column of the drug.

**SIMPLE PERCOLATION:**After collecting 3/4th of the required volume of the finished product or when the drug is completely exhausted, the marc is pressed. Mix the expressed liquid with percolate. Add sufficient quantity of menstruum to produce the required volume and then filter. E.g. tincture of belladona, compound tincture of cardamom, strong tincture of ginger.

**PERCOLATION PROCESS FOR CONCENTRATED PREPARATIONS**:

Used to prepare liquid extracts and solid extracts.

Types of processes are:

Reserve percolation process

Modified percolation process

**Reserved Percolation Process:** In this process, a part of percolate, usually 3/4th of the volume of the finished preparation, is reserved (first percolate) containing high solute concentration. • Percolation process is continued till the drug is completely exhausted. • The percolate thus receives contains traces of active constituents of the drug. • Evaporation or distillation is done to recover the costly menstruum. • Hence, the major portion of the active constituents of the drug are saved from detorioration. • The remaining soft extract is then added to reserve percolate. • Volume make up is done using menstruum.

**MODIFIED PERCOLATION PROCESS**: In percolation process, the drug/percolate (d/p) ratio is about 1:4, the d/p ratio is reduced to 1:3 by modifying the percolation process and hence there is a lot of saving in heat, time and menstruum. • Percolation is the displacement process. • The strong solution of active constituents of drug formed during maceration is displaced by the fresh menstruum when percolation process is started. • Menstruum remaining in contact with the drug dissolves more matter than the flowing menstrum.

**MODIFIED PERCOLATION PROCESS:**

Hence, more menstruum is required to exhaust the drug when simple percolation process is used.

In simple percolation process: Drug Imbitition, Maceration, percolation and collect the percolate, i.e. ¾ of the volume of the finished product.

In modified percolation process: Drug-imbibition-maceration-percolation and collect 1000ml of percolate (24hr) -maceration-percolation and collect 1000ml of percolate (12hr) -maceration –percolation and collect 1000ml of percolate (12hr) Drug:percolate 1000gm:3000ml d/p=1:3

After exhaustion of the drug, the percolate is evaporated and then mixed with the main percolate. The final volume is made by adding more of menstruum.

**Continuous hot percolation process or soxhlet extraction or soxhleation** : When active constituents of the drug are not freely soluble in the solvent or difficult to be displaced from the cells of the drug, then it becomes necessary to extract the crude drug by action of hot menstruum for a considerable length of time. The fixed oils from seeds and alkaloids from the drug are extracted by continuous hot percolation process using benzene, chloroform, petroleum, ether etc.

Soxhlet apparatus:it consist of

1.Flask containing the boiling water

2. Soxhlet Extractor: in which the drug to be extracted is packed. It has a side tube which carries the vapors of the solvent from the flask to the condenser and a siphon tube which siphons over the extract from soxhlet extractor to the flask. A condenser in which the vapors of the solvent are condensed again into solvent.

**PROCEDURE:** The drug is packed in a paper cylinder made from a filter paper and it is placed in the body of soxhlet extractor. The solvent is placed in the flask. The apparatus is then fitted as shown is figure. When solvent is boiled on heating flask, it gets converted into vapors. These vapors enter into the condenser through the side tube and get condensed into hot liquid which falls on column of the drug. When the extractor gets filled with the solvent, the level of siphon tube also raises up to its top.

**Soxhlation**: The solvent containing active constituents in the siphon tube siphon over and run into the flask, thus emptying the body of extractor.This alteration of filling and emptying the body of extractor goes on continuously until the drug is exhausted (normally 15 times). The soluble active constituent of the drug remain in the flask where solvent is repeatedly volatilized.

**Factors affecting the choice of extraction process**.

1. **Character of drug**

Knowledge of pharmacognosy – maceration process if drug is soft, percolation process used when drug is hard and tough

2. **Therapeutic value of the drug:**

When the drug has high therapeutic value, maximum extraction is required, so percolation process is used e.g. Belladona.

3. **Cost of drug** • costly drugs are extracted by percolation process, whereas cheap drugs are extracted by maceration process.

4. **Stability of drug:** Thermolabile drugs-maceration or percolation should be done. No hot extraction process should be carried out.

5. **Solvent**: Maceration process recommended-if water is used as solvent. Percolation process-nonaqueous solvents.

6**. Concentration of product:** The dilute products such as tinctures can be made by using maceration or percolation process, depending on other factors.

For semi-concentrated preparations, such as concentrated infusions, double or triple maceration process can be used. The liquid extracts or dry extracts or dry extracts which are concentrated preparations are prepared by using percolation process.

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