EMULSIONS

VARUN.D

PURPOSES OF EMULSIONS

- ✓Increased drug solubility
- ✓Increased drug stability
- ✓Prolonged drug action
- ✓Improved taste
- ✓Improved appearance.

PHASES OF EMULSIONS

- Two Phase systems
  - Liquid droplet – Dipersed / Internal / Discontinous.
  - Other Liquid – Dispersion medium / External Phase / Continous Phase.
- One Phase is usually an aqueous solution, other phase is usually lipid or oily.

- Lipid ranges from vegetable or hydrocarbon oils to semisolid hydrocarbon & waxes.

  - W / O
  - O/ W
  - W /O /W
  - O/W / O

- The type of emulsion formed is primarily determined by the relative phase volumes and the emulsifying agent used.

- For an ideal emulsion, the maximum conc. of internal phase is 74% (O/W emulsion can be prepared containing ≤74% Oil).

EMULSIFYING AGENTS

- Any compound that lowers the interfacial tension and forms a film at the interface can potentially function as an emulsifying agent.

- The effectiveness of emulsifying agent depends on its chemical structure, concentration, solution pH, physical properties and electrostatic effect.

- True emulsifying agents (Primary agents) can form and stabilize emulsions by themselves.

- Stabilizers (Auxillary agents) do not form acceptable emulsions alone, but assists primary agents in stabilizing the product (for ex: increasing viscosity)

- Emulsifying agents are either natural or synthetic.

NATURAL EMULSIFYING AGENTS

ACACIA

✓Forms a good stable emulsion of low viscosity.

✓Tends to cream easily

✓Acidic.

✓Stable @ pH 2 – 10.

✓Like other gums it is negatively charged…….dehydrates easily…..requires preservative.

✓Incompatible with Peruviam balsm, Bismuth salts & Carbonates.

TRAGACANTH

- Forms a stable emulsion that is coarser than Acacia emulsion.

- It is anionic & difficult to hydrate.

- Less than $1/10^{th}$ of the amount used for Acacia is needed.

AGAR

✓Anionic gum that is primarily used to increase the viscosity.

✓Stability is affected by heating, dehydration and destruction to charge.

✓Susceptible to microbial degradation.

PECTIN

✓It is a quasi emulsifier that is used in the same proportion as Tragacanth.

GELATIN

- It provides good emulsion stabilization at a conc. of 0.5 – 1.0 %.

- May be anionic or cationic, depending on its Isoelectric point.

- Type A gelatin (+) prepared by acid treated precursor…used in acidic media.

- Type B gelatin (-) prepared by alkali treated precursor…used in basic media.

METHYL CELLULOSE (Celacol)

- It is anionic and induces emulgent action by increasing viscosity.
- Primary emulsifier with mineral oil and cod liver oil.
- Yields an O/W emulsion.
- Used @ 2% conc.
- (Hydroxy Ethyl Cellulose – Natrosol 250)

CARBOXY METHYL CELLULOSE

- It is anionic and is used as emulgent to increase viscosity.
- Tolerates alcohol upto 40%.
- Precipitates in presence of free acids.
- (SCMC – Edifas, Cellosize)

SYSNTHETIC EMULSIFYING AGENTS

✓These are anionic, cationic or non ionic.

✓These surfactants are amphiphilic molecules.

✓Some are lipophilic, where as some are predominantly hydrophilic.

✓Imbalance in hydrophilicity and lipophilicity is reflected in HLB scale.

✓Larger the HLB value…more the hydrophilic nature.

HLB RANGE	SURFACTANT APPLICATION
0 - 3	Antifoaming agents
4 - 6	W/O Emulsifying agents
7 - 9	Wetting agents
8 - 18	O/W Emulsifying agents
13 - 15	Detergents
10 - 18	Solubilizing agents

Anionic Synthetic agents include….

- ✓Sulfuric acid esters (Ex: SLS)

- ✓Sulfonic acid derivatives
(Ex: Dioctyl sodium sulfosuccinate)

- ✓Soaps

SOAPS

- Soaps are for external use..
- They have high pH and are therefore sensitive to the addition of acids and electrolytes.
  - ✓Alkali soaps are hydrophilic ~O/W emulsion.
  - ✓Metallic soaps are water insoluble ~W/O emulsion.
  - ✓Monovalent soaps ~O/W emulsion..
  - ✓Polyvalent soaps ~W/O emulsion.

CATIONIC SYNTHETIC AGENTS

- ✓Ex: Benzalkonium chloride.
- ✓Used as surface active agent in 1% conc.
- ✓They are incompatible with soaps.

NONIONIC SYNTHETIC AGENTS

- These are resistant to the addition of acids and electrolytes.

✓SORBITAN esters known as SPANS are hydrophobic in nature and forms W/O emulsion.

- They have low HLB values (1-9)

✓POLYSORBATES known as TWEENS are hydrophilic in nature and forms O/W emulsion.

- They may form complexes with phenolic compounds.
- They have high HLB values (11-20)

INSTABILITY IN EMULSIONS

- A stable emulsion is one in which the globules…
  - Retain their initial character
    (mean size & size distribution)
  - Remain uniformly distributed throughout the continuous phase.
- Two common deviations from this ideal behavior are….
  - ✓Cracking
  - ✓Creaming
  - ✓Phase Inversion

Examples of Cracking Phenomenon…….

1. Addition of Emulsifying agent of opposite type.

- Soaps of monovalent metals produce O/W emulsiuon ….. soaps of divalent metals produce W/O emulsion.

  - Addition of monovalent soap to divalent soap emulsion or a divalent soap to monovalent emulsion tends to instability…Cracking.

- Anionic & Cationic emulsifying agents are mutually incompatible.

2. Decomposition or Precipitation of Emulsifying agents

- Alkali soaps are decomposed by acids….fatty acid is liberated and the alkali salt of the added acid is produced….which has no emulsifying power.
  - Acid causes cracking of soft soap emulsions such as Turpentine Liniment.

- Sodium soaps are salted out by NaCl & other electrolytes….. addition of sufficient electrolyte to sodium soap emulsion precipitates emulsifying agent and causes cracking.
  - Similarly with Potassium soap emulsions.

- Anionic emulsifying agents are incompatible with substances with large cations and cationic emulsifying agents are incompatible with large anions.

- Nonionic emulsifying agents are incompatible with Phenol.

- Gums and proteins like gelatin, casein are insoluble in alcohol…. If so, precipitated and cracking ensures.

3. Addition of Common Solvent

- Addition of liquid in which both disperse and continuous phases are soluble forms a one phase system and destroys the emulsion.

  - Ex: Turpentine / Castor Oil, soft soap & water are soluble and miscible with alcohol….addition of sufficient alcohol to an emulsion of these substances produces a clear solution.

4. Microbial Action

- Emulsions not intended for immediate use should contain a preservative to prevent growth of moulds & bacteria that might destroy the emulsifying agent and causes cracking.

5. Incorporation of Excess Disperse Phase

- If a given space is filled with closely packed small spheres of uniform diameter, they will occupy only 74% of the volume irrespective of their size.

- Emulsions with dispersed phase conc. (Phase volume ratio) in excess of 74% ~~~ they tend to crack immediately.

CREAMING

- Layer of cream forms on surface of milk, which contain much of disperse phase (Fat)than the original milk.

- Creaming may be defined as formation of layer of relatively concentrated emulsion.

- Creamed emulsion may be made homogeneous again by shaking….Creaming is less serious than cracking.

- Large droplets cream more rapidly and coalesce more rapidly in the cream layer and the emulsion eventually cracks.

- The cream will be at the top of the emulsion only if the density of the dispersed phase is lower than that of continuous phase.

- Most oils have a wt/ml of less than 1, oil globules will rise in an O/W emulsion and water globules will sink (giving a cream at the bottom) in an W/O emulsion.

Creaming can be minimized by…..

1) Reducing the mean size and the size distribution of globules….since small globules cream less rapidly …… which is achieved by Homogenizer.

- The size of globules in an emulsion vary from 1µm to 30 µm or more in diameter.

✓By Hand / mechanical mixer – I to 50 µm.

✓By Homogenizer – t to 3 µm.

2) Increasing the viscosity of continuous phase to retard the movement of globules.

- Syrup & Glycerin increase the viscosity and increases the difference in density between continuous and disperse phase.

- Tragacanth, Sod. Alginate & MC increases the viscosity without affecting the density and suitable for O/E emulsions.

- Soft Paraffin – W/O emulsion..

3) Storage in cool place … decrease in temperate… increase viscosity of continuous phase and the no. of collisions between the globules decreases.

✓Freezing of aqueous phase may be avoided since ice may separate and exert pressure on globules…. result in cracking.

PHASE INVERSION

- Emulsion type is determined by solubility of emulsifying agent, if it is more soluble in water than in oil….the former will be continuous phase and vice versa.

- Addition of more substance that alters the solubility of emulsifying agent may cause reversal of the phase.
  - Ex: Bees wax yield W/O emulsion and the addition of soap causes inversion.

- Most stable range of dispersing agents is 30 – 60%.....incorporation of higher conc. leads to phase inversion.

THANK YOU