© IJCIRAS | ISSN (O) - 2581-5334
May 2019 | Vol. 1 Issue. 12

LIQUID CRYSTALS: A REVIEW

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Abstract

Liquid crystals also called as mesophase they are the substances that flow like liquids but maintain specific of the well-ordered arrangement characteristics of crystalline solids. Made by the two ways that is , classified into two types 1) Thermotropic LCs and another is 2) Lyotropic LCs The Thermotropic is created by temperature difference in the liquid state, while the Lyotropic LCs is made by liquefying the compound in several solvents. Also its deals the systems adequate vast amplitude molecular movement so that molecules can be change sites of molecules and reorient self forming LC phases. The thermotropic LCs are generally single-compound systems, whereas lyotropic LCs are always solutions containing multiple compounds having solute and solvent. Main aim of this review article is to focus on Pharmaceutical Liquid crystals (LCs) as per its need, Objectives, applications, and its advantages over the other dosage forms, also it is importance in recent advance in novel system. Objective of this review article is also to deliver in detail information of pharmaceutical LCs technology which include its latest & advanced in method development of liquid crystals

Keyword: LCs -Liquid crystals Liquid crystals - Mesophase, Cubosomes

1.INTRODUCTION

Liquid crystals was been revealed in starting for cholesterol found in incentives by F. Reinitzer. More than 100 years after, examination of biological LC materials is still interest. However, the focus has shifted from the study of common LC features to more refined subjects such as their impact on molecular organization relevant for biological processes. Living cells carry liquid crystalline environments(1). In 1888 year the finding of a mid liquid crystalline state, is recognized by Friedrich Reinitzer, throughout the experiments on a cholesterol based matter trying to figure out the correct formula and molecular weight of cholesterol, he was hit by the fact that this matter appeared to have two melting points. Solid crystal molten into a hazy liquid at 145.5°C which existed until 178.5 °C where the muddiness unexpectedly gone, giving way to a clear transparent liquid. The liquid crystals called as mesophase inter mediate between the crystalline solid state and the amorphous liquid state. (2,3)**.** Liquid Crystals nano carriers are intermediary state between the solid and liquid state. It is mostly named a mesomorphic state. (4) from reverse cubic phase colloidal particles are interior aqueous zones also afford certain benefits in technical applications compared by means of droplets of general oil-in-water emulsions (o/w).(5) These surroundings one the one hand carry out a definite molecular organization on other solvated molecules and accumulations. The liquid crystal is substance that which is thermodynamically situated in in the middle of the isotropic liquid and the crystalline phase. They show flow properties like a liquid and at the same time partly hold the order of a crystal.(6) Liquid crystal can be deliberated a quarter state of matter following solid, liquid, and gas. Liquid-crystal phases, as their name suggests, be existent between the predictable crystal phase and the liquid phase. Typically, liquid-crystal molecules keep rod like structure or disc like anisotropic structures. The distinctive characteristic of liquid crystals is the propensity of the molecules to support themselves with long-range direction (7)

The liquid crystals can flow like a liquids, but the molecules in the liquid are organized and/or in favor of in a crystal-like manner. In these two generic classes of liquid crystals: which are changes are driven by thermal processes, called as thermotropic liquid crystals &

lyotropics system are strongly influenced by solvents and many thermotropic liquid crystals exhibit a diversity of stages as the temperature of syatem is altered. For example, a specific type of LC particle may exhibit numerous smectic and nematic phases as the temperature is increased.

Thermotropic liquid crystal materials have specific molecular structure, which composes of two parts, namely referred the center core and side chain. Here is core part is a rigid body which carries shape anisotropy to the molecule, and the side chain part is a flexible region which provides mobility. (8)

Therefore, they keep anisotropic physical nature for example their elastic behavior, dielectric constant, refractive index, or viscosity, just to name a rare. But while being partly ordered, LCs also show flow properties like a liquid; they are accordingly anisotropic fluids. The liquid crystalline state can be carried about through two basically dissimilar ways, leading to the two basic classes of LC, thermo tropic phases & lyotropic. Cubosomes are nanoparticles having size ranges from 10-500nm in diameter phases (9)

2.CLASSIFICATION OF LIQUID CRYSTALS

The liquid crystals are categorized in two main categories i.e.

2.1. thermo tropic and lyotropic.

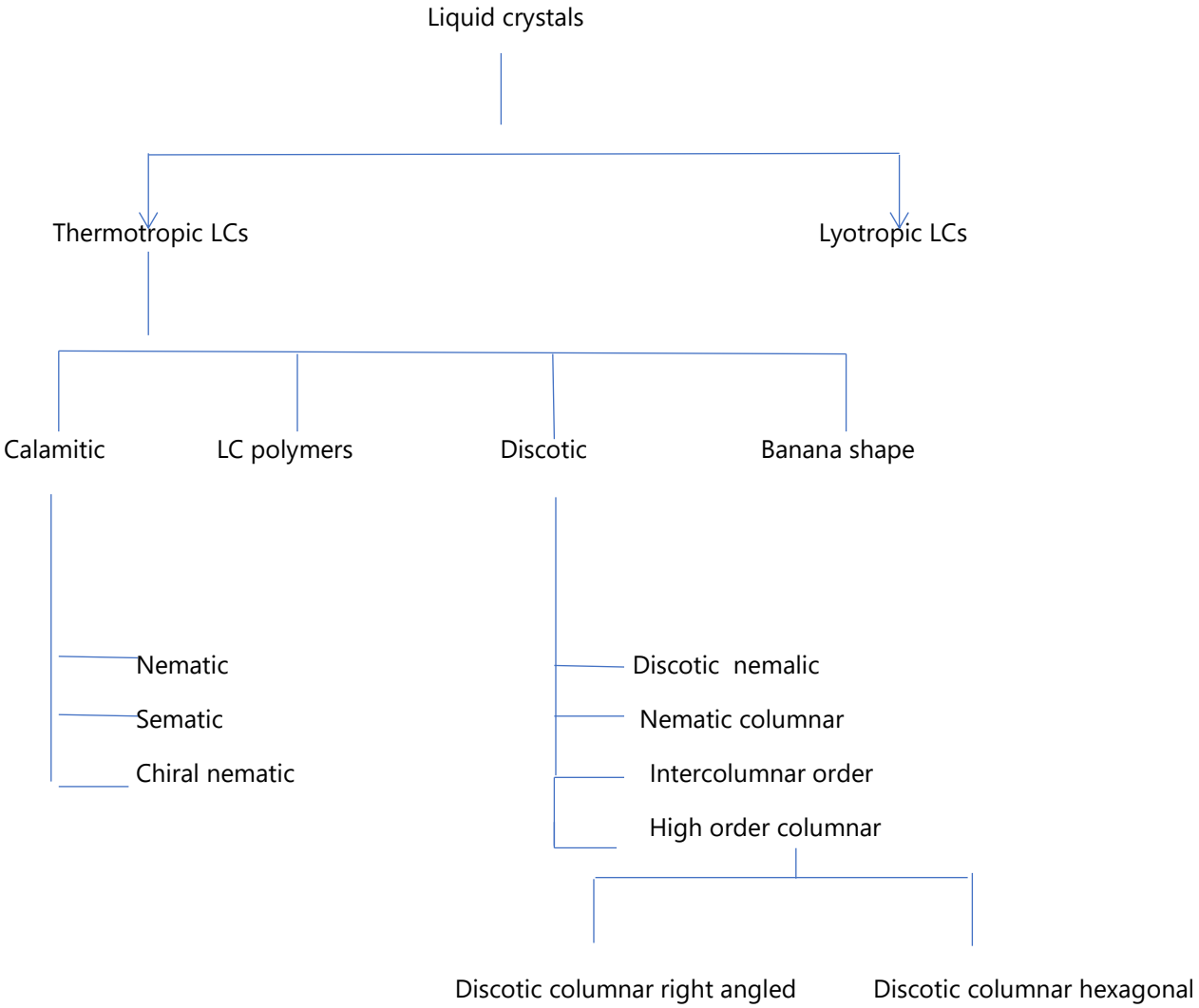
These categories are further illustrious into various phases reliant on the variations in their orientational or positional order under effect of external factors such as per temperature. (10) In suitable conditions, the molecules of LCs show orientational direction such that all the axes line up and form a supposed hematic liquid crystal. The molecules are still capable to transfer the world over in the fluid, but their orientation remains the same. It is the least well-arranged LC phase. On the conflicting, smectic (Sm) phase displays the orientational order but also positional. In smectic phase, the molecular cores of mass are organized in layers and the drive is mainly limited inside the layers. In cholesteric LC phase, molecules express intermolecular forces that errand arrangement between molecules at a minor angle to one another.

2.2. Thermo tropic Liquid Crystals

Thermotropic LCs are the ones which are extensively recognized due to their applicational influence in laptop, flat screen televisions, and tablet displays, or mobile phones. All these applications depend on the point that LCs reveal elastic behaviour and can be addressed via electric or magnetic fields, which alter the orientation of the optic axis, and therefore the birefringence. Thermotropic LCs are additional illustrious by their degree of order, show more stage of transitions inside the temperature regime of the liquid crystalline state (2)

2.3. Lyotropic Liquid Crystals-

Lyotropic LCs instead are detected when altering the concentration of a shape or property anisotropic dispersant in an isotropic solvent. A max, lyotropic phases are observed as a function of amount of amphiphilic molecules in aqua or other solvents, as schematically shown in Figure . Below the critical micelle concentration(cmc), the amphiphiles are molecularly isolated in the solvent, at superior concentrations form micelles, which can be spherical, rod or disk -like type, depending on the molecular shape. At even greater concentrations, these micelles aggregate to well-ordered structures and can procedure hexagonal, cubic or lamellar phases, also of the inverse Nanomaterials type. (6, 2



(Fig No .1 Types of liquid crystals)

2.4. Advantage of liquid crystals

1. Greater drug contents surface area and cubic crystalline structures because of high center

2. Comparatively simple process of preparation.

3. Biodegradability of lipids.

4. Capability of encapsulating amphiphilic, hydrophilic, hydrophobic substances possible.

5. Controlled release & targeted release of bioactive agents.

6. Although maximum liquid crystalline systems convert into micelles at advanced levels of dilution.

7. Cubosomes stay steady almost at any dilution level because of the relative insolvability of cubic phase making lipid in water. So, cubosomes can easily be fused into product preparations.

8. The cubic phases of cubosomes can be broken and discrete to form particulate spreading that is colloidally and/or thermodynamically constant for longer time.

9. Enlarged convenience and obedience (orally, topically and intravenously).

10. Better bioavailability due to size

11. Improved efficacy

12. Reduced side effects related with high initial plasma levels from rapid drug release on injection (drug burst).

13. Reduced health care costs due to simplified handling and less repeated administration

14. Decreased risks of drug misuse and misdirection (11)

3.METHOD OF PREPARATION OF LCS.

(a) Probe Sonication

(b) Spray drying

(c) Bottom-up approach

(d) Heat treatment

(e) Top-down approach

3.1. Probe Sonication

The higher shear homogenization technqueic and ultrasound scattering techniques, which were primarily used for the production of solid lipid nano dispersion. However, its superiority is compromised by the occurrence of microparticles. A pre-emulsion was found under stirring with an Ultra-Turrax T25 by adding melted lipid to a mixture of surfactants and water. A sonication probe was placed in this pre-emulsion which lead to droplet breaking up and subsequent formation of oil in water (o/w) at room temperature nanoemultion was immediately cool down to produce liquid crystals.

3.1.1. Advantages

1. Both methods are widespread and easy to handle

2. Equipments whatever use here are very common in every lab

3. Reduced shear stress

3.1.2. Disadvantages

1. Potential metal contamination

2. Physical instability like particle growth upon storage

3.2. Spray drying

To make wider the uses of liquid crystals in the pharmaceutical industry, by spray drying dry powder precursors can be fabricated and used for the preparation of oral solid formulations and inhalants. This methodology was initially proposed and investigated by scientist Spicer. In his investigation, the powder precursor could be ready by drying a pre-dispersed aqueous solution that comprised of GMO, hydrophobically improved starch and water or contained dextran, GMO, ethanol and water, then the colloidally steady dispersions of nano-structured liquid crystals may be hydration of the precursors.

3.2.1. Advantages

1) Spray drying method is useful for powder preparation such as DPI (Dry powder inhaler, dry syrup).

2) This technique used for preparation of microencapsulation.

3) Organic solvent can also use in this method.

3.2.2. Disadvantages

1) By this method has low amount yield of formulation as 5-30% out of 100%.

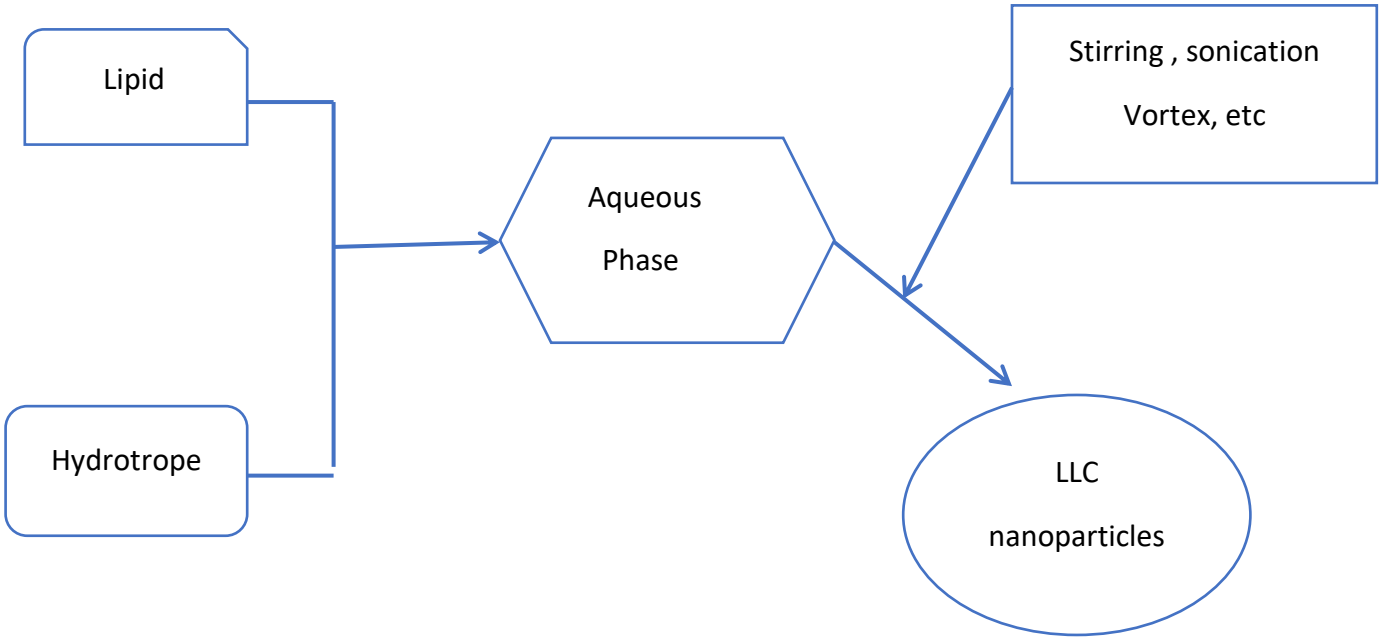
2) The spray drying method is complicated as compare to other methods.

3.3. Bottom-up approach

In compared to top-down approach and this dilution-based approach can be create liquid crystals without any difficulty. In other words, it needs less energy input. Moreover, this method is more effective at producing small particles. In other words, it needs less energy input. The dilution-based method can consider as a process of smaller particles making larger particles through accumulation, which is comparable with the use of precipitation processes to produce nanoparticles, while the top-down method is more similar to the attrition of big particles. Liquid crystals are prepared by dilution show long term stability, which might be recognized to the homo disperse stabilizers on top of the surface of liquid crystals. It should be consider, that this procedure via dilution is a pathway of charting routes on the ternary phase diagram (lipid and water hydrotrope), which is requires information of the full phase behavior; hence, the degree of dilution is difficult to regulator exactly. Due to the adding of hydrotrope, many issues stand up, such as the effects applied by variable concentrations of hydrotrope on the physic-chemical

assets of LLC nanoparticles and the likely happening of irritation and allergic response when the mesophase preparations are administered. Finally, this bottom- up method cannot effectively escape creating vesicles**. (11)**

In this liquid crystals are allowable to form or crystallize from carrier. Almgren et., al. discourse the formation of liquid crystals by separating L2 or inverse micellar phase droplets in water at 80°c, and permit them to gradually cool, gradually droplets become crystallizes to liquid crystals. This is extra durable in large scale manufacture of liquid crystals. Developed LC at room temperature is by diluting aqueous poloxamer 407 solution and monoolein-ethanol solution. The cubosomes are instinctively designed by emulsification.(1)



(Fig No.2 Bottom up Technique(11))

3.3.1. Advantages

1) Lower energy input.

2) Less time consuming process.

3) At high concentration prevent the formation of LCs.

4) There is no need of any organic solvent

3.3.2. Disadvantages

1) Milky white formulation made.

2) Hydrotrope which shows allergic reaction when the liquid crystals formulation take orally.

3.4. Heat treatment

The co-occurrence of cubic liquid crystals with vesicles is speculated to deliver multiphase manipulation of the sustained release of drugs; hence, to better investigate the release behavior of plain mesophases, vesicles should be eliminated as much as possible. In this case, heat treatment can be regarded as a good approach. Note that in the strictest sense, heat treatment is not an integrated process for the manufacture of cubosomes because it only promotes the transformation from non-cubic vesicles to well-ordered cubic particles. The dispersed particles, therefore, can be produced by a simple processing scheme comprising a homogenization and heat-treatment step. From the reported studies, heat treatment could cause a decrease in the small particle size fraction that corresponded to vesicles and form more cubic phases with narrow

particle distribution and good colloidal stability . The reason for transition could be speculated as an elevated temperature giving rise to a reduction in solubility and stability. When the temperature was below cloud point, the surfactant had a high solubility and thus the particles could exist stably and the phenomenon of fusion was hardly observed. Once reaching cloud point, the solubility of surfactant decreased notably and a notable fast fusion among vesicles would occur.

3.4.1. Advantages

1) Good colloidal dispersion is produced.

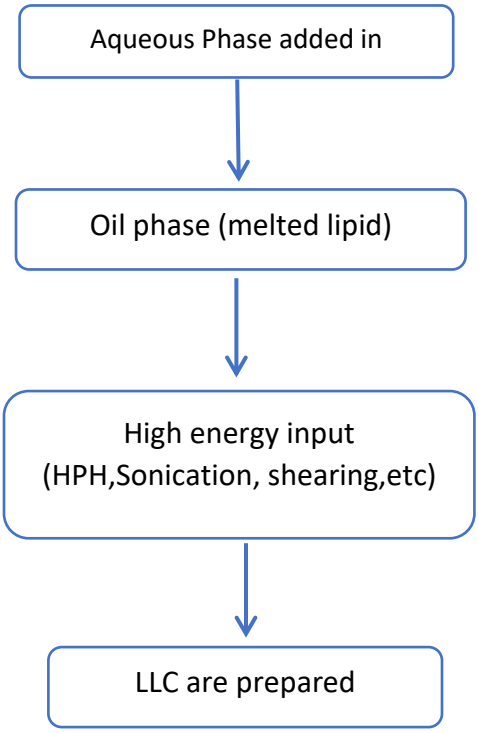
2) Reduction of particle size.

3.4.2. Disadvantages

1) Degradation of thermo sensitive substance due to formation of aggregate. Reduction of stability of formulation. (12)

3.5. Top-down approach

The extreme viscous bulk phase is prepared by mixing structure-forming lipids with stabilizers, and then the resultant is dispersed into aqueous solution through the input of high energy such as high-pressure homogenization (HPH), sonication or shearing to form LLC nanoparticles. At present, HPH is the most extensively used technique in the preparation of LLC nanoparticles . Cubosomes. Based on the results observed, the concentration of F127 and temperature during HPH were regarded as crucially important parameters. Recently, a novel approach of shearing was proposed to fabricate LLC nanoparticles using a laboratory built- Shearing apparatus. Compared with the well-established ultrasonication approach, the shearing treatment could effectively prepare more stable and homogeneous cubosomes or hexosomes with high content of the hydrophobic phase (oil + lipophilic additives) within a short time (less than one minute). It seems that the preparation procedure is simple enough to be realized conveniently. In fact, the operation units in this procedure require several cycles to achieve the desired Nanoparticles with appropriate characteristics and the high-energy input is also regarded as a barrier to the temperature resensitive ingredients (12,(13)



(Fig No:3 Top Down Technique(11))

3.5.1. Advantages

1) Lower impact to overall organization.

2) Visibility of formulation changes is clear.

3) No need of organic solvent.

4) Simple method as compare to other method such as spray drying.

3.5.2. Disadvantages

1) Solution provides limited coverage in the first phase.

2) High energy input required.

3) Time consuming process(43Manufacture of Cubosomes (12)

4.APPLICATIONS OF LIQUID CRYSTALS

4.1. Oral drug delivery

Liquid crystals address the different challenges in oral delivery of several promising compounds together with large molecular size, poor aqueous solubility & poor absorption. In a different application large proteins have been used for local activity in the gastrointestinal tract. Liquid crystalline nanoparticles carriers can be combined with targeting release and controlled release. The particles are intended to procedure in situ in a controlled rate, which permits an effective in vivo distribution of the drug from dosage form. Cubosomes carriers can also be released at various absorption sites, for example in the upper / lower intestine, which is important for the drugs that have narrow absorption window1.

4.2. In topical and mucosal depositions

Cubic phases are more bio adhesive in the nature, so that they can suitably use in topical & mucosal depositions and delivery of different drugs by dosage forms.

4.3. Controlled-Release Drug Delivery

Controlled release of solubilized active compounds is the most widely held application pursued by cubosomes investigators, and brilliant reviews happen of attempted delivery applications also pharmaceutical active compounds that have been solubilized in bulk cubosomes and liquid crystals. Cubic phase is attractive for controlled release because of its lesser aperture size (5–10 nm) its capability to solubilize hydrophobic, hydrophilic and amphiphilic particles and its biodegradability to simple enzyme action. Cubic phase is intensely bio adhesive and is thought to be a skin permeation enhancer, suggesting exceptional compatibility with mucosal deposition and topical and delivery of active compounds.

4.4. Intravenous drug delivery systems

Liquid crystals containing internal liquid crystal structures of curved lipid membranes are used for solubilize encapsulate and distribute medicines to disease zones within the body. While liposomes and emulsions have found use as intravenous carriers in drug products, liquid crystal nanoparticle structures improved payloads of proteins, peptides and many insoluble small molecules, and are greatest carriers for injection or infusion of many actives.

4.5. Topical drug delivery systems

Topical delivery system is the different mode of liquid crystal application. They are based on the exploitation of the particular properties of liquid crystals. Topical delivery systems are exclusive forming bio adhesive LC formulations used to ease the controlled and effective drug distribution to buccal, ophthalmic vaginal, and others.

5.RECENT APPLICATION OF LIQUID CRYSTALS

5.1. Melanoma (cancer) therapy

Newly same anticancer compounds have been successfully encarporated in liquid crystals and considered physico chemically. The unique structure of this favorable nano carrier recommends its application in melanoma treatment. An object for size does´ pass

by the tight junctions that exist between the endothelial cell lining of the vessels. Passive targeting is largely reliant on the capability of a drug nano carrier size to exhibit an improved circulation lifetime resulting in improved accumulation at the specific targeted site. Circulation time is dictated by nanoparticle physic-chemical charecters (size, solubility, charge, biodegradability, shape, rigidity), which can be simply manipulated in the majority of the delivery systems defined.

5.2. Drug delivery vehicle

The drug delivery vehicle is a general application for such new materials. The rapid development of the life-sciences industry is predictable to drive earlier "exotic" delivery vehicles and excipients into wider market places, As like personal care and consumer products. Therefore, self-assembled surfactant phases have been widely inspected for compatibility with many medical active ingredients & their applications.

5.3. Sustained release behaviour

Even more current patent achievement by points to liquid crystals use in personal care product areas such as various, hair care, skin care, cosmetics, and antiperspirants. A wide variety of drugs with different physico-chemical charecters have been added in liquid crystals and their sustained release performance was also studied. Sustained behavior of cubosomes was because of cubosome residue particles. Monoglyceride based cubosomes dispersion can be introdused for topical use, as like for percutaneous or mucosal applications.

5.4. In treatment of viral diseases

Since of the microbicidal stuffs of monoglycerids, can be used to in intravaginal therapy of sexually transferred diseases caused due to viruses (e.g. HSV, HIV) or due to bacterias (e.g. Neisseria genorrticae and Chlamydia trachomatis). Because of similarity between the structure of the stratum corneum and the cubic phase structure structure, it is judicious to suppose the construction of mixture of stratum corneum lipids with cubosomal monolein. This type of interaction may lead to the formation of a cubosomes goods yard in this layer, from which medication can be released in a controlled manner.

5.5. In topical and mucosal depositions

Cubic phases are most bioadhesive by nature, so that they can suitably use for topical and mucosal depositions and conveyance of different drugs.

5.6. Controlled-Release Drug Delivery

Controlled release of solubilized actives compounds is the wildly used application followed by LCs researchers, and outstanding evaluations occur for delivery applications as well as pharmaceutical active ingredients that have been solubilized in bulk cubic phase and LCs. Cubic phase is most suitable for controlled release because of its very small pore size (5–10 nm); its capability to the solubilize hydrophobic, hydrophilic & amphiphilic molecules; in addition its biodegradability by simple enzyme action. Cubic phase is intensely bioadhesive and it be a skin penetration enhancer, suggestive of good compatibility with topical and mucosal admission and delivery of active ingredients.

6.CHARACTERIZATION

6.1. Visual inspection

Nearby one week after preparation of LC, the dispersions were visually evaluated for optical appearance (e.g., color, turbidity, homogeneity, occurrence of any macroscopic particles) be used to evaluate the possible variants by time. (11)

7.PARTICLE SIZE DISTRIBUTION

The mean particle size and the polydispersity index (PDI) evaluation of the ready liquid crystals in the present study were determined by the light scattering depends on laser diffraction by Malvern zeta sizer 2000 (Malvern Instruments, Malvern, UK). Samples were diluted about 100-fold with water & the dimensions were conducted at temperature 25ºC. (21, 20). And the particle size of mesophase are evaluated by the help of the instrument are named as (Brookhaven Instruments Corporation, Austin, TX, USA) dynamic light scattering. The DLS, is occasionally called as photon correlation spectroscopy (PCS) for the mesophases preparations, (14) polarization microscope is use to verify the special structure of the LLC composition, (Leica Q500MC image processing and analyzing system, Leica Microsystems Cambridge Ltd., Cambridge, United Kingdom) with crossed polarizers at the room temperature at magnification was 200×. (15)

By using disposable zeta cells filled the surface charge of the particles was evaluated with 1 mL of LC dispersal which was 1st diluted to 99.5 wt% of water. Cryogenic transmission electron microscopy (Cryo-TEM) Lipid LC dispersions for electron microscopy were formed in a exact environment confirmation system to check stable temperature to avoid loss of water during sample preparation. The temperature of climate compartment was keep at 25−28°C, and the relative humidity was kept near to saturation to avoid sample evaporation. The samples were formed by placing 5 µL of LCs dispersion on lacey carbon filmed copper. (16)

8.POLARIZING LIGHT MICROSCOPY (PLM)

The surface and temperature-induced of LCs and alterations of Cubic phases were examined by a polarizing microscope. Optiphot is fitted out with the digital camera DS-2Mv (Nikon) and a heating table is Analysa LTS350 (Linkam) is also there. A very small specimen of sample was placed in between two microscope slides & their edges were instantly wrapped with a thermo stable silicon grease to avoid evaporation of water from the specimen. A step wise increase in temperature i.e. (Typically 5°C in every step with a heating rate of 1°C/min) was used to encourage phase transitions. (17) The polarized light microscopy (PLM) is can be used full to reveal the optically anisotropic (possibly vesicular) surface coating of the LCs and also can differentiate between anisotropic and isotropic substances.(11)

9.TRANSMISSION ELECTRON MICROSCOPY

In this samples of formulation is prepared and then placing a 10 µl droplet of the formulation on top of a 300 mesh size carbon-coated copper grid and allowing the LCs settle down for 3–5 min. (19)Then, the extra sample was removed. The air-dried samples was negatively stained with 1% uranyl acetate up to 3–5 min. The samples of mesophase then observed on a JEOL Model JEM 1400 120KV TEM (JEOL-USA, Wil- mington, DE, USA) and take pictures of digitally on a Gatan axis-mount 2kx2k digital camera(17) Transmission electron microscopy can be used to view the shape of the mesophase(11)

10.SMALL-ANGLE X-RAY DIFFRACTION (SAXD)

Small angle X-ray scattering can be used to identify the three-dimensional arrangements of different groups in the formulation liquid crystals(sample).(11) The designs were composed with the Siemans two-dimensional small-angle scattering system, which is consisting of the HI-STAR wire detector and Anton ParrHR-PHKcollimation system.(18) The formulation of mesophase in which (SAXS) Small-angle X-ray scattering measurements were delivered with the help of a high-flux SAXS instrument (Anton Paar GmbH, Graz, Austria) and using of the imaging plate (IP) detector for the detecting the sample.The formulation of liquid crystals samples were carefully added into a quartz capillary with a 1 mm capillary diameter and up to exposed for 60 minutes(19) Formulation of LCs were enclosed in a stainless steel sample vessel using polymeric sheet windows. The diffraction patterns were noted for at least 1200s. (17)

11.HIGH PERFORMANCE LIQUID CHROMATOGRAPHY (HPLC)

The sample concentration was determined with the help of Agilent HPLC 1100 Series (Agilent Technologies, USA) Determination was passed out in a solvent system of formic acid – methanol–water. Data were composed and managed using a ChemStation software version B.01.03. The gained values with standard methanolic sample solutions showed linearity over the concentration range of 0.1–100 µg/g with a correlation coefficient r2 value of 0.999. The quantification limit in the HPLC assay was 0.1 µg/g and standard deviation under repeatability conditions was no more than 5.6% in all concentrations tested, liquid crystals(LC) phases and Liquid crystals nanoparticles dispersions were prepared using sample standard with respective lipid compositions.(16)

12.DETERMINATION OF ENTRAPMENT EFFICIENCY

Drug loading of Liquid crystals and Entrapment efficiency can be determined with the help of ultra-filtration techniques. In liquid crystals formulation Un loaded drug concentration is finding, which is withdrawn from the total drug added. The amount of drug is analyzed by use of UV spectrophotometer. (11) freshly prepared 1ml of liquid crystals formulation dispersion was diluted upto 10 mL with deionized water and the diluted samples up 3ml was placed in centrifuge tube for specific time (15 min) and centrifuged at specific rate

of rotation (4000 rpm). Certain active ingredients are adsorbed to the ultrafiltration membrane to a some amount, the drug adsorption to the ultrafiltration membrane was examined by filtration of drug solution of known amount pass through the membrane and determining drug concentrations in the ultrafiltrate. By spectrophotometrically the free drug contained in filtrate was measured at specific λmax of drug. The quantity of entrapped drug was achieved by subtracting the quantity of free drug from the total drug incorporated in 1 ml of LCs dispersion. The total amount of drug incorporated in 1 ml of LCs dispersion was examined after adding of 9.0 ml methanol to dissolve the drug loaded-LCs. The resulting solution was examined for the total drug content spectrophotometrically with methanol as blank. (20) The EE was determined by subtracting the quantity of free drug from the calculated total incorporated drug is weight.

The entrapment efficiency i.e.(EE%) is can be calculated as:

EE% = WE/ WA% ...(eq no 1)

Where, WE is the mass of CI entrapped in the CI-Cubs, and WA is th eweight of CI in the sy-stem (21)

13.VISCOSITY

The prepared mesophase gel formulation were evaluated using viscometer named as rotational Brookfield viscometer of cone and plate structure, with the help of spindle bar CPE- 41 at temperature 25 ± 2 °C. About 0.5 g of the tested sample was applied to the plate and settings the speed range from 0.3 to 60 rpm or 0.5 to 100 rpm with 10 s among each 2 successive speeds. When the torque was within 10–100% the standard range and rheological data were recorded (21)

14.DRUG CONTENT

In drug content drug loaded liquid crystals formulation and methanol are used. The mesophase formulation mixed with methanol then sonicated for 10 min to obtain a clea

solution. Concentrations of drug were determined spectrophotometrically at λ max of drug

Drug Content = actual yield/Theoritical yield×100. (22)

14.1. Stability studies

The physical stability can be studied by analysis of organoleptic and morphological characteristics as a function of time. Particle size distribution and drug content can be judged at different time period or intervals can also be used to evaluate the possible changes by time. (11)

15.CONCLUSION

The technique of formulating liquid crystal of drug can be useful and effective for delivering the drug through desired target. This technique can be employed widely in topical delivery of the drug as it hold the merits such as smooth feel and drug loading of incompatible molecule. Day by day numerous patents are approaching in this LCs technique. It is the new technique of drug loading & important techniques needs attention further for its practice in actual scientific industries to provide a quality outcome for a society.

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