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A RECENT TREND ON NOVEL DRUG DELIVERY SYSTEM

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ABSTRACT

Novel Drug Delivery System Novel drug delivery systems have gained high beneficial interests in the field of pharmaceutical sciences due to its enhanced therapy by enlarging the efficacy and duration of drug activity, improved patient compliance through reduced dosing frequency and convenient routes of administration and enhanced targeting for a specific site to decrease unwanted adverse effects. The provocation for both drug and drug delivery companies is to deliver both existing and emerging drug technologies in a way that enhances the welfare to the patients. Over the past several years, great progress has been made on evolution of novel drug delivery systems. The variety of novel formulations like polymeric nanoparticles, liposomes, microemulsions, microsphere has been reported using bioactive and plant extracts. The novel formulations are reported to have remarkable advantages over conventional formulations which include enhancement of solubility, bioavailability, protection from toxicity, improvement of pharmacological activity, improvement of stability, enhanced tissue macrophages distribution, sustained delivery, and protection from physical and chemical degradation. The present review highlights the current status of the development of novel formulations and summarizes their method of preparation, type of active ingredients, size, and entrapment efficiency, route of administration, biological activity and applications of novel formulations.

Keywords: Novel Drug Delivery System, Nanoparticles, Microspheres, Liposomes

1. INTRODUCTION:-

1.1 NOVEL DRUG DELIVERY SYSTEM (NDDS):-

Novel drug delivery system refers to the approaches, formulations, technologies, and systems for delivering a pharmaceutical compound in the body as needed to safely achieve its desired therapeutic effects. It may involve scientific site-targeting within the body, or it might involve facilitating systemic pharmacokinetics effect of action [1]. It is advanced drug delivery system which improves drug potency, control drug deliverance to give a sustained therapeutic effect, provide greater safety, finally it is to target a drug specifically to a desired tissue [2]. NDDS is a system for delivery of drug other than conventional drug delivery system and also a combination of advance technique and new dosage forms which are far better than conventional dosage forms [3]. Novel drug delivery system is based on its unique hallmarks from the fields of drug delivery system, diagnosis, and imaging

There are several different type of nanocarriers including nanoparticles, liposomes, Dendrimers, microemulsion, and drug conjugates, which have been used for enhancing the drug delivery of chemotherapeutics, radiation therapy, gene therapy and immunotherapy. Along with the

enormous progress achieved in the field of Novel Drug Delivery System [4] (Figure 1.1).

1.1.1 ADVANTAGE OF NDDS:-

- Novel drug delivery system decreased dosing frequency.
- It reduced rate of rise of drug concentration in blood.
- It enhanced bioavailability and reduced side effects.
- Act at the targeted point of the level [5].
- Accurate dosing.
- Decreased toxicity/side effects.
- Beneficial to patients with improve comfort and standard of living

1.2 CLASSIFICATION OF NOVEL DRUG DELIVERY SYSTEM:-

1.2.1 NANOPARTICLE:-

Nanoparticles are sub-micron particles with lengths that range from 1 to 100 nm, according to the American Society for Testing and Materials (ASTM) Nanoparticles are prepared with different materials and exhibit plentiful forms, which provide a variety of choices for pharmaceutical preparations. The choice of Nano-carrier materials may affect the therapeutic effect of drugs on certain diseases that act at the targeted point of the diseased cell [6] (Figure 1.2).

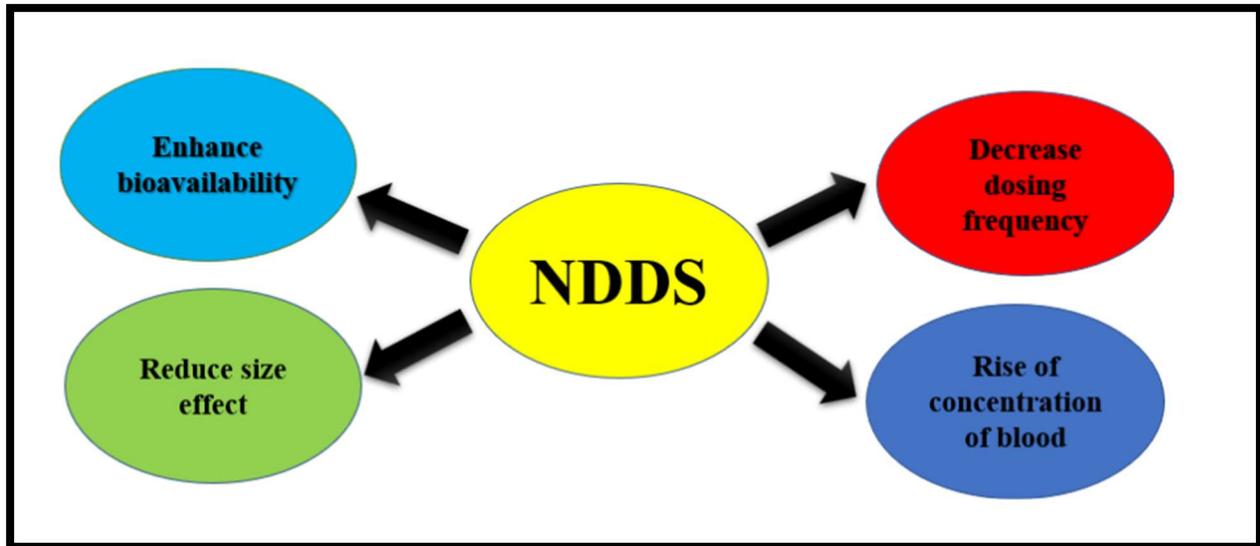


Figure 1.1: Advantages of Novel Drug Delivery System

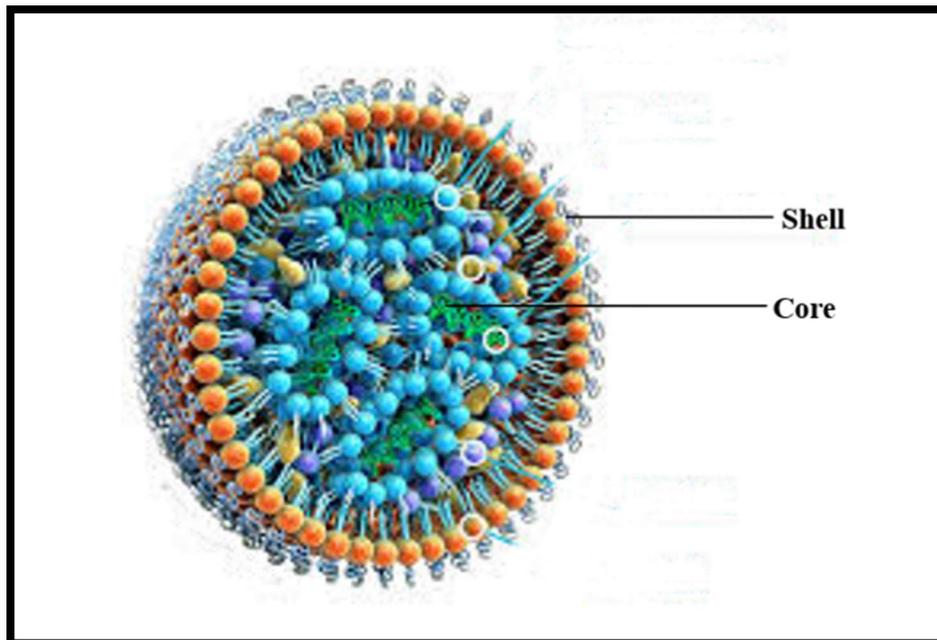


Figure 1.2: Structure of Nanoparticle

The chemical origin of nanoparticles is greatly influenced by their chemical origin, which is responsible for their behavior and fate in the environment. Nanoparticles have innovatory physicochemical characteristics superior to the mass material due to their enormous

surface to volume proportion, higher reactivity, huge surface to volume, stability, bioactivity, bioavailability, controlled particle size, controlled release of drugs, site-specific targeting and controlled arrival of medications [7] (Figure 1.3).

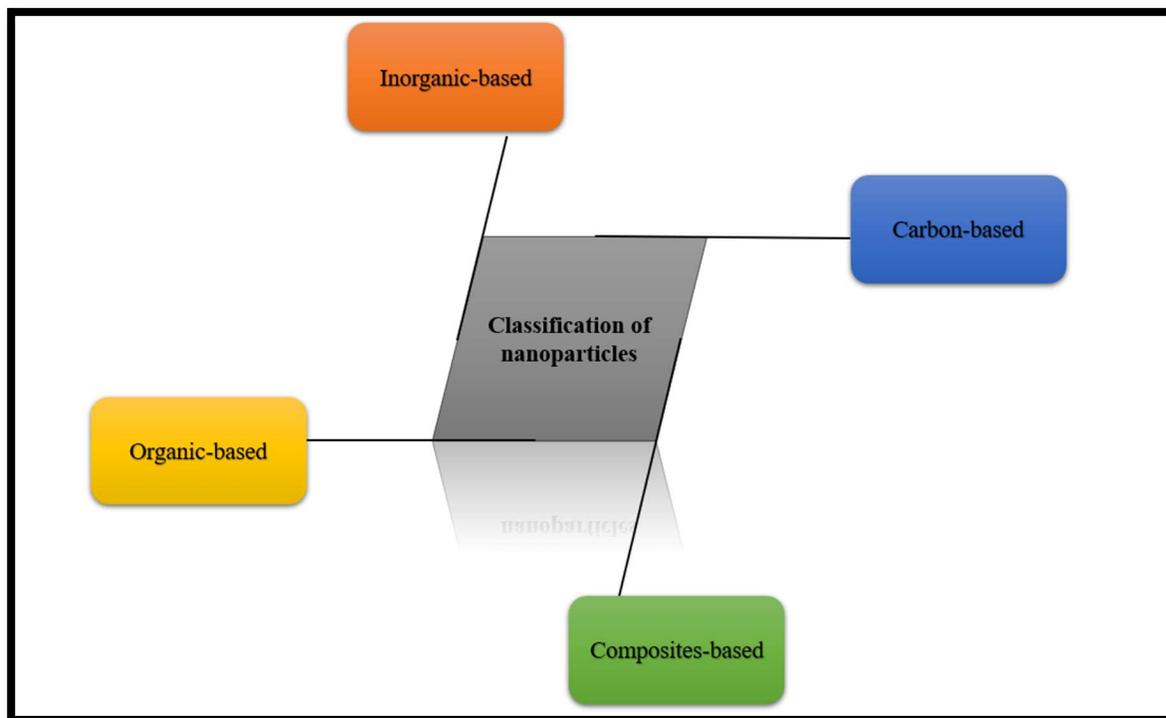


Figure.1.3: Classification of nanoparticles

Nanoparticles possess special chemical, physical and optical characteristics. At the Nano scale, properties of the particles change unpredictably, making them behave differently with the same substance at the macro scale. Nanoparticles are ideal in a diversity of areas, such as energy, medical, electronic and commercial products, due to their high reactivity and special features

Using nanoparticles leads to the production of efficient, durable, lighter, firmer, and cleaner products and materials [8].

1.2.2. LIPOSOME:-

Liposomes are one the main advanced approaches in Novel drug delivery system. Research related to liposomes Have gained an attractive importance in pharmaceutical,

biological, and medical field since liposomes consider the most proper carries for the introduction of all kind of agents, such as anticancer drug, antibiotics, anti-inflammatory, genes, and antifungal [10].

Liposomes consist of one or more concentric lipid bilayers, which enclosed an internal aqueous volume. For drug delivery applications liposomes are usually unilamellar and range in diameter from about 50-150 nm. Large liposomes are rapidly removed from the blood circulation. Liposomes are unique in their ability to accommodate drugs, which differ widely in physicochemical properties such as polarity, charge and size. Sites in liposomes where these drug can localise includes the liposome bilayers with its

hydrophobic hydrocarbon chain core, its large polar surface which can be neutral or charged, and the internal aqueous space [11] (Figure 1.4).

Liposomes can be formulated using a wide range of methods which influence the liposomes characteristics, such as size lamellarity and encapsulation efficiency (EE, which is expressed as the percentage of drug that is successfully entrapped into the liposome). The concentration of incorporated substance in liposome can be determined using different analytical methods (UV-Vis detection, HPLC, GC, GC-MS etc.)

depending on the active compound which is incorporated in liposomes. When the incorporated substance is protein, direct and indirect methods for EE determination could be used. While the incorporated substance is protein, direct and indirect methods, the non-entrapped protein or drug is considered [12]. The liposome preparation methods can be categorized as conventional and novel method (e.g. supercritical assisted method for liposome preparation). There are already some review articles where SCFs technologies for liposomes preparation are described [13] (Figure 1.5).

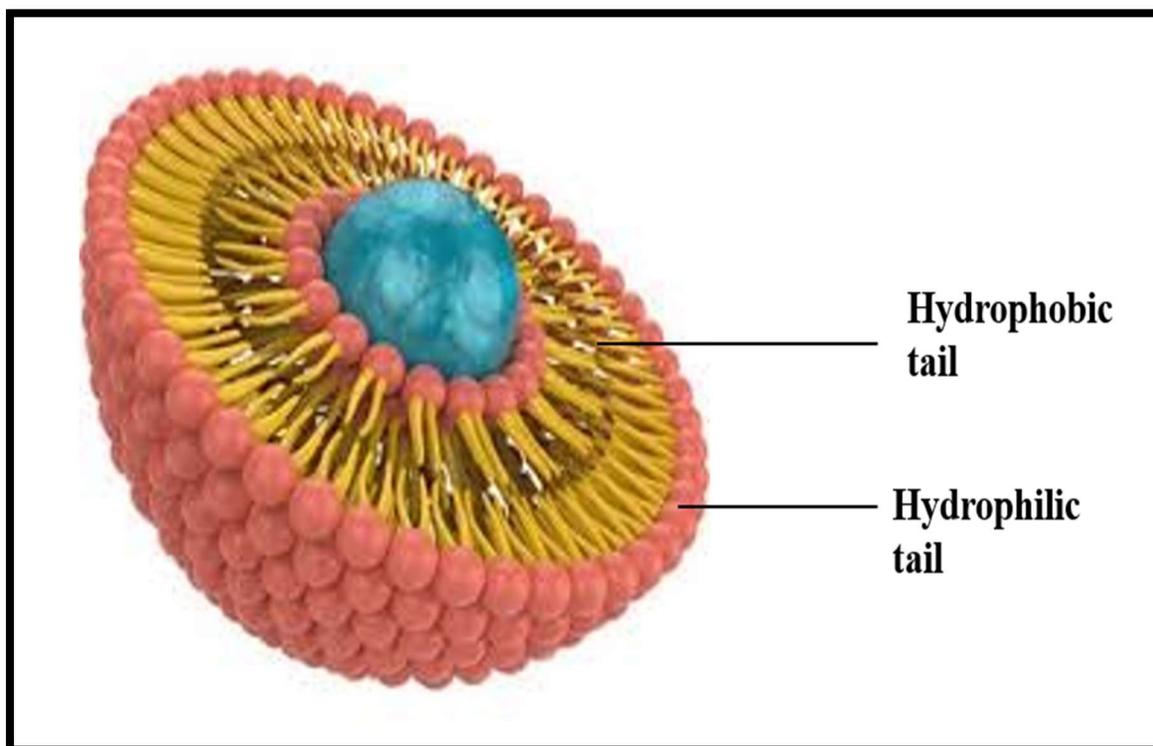


Figure 1.4: Structure of Liposome

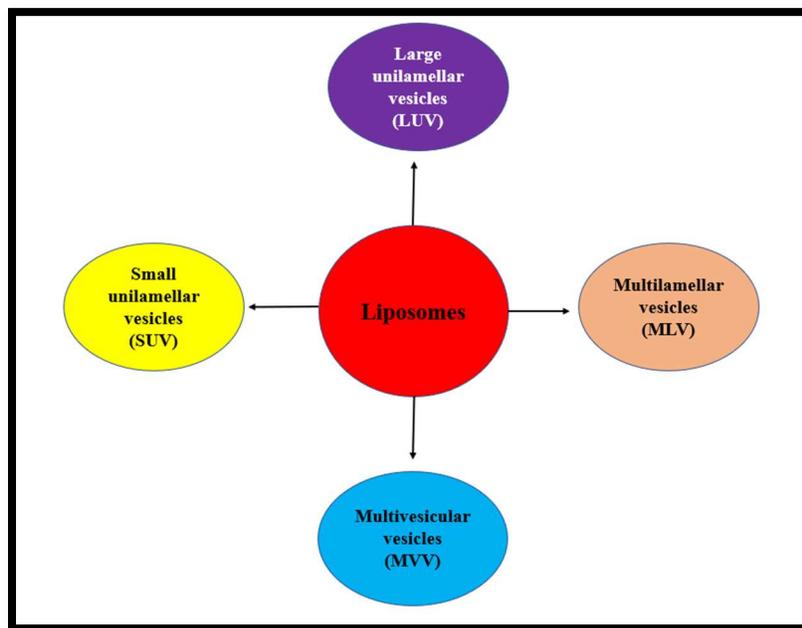


Figure 1.5: Classification of liposomes

1.2.3 DENDRIMERS:-

The word “dendrimer” derived from a Greek phrase of “dendron”, which means tree or meros or branch. As early as 1978, Buhleir and coworkers synthesized and reported the first cascade and “nonskid-chain-like” molecules with molecular cavity topologies, which later were recognized as the early form of dendritic polymers. Similarly new class of polymer called starburst macromolecule was developed by the Tomalia et al. in 1985, where they synthesized star polymer widen the horizons of the scope of dendrimers [14]. Dendrimers is different form traditional linear polymer by its mono-dispersity, high symmetry, and surface polyvalency [15]. The repeated growth reaction during dendrimer synthesis lead to higher generation

and degree of branching. They are a three-dimensional nano-sized highly branched tree-like architecture and in general, has spherical geometry dimension [16] (Figure 1.6).

Dendrimer consist of dendrons which are arms initiated from the central core. In general, dendrimers consist of three essential part A. central core, B. Repeated unit attached to the central core most of the cases these units are radially homocentric layers called generations, C. Function group at the periphery of the dendrimers the pharmacokinetic profiles and biocompatibility [17].

Dendrimers can be classified on the basic of the chemical structure and physical characteristics as depicted in Figure 1.7 below.

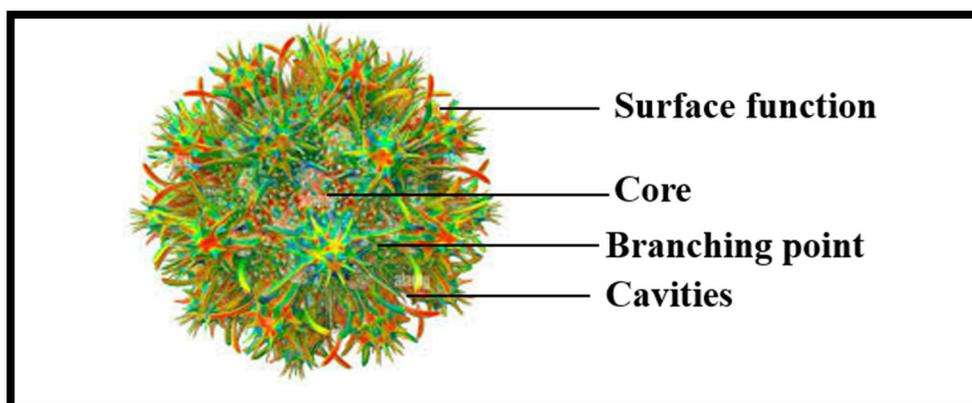


Figure 1.6: Structure of dendrimers

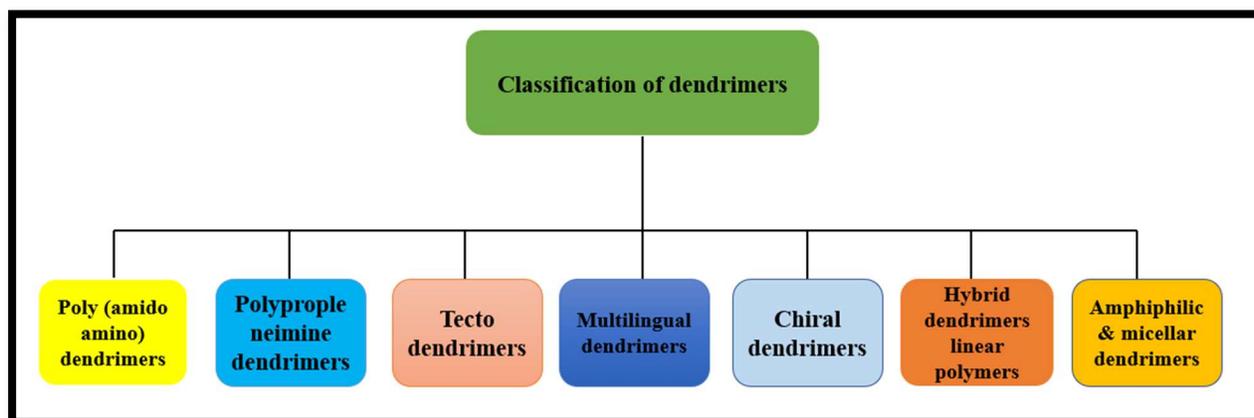


Figure 1.7: Classification of Dendrimers

Dendrimers are well known for their unique properties such as mono-dispersity which provides the capability to reproduce dendrimers at a scalable level [18].

The drug can be accommodated in the internal voids or functionalized at the surface of the dendrimers by the synthesis routes [19]. In general, there are two synthesis routes for dendrimers, divergent synthesis and convergent synthesis, in divergent synthesis, dendrimer structure grows from center core to

periphery by iterative addition of monomeric units for divergent synthesis multifunctional core is required where dendrimer propagates with the addition of monomeric unit to the exterior side of the center core. In case of PAMAM dendrimer, the convergent synthesis route is developed to overcome the shortcomings of the divergent synthesis route [19, 20].

1.2.4 MICROEMULSION:-

Microemulsion are ternary system comprising an aqueous phase, an oily phase and a relatively large proportion of amphiphilic compound and co-surfactant which enable the obtaining of a single optically isotropic and thermodynamically stable liquid dispersion [21]. Means size of inner phase globules is in 10-100 nm scale. It is thermodynamically stable, transparent, isotropic single-phase mixtures of two immiscible liquids stabilized by surfactants [22].

They are excellent applicant as potential drug delivery system because of their improved drug solubilization, long shelf life, and ease of preparation and administration routes [23].

Preparation of a microemulsion to be used as drug nanocarriers system requires a careful selection of both qualitative and quantitative composition [24]. The components should be chosen to fit the biocompatibility demand of the administration route [25].

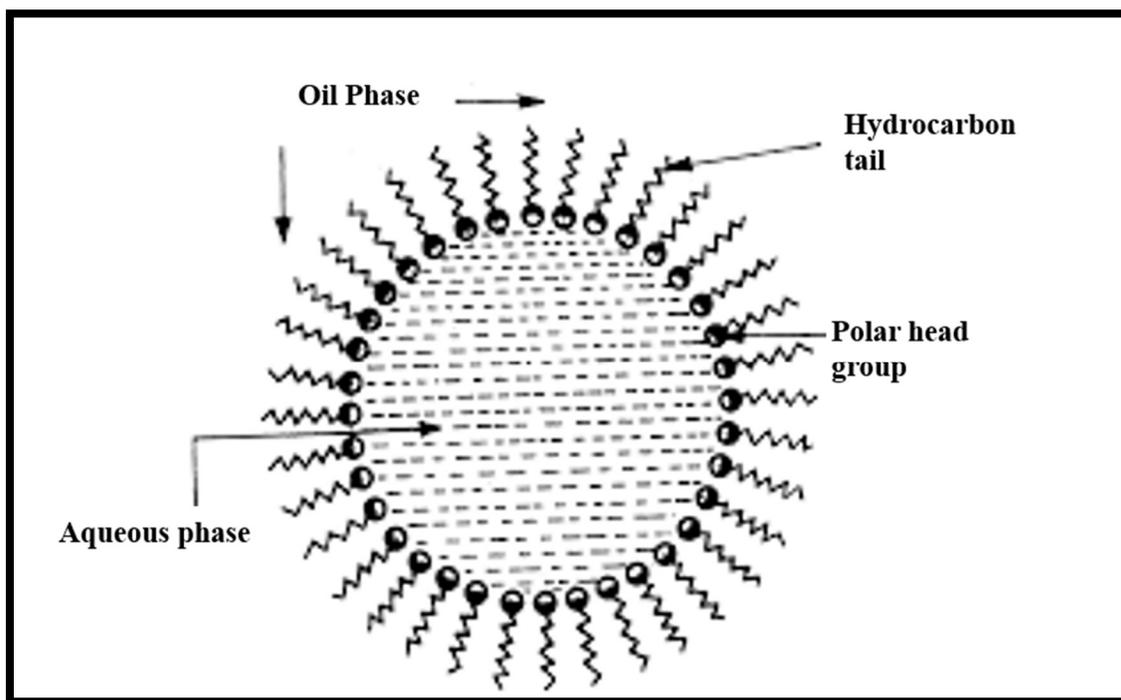


Figure 1.8: Structure of microemulsion

Microemulsion are dynamic system depend on the nature of the dispersed liquid so that dispersion liquid may be formulated by two types: O/W emulsion and W/O emulsion [25]. In W/O microemulsion, water droplets are

dispersed in the continuous oil phase while O/W microemulsion is formed when oil droplets are dispersed in the continuous aqueous phase [26].

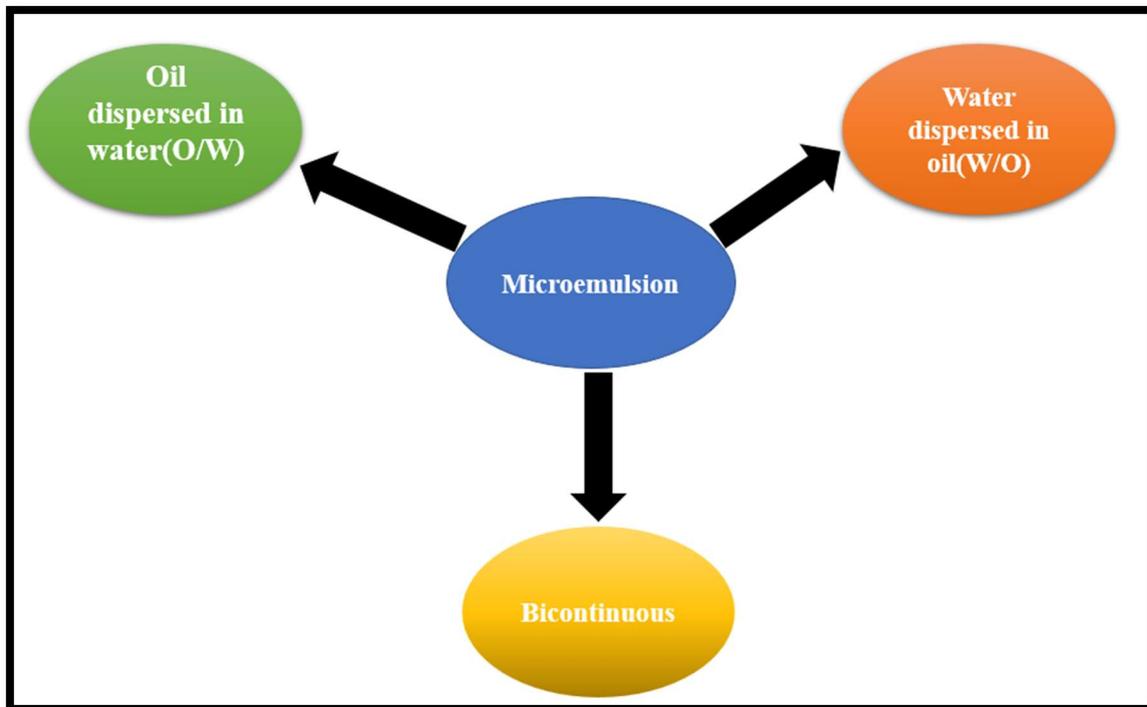


Figure 1.9: Types of Microemulsion

Microemulsion have been shown to be able to protect unstable drug release, increase drug solubility, increase bioavailability and reduce patient changeability. It has proven possible to formulate preparation suitable for most routes of administration [27]. There is still a considerable amount of elemental work characterizing the physicochemical behavior of microemulsion that needs to be performed before they can defend to their potential as multipurpose drug delivery vehicles [28].

1.2.5: MICROSPHERE:-

Microsphere are drug delivery system which is obtain to control drug delivery in forms of bioavailability, stability and to target the drug to specific site at a prearranged rate [29]. They

are made from polymeric waxy or other protective material such as natural, semi synthetic and synthetic polymers. microsphere is a micron-sized sphere which is characterized as solid, diameter having between 1-1000 μm [30].

Microsphere are one of the novel drug delivery system in which therapeutic substituent to conventional or instant release single-unit dosage form [31]. It consisting of a continuous phase of one or more mixed and dissolved polymers, in which drugs and other components are dispersed or dissolved in a matrix [32].

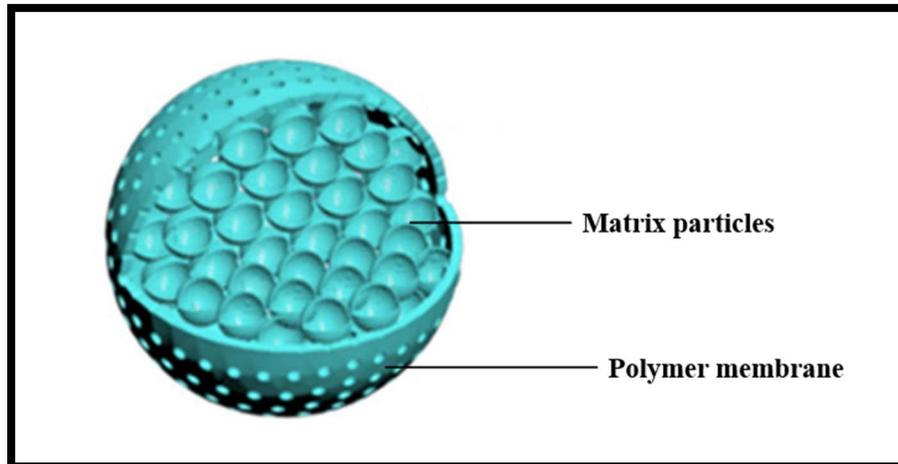


Figure 1.10: Structure of Microsphere

These microsphere prepared and fill them in a hard gelatin or compress them directly [33]. The microsphere which are prepared by using different techniques for the preparation of microsphere provides multiple options to control as drug administration aspects and to enhance the therapeutic efficacy, reduce toxicity, improve patient compliance and convenience [34]. In addition, the preparation

of microsphere demonstrated good drug-loading and sustained-release ability which enables drugs to be transported to the target via a polymer matrix. Microsphere are mainly administered orally, intravenously, or through subcutaneous implantation, intraperitoneal injection, etc. [35]. Microsphere will get central place in novel drug delivery in future [36].

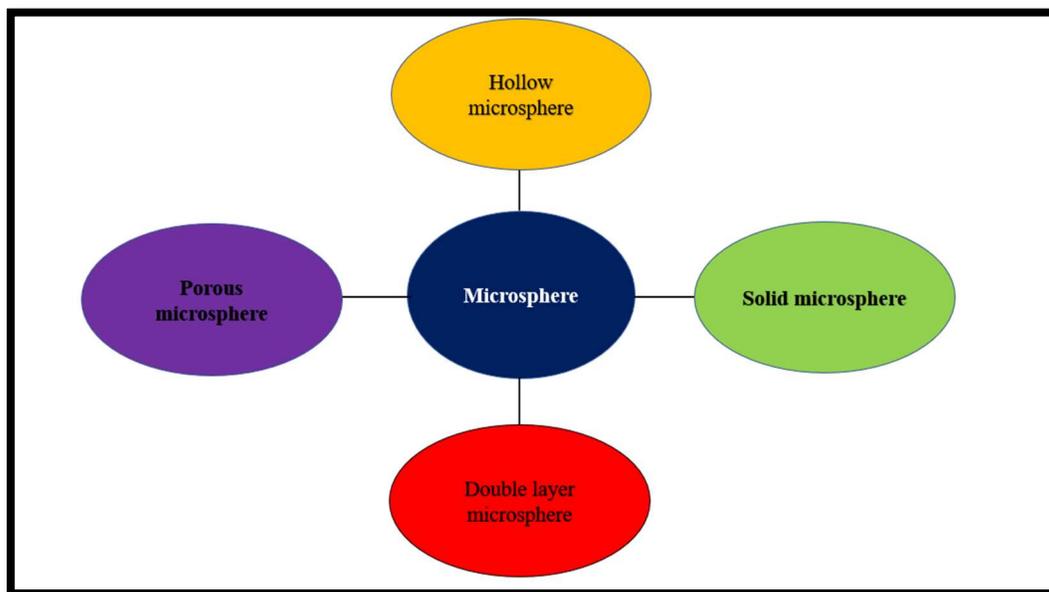


Figure 1.11: Types of Microsphere

Table 1.1: Different Novel formulations

S. No.	Novel formulations	Active Ingredient	Scientist	Reference
1.	Liposome	Paclitaxel	Bing Han, Yue Yang	[37]
2.	Liposome	Anthrakinone	Dina Fathalla , Eman M. K. Youssef and Ghareb M. Soliman	[38]
3.	Nanoparticle	Curcumin	RanMeng, ZhengzongWu, Qiu-TaoXie, Jie-ShunCheng, BaoZhang	[39]
4.	Nanoparticle	Resveratrol	Zhongyu Yang, David Julian McClements, Xinwen Peng	[40]
5.	Dendrimers	PAMAM	Hailin Cong, Liping Zhou, Qingye Meng, Yixin Zhang, Bing Yu, Youqing Shen, Hao Hu	[41]
6.	Dendrimers	Poly propylene imine	Aminoddin Haji, Ahmad Mousavi Shoushatri	[42]
7.	Microemulsion	Pluronic F127/Doxorubicin	Abbas Rahdar, Mohammad Reza, Mahmood Barani, Saman Sargazi, Maryam Zaholi	[43]
8.	Microemulsion	Resveratrol	Hongwei Tang, Jun Zhou, Chuntao Kuang	[44]
9.	Microsphere	Ropivacaine	Xun Li, Yi Wei, Piping Lv, Youbin Wu, Kenji Ogino, Guanghi Ma	[45]
10.	Microsphere	Tanshinone	Chao Luo, Qun Yang, Xinyu Lin, Chenze Qi, Guohau Li	[46]

2. CONCLUSION:

Novel drug delivery system not only decreases the frequent administration to overcome noncompliance but also assist to grow the therapeutic value by decreasing toxicity and improving the bioavailability and so on. Extensive research is going on for herbal drugs to incorporate them in novel drug delivery systems. Application of these novel techniques to natural medicines will led to increased bioavailability, decreased toxicity, sustained release action, protection from GI degradation which cannot be obtained through conventional drug delivery system due to large molecular size, poor solubility,

degradation of herbal medicines in Gastrointestinal media.

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