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A SYSTEMATIC REVIEW ON NANOCAPSULE: A NOVEL DRUG DELIVERY SYSTEM

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ABSTRACT

Nanocspsule are tiny capsule that range in size from 10 nm to 1000nm.they are composed up of a liquid /solid core with a cavity in which the medicine is inserted and an unique polymer membrane made up natural or synthetic polymers they are attractive due to the protective coating, which is often pyrophoric and quickly oxidised, delaying the release of active substances. For creating nanocapsule variety of technological processs are used , although interfacial polymerisation for monomer and nanodeposition for premade polymer preformed polymer are the most popular .size distribution are the most essential properties in their preparation,which may be assessed using a variety of techniques such as x-Ray defraction ,scaning electron microscopy ,transmission electron microscopy ,X-Ray photoelectron spectroscopy ,superconducting quantum interference device ,multiangle laser light scattering and other spectroscopic techniques are among the others.nanocapsule with a high degree of repeatability that can be use in varity of biological applications. They can be applied to awide range of conditions .botanical pesticides,genetic modifications ,cosmetics ,cleansing product ,sewage treatment and adhesive are just a few of the things that will be discussed. Anti infection nanocapsule bandages ,component applications ,tailored medicine administrations in cancers. Lipid nanoparticles nanocapsule in food technology and agricultiure. Biopharmaceuticals are now more effectively delivered. using a nanocapsule to deliver active substance to specific locations poses a number of challenges and opportunities.Future reaserch and development opportunities for novel ,improved medication.

***Keyword**: Nanocapsule, Cosmetic, Sewage treatment, agriculture, lipid, Anti-infection.*

1. INTRODUCTION

Humans have long employed plant-based organic ingredients as medicines to treat a variety of ailments.Upon this basis of traditional knowledge and traditions, modern medications are primarily developed from plants.Natural resources provide over a quarter of all main medicinal chemicals and their derivatives.Natural chemicals with various molecular origins were used to develop novel medications.Natural products have unique characteristics such as high chemical variety, chemical and biological capabilities with broad macromolecular specificity, and low toxicity. As a result, an unique drug delivery system was discovered.

Natural chemicals are presently being tested for the treatment of a variety of diseases, including diabetes, cancers, cardiology, inflammation, and microbial disorders, due fto their unique benefits, such as minimal toxicity and side effects, low cost, and high therapeutic potential. As a result of these issues, numerous natural substances are failing to progress through the clinical trial stages. Nanoparticle drug delivery systems are designed technologies that use nanoparticles to deliver therapeutic drugs with precision and control. Nanoparticles feature a high surface-area-to-volume ratio, chemical and geometric tenability and the ability to change shape to interact with biomolecules to facilitate uptake across the cell membrane. A unique therapeutic implementation of nanocapsules may be observed in connection with implant infections, particularly if the infection is associated with the presence of a biofilm. The capsule surface may interact specifically with the biofilm's polymer framework (extracellular polymeric substances – EPS), for example, through electrostatic interactions or polymer entanglements.If all these interactions are specific enough, the capsules may accumulate locally on the biofilm surface.Finally, the biological breakdown of the capsule wall will cause the capsule to be released locally contents. If the capsules contain an appropriate active ingredient,This results in effective delivery of drugs to the patient infected interface and may spark new approaches to treatment of implant infections.

For targeting and controlled release, the surface area also has a high affinity for drugs and small molecules such as ligands or antibodies.Nanoparticles are a class of organic and inorganic materials. Each material has uniquely tunable properties, allowing it to be designed for specific applications such as:

1. Crossing the blood brain barrier (BBB) in brain brain disorders.
2. Improving targeted intracellular delivery to confirm that treatments reach the appropriate structures within the cell.
3. Integrating diagnosis and treatment.

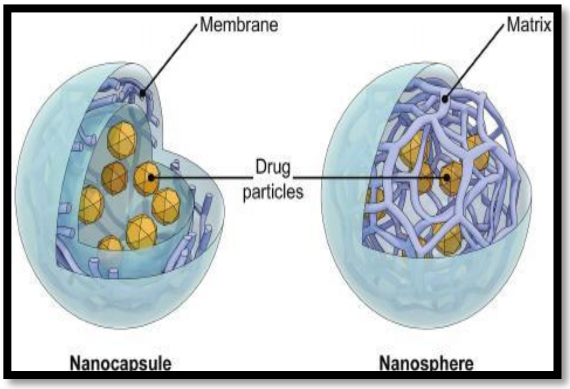

Fig 1 : Structures of Nanocapsule

2. CHARACTERIZATION TECHNIQUES

Because of their small size and complex formation, nanocapsules are difficult to characterise. Among the techniques are quasi-elastic light scattering (QELS), gel permeation chromatography (GPC), transmission electron microscopy (TEM), scanning force microscopy (SFM), and scanning electron microscopy (SEM). However, these methods did not provide a clear picture of the Nanocapsules shell. The structure, size and size distribution, density, and zeta potential of Nano capsules are of particular interest. Nanoparticle characterization is a branch of nanometrology that deals with the characterization or measurement of the physical and chemical properties of nanoparticles. Other physical properties such as shape, size, surface properties, crystalline nature.

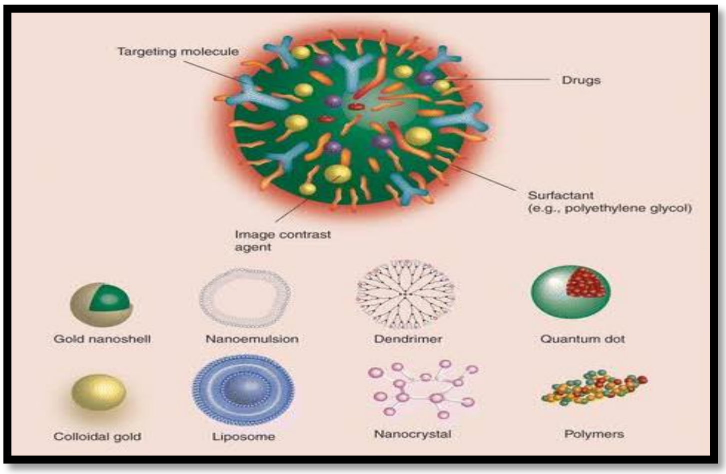

Figure 2: Nanoparticles which differ in Size, Shape, and Dispersion

3. NANOPARTICLE CHARACTERIZATION TECHNIQUES

- **Microscopical Techniques:**

Individual nanoparticles are imaged using microscopic technologies to determine their shape, size, and position. The preferred methods for detecting the Characterisation of Nanocapsules are electron microscopy and scanning probe microscopy. Because nanoparticles are smaller than the visible light diffraction limit. Furthermore, because microscopy relies on single-particle data, enormous numbers of individual molecules must be described in order to determine bulk properties. Improved dark-field microscopy with hyperspectral imaging, a recent approach, shows potential for imaging nanoparticles in complex matrices like biological tissue with improved contrast and through

Figure 3: Electron Microscope scans the ndividual Characterization of Nanoparticles.

- **Size and Dispersion:**

External dimensions of a particle is the particle size, and Dispersity is a measure of the range of particle sizes in a sample. If the particle is elongated or irregularly shaped, the size will differ between dimensions.

Size can also be calculated from microscope images using measured parameters such as:

- Feret diameter
- Martin diameter and Projected area diameter.

Size can be calculated from physical properties such as

- Settling velocity
- Diffusion rate or coefficient, and
- Electrical mobility

For nanoparticles in suspension, techniques include

- dynamic light scattering,
- laser diffraction,
- Field flow fractionation
- particle tracking analysis
- size exclusion chromatography
- centrifugal sedimentation,and atomic force
- microscopy.

For airborne nanoparticles, techniques for measuring size include

- cascade impactors.
- electrical low-pressure impactors,
- mobility analyser and
- time of flight mass spectroscopy

Surface Chemistry and Charge: Surface Chemistry refers to the elemental or molecular chemistry of particle surfaces. There is no clear definition of what defines a surface layer, which is usually determined by the measurement method used. In comparison to micron-scale particles, nanoparticles have a higher fraction of atoms on their surfaces, and surface atoms are in direct contact with solvents and impact their interactions with other molecules. Some nanoparticles, such as quantum dots, may have a core–shell structure, in which the atoms on the outer surface differ from those on the inside. The charge resulting from protons adsorption or desorption on hydroxylated sites on a nanoparticle surface is known as surface charge. Nanoparticle agglomeration, dissolution, and bioaccumulation are all influenced by surface energy or wettability. They can be measured through heat of immersion microcalorimetry studies, or through contact angle measurements

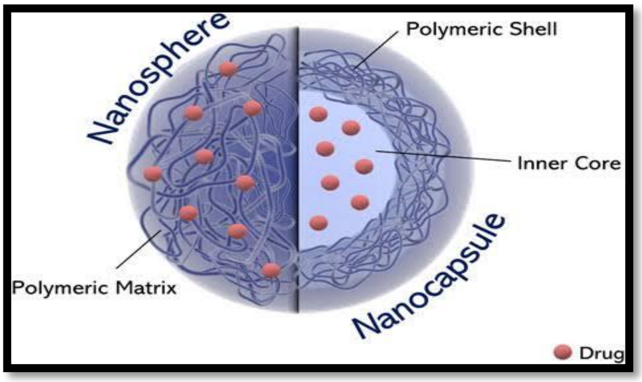

Figure 4:Surface of Nanocapaule

- **Determination of the ph of Nanocapsule:**

Composition of Nano capsules pH is measured usin digital pH meter at room temperature. Nanocapsules dispersion pH values fall within range 3.0-7.5.

4. PREPARATION METHODS OF NANOCAPSULE

1. Nanoprecipitation Method:

Nanoprecipitation method is also called solvent displacement or interfacial displacement the most used polymers biodigradable are polyester, especially poly-epolylactide (PLA) and polylactide PLG

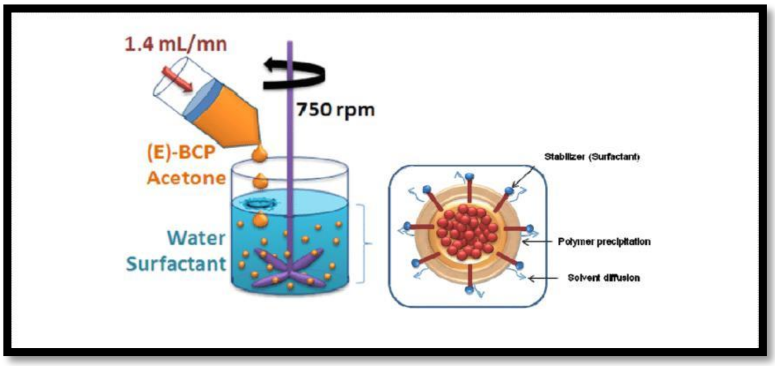

Figure 5: Preparation of Nanocapsules by Nanoprecipitation Method.

2. Polymerization Method :

The medicament is placed either by solubilizing in the polymerization media or by adsorption of nanoparticles after the polymers are polymerized in a water - soluble solution to create nanoparticles. Ultracentrifugation is a process for purifying nanoparticle suspensions by removing various stabilisers and surfactants used in polymerization. The nanoparticles are subsequently resuspended in a surfactant medium that is isotonic.Polybutycyanoacrylate or polyalkylcyanoacrylate nanoparticles have been suggested.

3. Emulsion–Diffusion Method:

In this method, the oil phase is made up of a small amount of water miscible organic solvent and a small amount of water immiscible organic solvent. Biodegradable polyesters, particularly PCL, PLA, and Eudragit, are extensively utilised. PHBHV (poly (hydroxybutyrate-cohydroxyvalerate)) is also can be used.

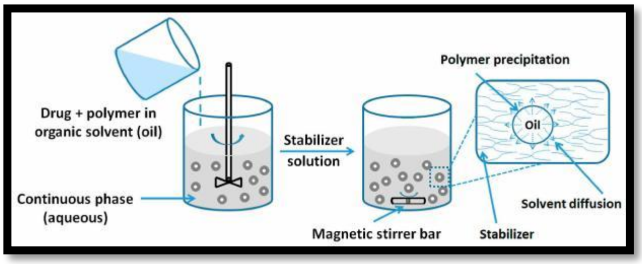

Figure 6 :Emulsion -Diffusion Method

4. Emulsion Polymerisation:

An example of a pre-emulsion preparation procedure is the M-6 Nanocapsule. Part I contained 40 g styrene, 0.8 g DVB (divinylbenzene), 0.82 g AIBN (2,2′-azobisisobutyronitrile), and 40 g Desmodur BL3175A; while Part II had 1.71 g SDS (sodium dodecylsulfate), 1.63 g Igepal CO-887, and 220 g water. Parts I and II were magnetically mixed for 10 minutes in separate containers.

The contents of Part II were then added to Part I under mechanical stirring and mixed for 30 minutes at 1,800 rpm. The resulting pre-emulsion was cooled to 5°C before being sonicated (until a particle size of 250 nm was reached) with a Misonix sonicator 3000. The pre-emulsion (Jackson et al 1991) was degassed for 30 minutes in a three-neck round bottom flask fitted with a mechanical stirring, reflux condenser, and nitrogen inlet. To finish the polymerization, the temperature was raised to 70°C and kept there for 8 hours. Electron irradiation deposition and chemical vapour deposition are two other nanocapsule preparation processes. Charge transfer, organic reagent assisted technique, laser vaporization-condensation Catalytic vapor-liquid-solid technique and solution-liquid-solid method.

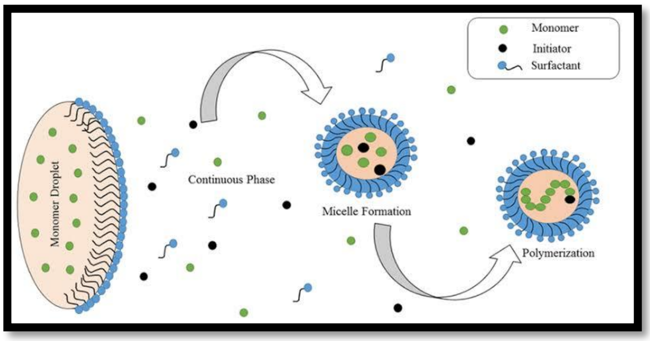

Figure 7 : Emulsion Polymerization Method

5. Polymer-Coating Method:

They use poly (methyl methacrylate) (PMMA), poly(methacrylate) (PMA), and PCL as layer-formed polymers. The production of nanocapsules is based on the engulfment mechanism in three-phase systems.

6. Layer-by-Layer Methods :

In the Layer by layer methods polycations are used such as chitosan, polylysine ,gelatin B, Polyallylamine (PAA), aminidextran, Protamine Sulfate.

The following polyamines are used :

- Sodium Alginate
- Polyacrylic acid
- Dextran sulfate
- Carboxymethyl cellulose
- Condrointin, Heparin
- Hyaluronic acid, Gelatin B

- **Nano-Based Drug Delivery Systems:**

There have been significant advancements in the field of delivery systems to transport therapeutic agents or natural-based active chemicals to their target locations for the treatment of a variety of diseases. Although a lot of drug delivery systems have been successfully implemented in recent years, there are still some issues to be addressed and sophisticated technologies to be created in order to successfully transport medications to their target sites.

- **Fundamentals Of Nanotechnology Based Techniques In Designing Of Drug:**

Nanomedicine is a branch of medicine that use nanoscale materials such as biocompatible nanoparticles and Nanorobots for a variety of applications in living organisms, including diagnosis, delivery, sensing, and actuation. Drugs with very low solubility have a variety of biopharmaceutical delivery issues, including limited bioaccess after oral intake, lower diffusion capacity into the outer membrane, higher intravenous dosage requirements, and undesirable side effects prior to the traditional formulated vaccination process. All of these constraints, however, could be solved by incorporating nanotechnology into the medication delivery process.

- **Drug Designing and Drug Delivery Process and Mechanism:**

With the recent advancement of nanomedicine and the advancement of drug discovery/design and drug delivery systems, various therapeutic procedures have been proposed and traditional clinical diagnostic methods have been investigated in order to improve drug specificity and diagnostic accuracy. For example, new medication administration methods are being investigated, with a focus on assuring tailored action in specific locations, hence minimising toxicity and boosting bioavailability in the organism. The advancement of experimental methodologies for the categorization and purification of proteins, peptides, and biological targets, as well as advances in computer sciences, are critical for the sector's growth and development.Furthermore, multiple research and reviews have been found in this domain; they focus on the rational design of various compounds and demonstrate the relevance of understanding various drug release mechanisms. Natural products can also serve as inspiration for drug development with desirable physicochemical features, and can provide feasible and innovative answers to drug design issues. In recent years, drug delivery technologies have also become more important. Such systems are simple to create and capable of encouraging the controlled release of active chemicals in the body.

5. EVALUATION STUDIES OF NANOCAPSULE

1. Studies on X-Ray Diffraction (XRD):

Powder XRD using a Rigaku D/max-2000 diffractometer with graphite monochromatized CuK (= 0.154 056 nm) at a voltage of 50 kV and a current of 250 mA is used to determine the phase of the products. The phase composition of processed items can be seen in the XRD pattern.

2. SEM (Scanning Electron Microscopy) :

It is a technique for examining objects using an electron microscope (SEM) .The architecture of hierarchical branching aggregates, defined by nanocapsules, may consist of flocculent structure, small clusters, big clusters, and big branches, which validates the structure's self-similar properties. It is distinguished by a Philips XL-30 scanning electron microscope (SEM), which displays the distinct morphology of small clusters at high magnification. Clusters are generated by tiny particles adhering together to form a flocculent structure.

3. Differential scanning Calorimetry (DSC) :

Both open (without a cover) and closed (with a lid) samples are subjected to DSC analysis (pan capped possessing a small hole in the center). According to the observations, both approaches have similar thermal characteristics.

4. Transmission Electron Microscopy (TEM):

Transmission Electron Microscopy (TEM) is a type of electron microscopy that (TEM) Transmission electron microscopy can be used to analyse the transport of insulin-loaded nanocapsules throughout the epithelium after oral route to experimental rats in both in vitro and in vivo experiments. The intestinal absorption of biodegradable nanocapsules leads to insulin transport across the epithelial mucosa, according to TEM findings.

5. Superconducting Quantum Interference Device (SQUID):

Quantum Design MPMS-7s or MPMS-5s superconducting quantum interference devices are used to measure the magnetic characteristics of nanocapsules. SQUIDs are the most sensitive detectors for detecting minute changes in magnetic flux, which accounts for the vast range of applications that SQUID devices can be used for.

6. FT-IR analysis:

The presence of characteristic peaks is confirmed by using the FTIR analysis. The peaks indicate the characteristic functional groups of compound.

6. APPLICATION OF NANOCAPSULE

1) **Nanocapsules as Drug Delivery Systems:** Nanocapsules made of dispersed polymer can be used as nano-sized drug carriers for controlled release and efficient drug targeting.

2) **Medical sector :** Water-soluble polymer shells are being created to deliver a protein, apoptin, into cancer cells. The capsules are 100 nanometers in diameter.

3) **Future Nanocapsule Bandages to Fight Infection:** This advanced dressing will speed up treatment by releasing antibiotics only when the wound gets infected, eliminating the need to remove the dressing and boosting the odds of the wound healing without scarring. This Nanocapsules bandage could be used for a variety of wounds, including ulcers, and even by military personnel on the battlefield.

4) **New Cancer Weapon-Nuclear Nanocapsules**:Chemists have discovered a technique to package some of nature's most powerful radioactive elements within DNA-sized tubes of pure carbon, a process they hope to utilise to target microscopic tumours and even lone leukaemia cells.

5) **Other Nanocapsule Applications:** Nanocapsules could be used in agrochemicals, cosmetics, genetic engineering, wastewater treatment, cleaning goods, and adhesive component applications, among others. Enzymes, catalysts, oils, adhesives, polymers, biomedicals, inorganic micro- and nanoparticles, latex particles, and even biological cells can all be encapsulated with them.

6) **Nutraceuticals**: compounds that are added to food to improve its nutritional value. These drugs' improved bioavailability is proportional to the size of the nanocarrier.

7) **Medication administration:** Nanocapsules have been proposed as a drug delivery mechanism for a variety of medications via several modes of administration, including oral, parenteral, and intravenous.

7. CONCLUSION

Nanocapsules are a contribution to methodological development formulation through a variety of ways, the most common of which are interfacial polymerization and interfacial Nano deposition. They are also capable of being released as monodisperse particles with well-defined biological, electrical, optical, and magnetic properties. Nanomaterials have a wide range of applications in the fields of biochemistry, pharmaceuticals, electronics, and molecular diagnostics. They offer a wide range of uses and good reproducibility due to their micronized size, and they can be used in life science applications. Nanocapsules are useful in a variety of fields, including agrochemicals, cosmetics, genetic engineering, waste water treatment, and cleaning goods. Enzymes, organic or inorganic catalysts, oil nanoparticles, adhesives, surface polymer, and even biological organisms can all be encapsulated with them. Nanocapsules have the potential to be employed as a good medicine.

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