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Review Article

Floating Microsponge: An Emerging Drug Delivery System

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Abstract

Floating microsponges are a method to extend gastric residence time, there with the aid of using concentrated on site-responsive medicament liberate withinside the top GIT for locally or systemic effect. Gastro retentive dosage forms (GRDFs) are getting utilized from a totally long term to enhance treatment with numerous main medications. Floating microsponge significantly enhances the therapy of stomach with the aid of using liberating the medication locally and for that reason used for medication selecting at specific organ. This may be sustained over an extended period of time. Floating drug delivery allow extended and non-stop release of the drug to the top a part of Gastro intestinal tract and this expressively amplify the period of drug release and enhance pharmacokinetic of medication which have slim healing window, with the aid of using this method dosing frequency and affected person compliance is increased. A microsponge's drug delivery system is a particularly cross-linkage, spongy, polymeric microsphere, polymeric device consisting permeable microspheres. Microsponges are prepared with the aid of using numerous techniques consisting of liquid-liquid suspension polymerization and quasi emulsion solvent diffusion method. Microsponge,s preparations are strong over variety of pH 1 to 11; microsponge,s preparations are strong on the temperature as much as 130^{0}C well suited with maximum vehicles and ingredients. The present assessment introduces microsponge,s technology at the side of its techniques of preparation, characterization, advantages, evaluation and release mechanism of microsponge,s drug delivery system, advertised product and up to date studies regarding microsponge.

Keywords: Floating microsponge, Oral administration, Controlled release, Quasi emulsion, Target release.

1. Introduction:

1.1 Floating Drug Delivery System [FDDS]:[1,2,3]

Oral route is maximum ideally path of drug delivery to easy administration, pliability in preparation, low price and affected person compliance. Oral controlled release drug delivery system suggests a few restrictions associated with gastric emptying time. Too rapid and variable gastric emptying should results in insufficient drug release from dosage form into absorption window main to low effectiveness of administered dose. Floating drug delivery system become to put together the presently awareness at the principle procedure of ability to float to acquire gastric retention time. The modern tendencies of FDDS together with the biological and approach variables influencing gastric retention, strategies to format floating structure, and their class and approach elements are enclosed in detail. Gastroretentive system can remain within the gastric region for several hours and as a result appreciably extend gastric residence time of drug. Prolong gastric retention enhances pliability of drugs which might be much less soluble in an immoderate pH environment}, decreases drug wastages and enhance bioavailability. FDDS has the main utility for the delivery of local drugs to the stomach.

1.2 Basic Gastrointestinal tract Physiology:[4]

For the improvement of Gastro-retentive drug delivery method should have expertise of body structure of gastrointestinal tract. Anatomically the stomach is split into 3 parts- (1) fundus, (2) body and (3) antrum(pylorus) The contiguous element fabricated from fundus and undigested material store in frame so frame acts as reservoir, and antrum (pylorus) is the responsible web page for mixing motion and acts as a pump, cause gastric emptying.

Stomach Physiology:[2,4]

The maximum crucial function of stomach is to process and to convey the food. It act as a short-time period storage reservoir, enzymatic digestion started out in stomach wherein various juices mix with food which is probably produced via gastric smooth muscles and ensuing in liquefaction of food and it's miles released for small intestine for in addition process]. Stomach is part of digestive system that's located amongst oesophagus and small bowel. Structurally the wall of stomach is alike to the alternative components of the digestive tube but stomach has a likewise oblique layer of smooth muscle inside the spherical layer which permits the motion inside the stomach. When stomach is empty, it's far gotten smaller and its mucous membrane and sub mucous membranes are thrown up into wonderful folds known as rugae.

Gastric emptying takes place all through each fasting in addition to fed states. In each conditions the arrangement of mobility is non - identical. Interdigestive series of electrical activities takes place throughout dieting conditions, which cycle every by stomach and bowel each 2 to a few hours. This is called interdigestive myloelectric cycle or migrating myloelectric cycle (MMC), that is in inclusion divided within quaternary stages that are fallowing.

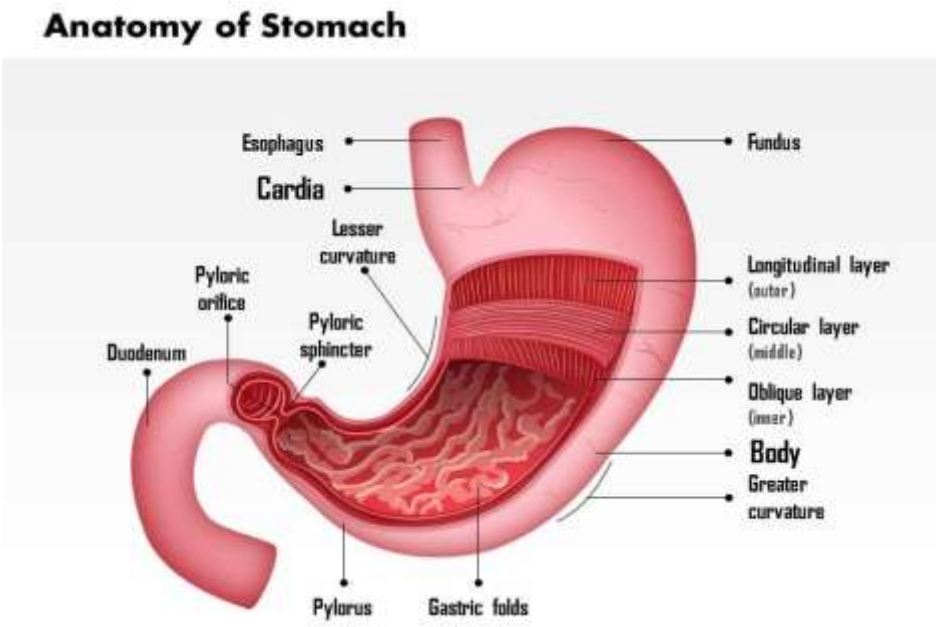

Figure 1: Anatomy of Stomach[5]

Table 1: Various Phases of Activity in migrating myoelectric cycle:[6]

Phase no.	Phase name	Activity
Phase 1	Basal Phase	This phase is enduring from 30 to 60 minutes along infrequent or no contractions.
Phase 2	Preburst Phase	This phase is consist intermittent movement capacity and contractions. That regularly will increase depth and frequency as phase development and it lasts for 20 to 40 minutes.
Phase 3	Brust Phase	This period have short duration of severe and normal contractions and those waves are liable for swept out of unabsorbed substances from stomach to the small bowel and those waves also are referred to as the care taker waves. Brust stage endures for 10 to 20 minutes.
Phase 4		This phase take place between phases 3 and 1 of 2 successive rotations and lasts for 0 - 5 minutes.[4]

1.3 Microsponge:[7]

Microsponges are minute sponge like micron length round shaped debris and incorporate actively pharmaceutical ingredient. Microsponges features a myriad of associated spaces inner an unfoldable form with a large permeable surface. Microsponges drug delivery system provide managed release of active elements, it presents several benefits above different generation such as advanced product stability, reduced adverse effects, prolonged elegance and prolonged preparation pliabilitys.

1.4 Characterstics of Microsponge:[8, 9]

- Microsponge preparations are sturdy over type of pH 1 to 11.
- Microsponge preparations are strong at the temperature approximately one hundred thirty degree centigrade.
- Microsponge preparations are properly suitable along maximum medium and components are decontaminating as its usual orifice length is 0.25 micro meter wherein microorganisms impenetrable.
- Microsponge preparations have greater burden (50 to 60%), none the less loose flowing and may be price effective.

1.5 Benefits of microsponge drug delivery systems: [10, 11]

- The performance of the product is increased.
- Prolonged release.
- Reduce irritation and consequently greater ideal affected person compliance.
- Enhanced outcome elegance.
- Authorizes for new consequences formation.
- Enhances effectiveness in therapy.
- Treatment or manage affirm extra quickly.
- Enhance manage of situation.
- Enhance pharmacokinetics of equal medications.
- Pliability is enhanced for the formation of new outcome.
- Microsponges are harmess and non – irritating.

- Enhances physical, chemical and thermal strength.
- Permits fusion of non-miscible outcomes.
- Enhances fabric technology e.g. fluid may be transformed to powders.

1.6 Characterstics of materials that is entrapped in microsponges:[12]

- It ought to be each absolutely mixable in monomer or able to being produced mixable via way of means of method of inclusion of little quantity of fluid non-miscible solvent.
- It ought to be water non-miscible or at most first-class slightly soluble.
- It ought to be immobile to monomers for that reason it is able to react among exceptional excipient in formulation.
- The pliability of actives within the medium ought to be restricted to keep away from beauty difficulties; now no longer extra than 10 to 12% w/w microsponges should be absorbed towards the medium. Or else, the medium will use up the microsponges in advance than the utilization.
- The round shape of microsponges need to not compress.
- Polymer format and burden of the microsponges for the active should be developed for required release rate for specified duration.

1.7 Limitations of Microsponges:[13, 14]

- Absorption of strains of residual monomers can also additionally cause poisonous impact withinside the body.
- The preparation technique in the major use biotic solvents as porogens, which cause an environmental danger, as a few can be enormously flammable, causing a protection hazard.

1.8 Properties of Drugs that is trapped into Microsponges:[15, 16]

- Either absolutely miscible in monomer or capable of being produced miscible with the resource of the usage of inclusion of little quantity of aquous non-miscible dissolvent.
- Microsponge is stable in touch with catalyzing polymer and situations of polymerization.
- The round form of microsponges ought to now no more collapse.
- Active materials which can be trapped in microsponge can then be included into numerous outcomes together with lotions, gels, creams and detergents.
- The pliability of actives within the automobile have to be confined to keep away from beauty complications; now no longer extra than 10 to 12% w/w microsponges have to be included into the medium. Or else the medium will use up the microsponges in advance than the utilization.
- Aqueous non-miscible or at maximum simplest barely dissolvable.
- Burden and polyurethane format of the microsponges for the active have to be perfect for necessary to liberate amount for specified duration of time.

2. MATERIALS AND METHODS: [17]

There are some drugs, polymers and other chemicals, which are used in preparation of floating drug delivery system, are as follows.

Table 2: Various materials used to formulate Microsponges.[18]

S. No.	Drugs	Polymers	Other Chemicals
1	Sulpiride	Ethyl cellulose	Magnesium Stearate
2	Allopurinol	Eudragit S100	Span 80
3	Diazepam	Tween 80	Dichloromethane
4	Ciprofloxacin	Polyvinyl alcohol	Citric acid
5	Misoprostol	Carbopol 940	Ethanol
6	Domperidone	Eudragit EPO	Sodium hydroxide
7	Famotidine	Eudragit E- 100	Sodium chloride

2.1 Preparati

- Drug loading in microsponges can take place in methods, one-step method or through manner of way of -step method as mentioned in liquid-liquid suspension polymerization and quasi emulsion solvent diffusion strategies which may be based mostly on physicochemical characterstics of medicament to be loaded.

A. Liquid-liquid suspension polymerization: [20]

In the Liquid-liquid suspension polymerization technique, the permeable microspheres are formulated through suspension polymerization technique in liquid-liquid systems. In the formulation, the monomers are firstly break down along side active components in a acceptable solvent mixture of monomer and afterwards distributed within the watery stage, which encompass additives (surface active agents, postponing agents, etc.). The polymerization is commenced through including reactants or through enhancing temperature or reflection.

The several points includes withinside the guidance of microsponges are outlined as ;

- Choice of monomer or amalgamation of monomers
- Development of chain monomers as polymerization begins.
- Development of stair due to circulate linking amongst series of small molecules.

- Doubling of monomer stair to shape round particles- Collection of liposomes, which provide upward push to development of bouquets of liposomes.
- Unbreakable of bouquets to shape microsponges.

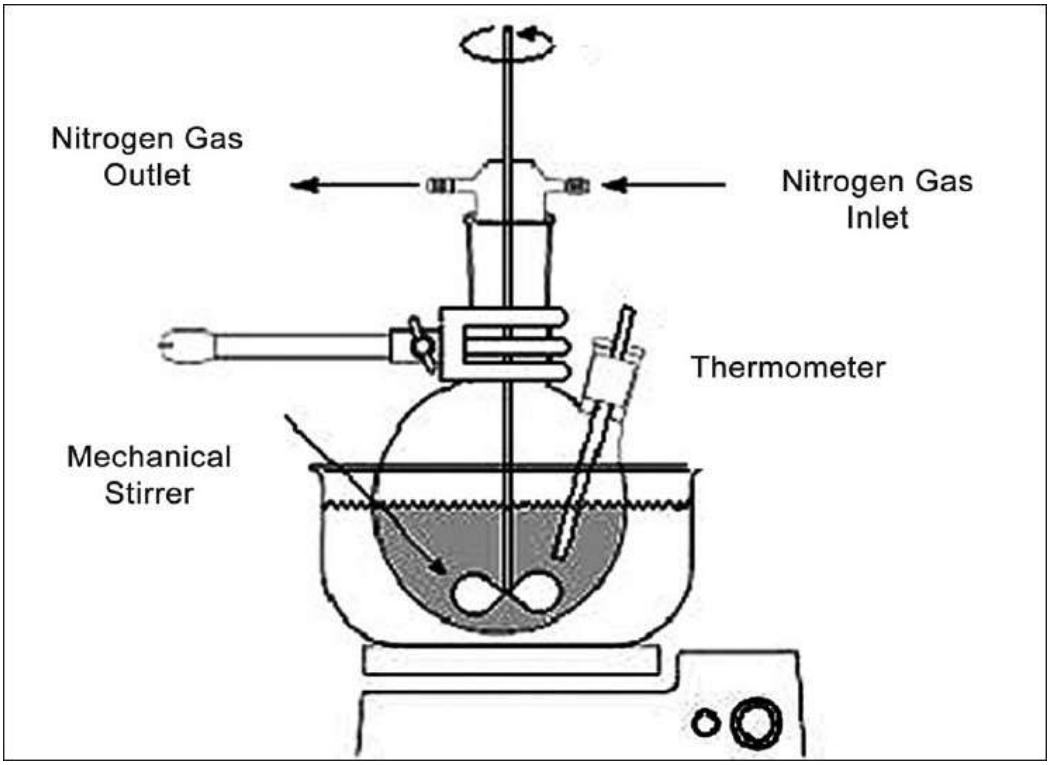

Figure 2: Reaction vessel for microsponge preparation by liquid liquid suspension polymerization.[21]

B. Quasi-emulsion solvent diffusion: [22]

In the Quasi-emulsion solvent diffusion approach this is the approach wherein the microsponges can formulated through manner of approach of quasi emulsion solvent diffusion approach utilizing the distinct polymer quantities. To put together the internal segment, Eudragit RS one hundred changed into disintegrated in ethyl alcohol. Then, the drug may be introduced to mixture and disintegrated in the process of ultrasonication at 35^0 c. The internal segment modified into coursed within the PVA mixture in aquous (external phase). Following sixty minutes of agitation, the aggregate is percolated to split the microsponges. The microsponges are parched within a hot air oven at 40°c for 12 Hr and weighed to decide manufacturing yield.

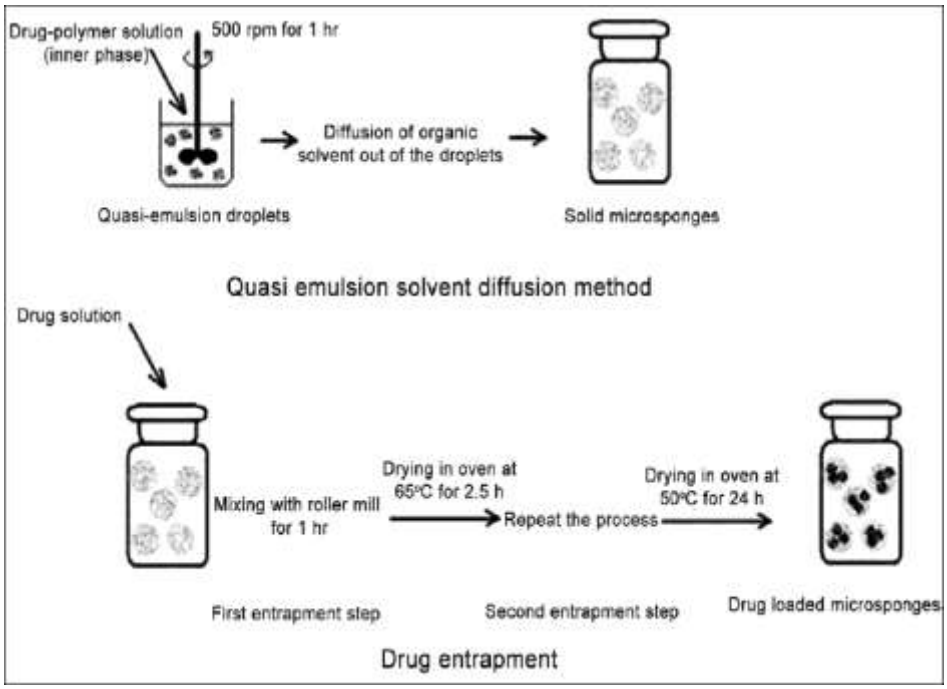

Figure 3: Method of quasi solvent diffusion [23]

2.2 Assessment of Microsponge:[24]

[A] Particle size determination:[25]

Laser light diffractometry or a few different appropriate strategies are the usages of Particle length evaluation of packed and unpacked microsponges. The merits may be indicated for each and every preparations, length area. The accumulative percentage mediaction release from microsponges of numerous particle length can be arranged closer to time to examine impact of particle length on medicament deliver. Particles larger than 30 micrometer may give dusty perception and subsequently debris of dimensions amongst 10 and 25 micrmeter are favored to apply in very last topical preparation.

[B] Scanning Electron Microscopy:[26]

For morphology and surface topography, organized microsponges may be lined with gold palladium below an argon environment at normal temperature after which the floor morphology of the microsponges may be studied with the useful resource of the usage of scanning electron microscopy (SME). SEM of a cracked microsponge's particle can be held its extraordinarily shape.

[C] Determination of loading efficiency and production yield:[27]

The loading efficiency (%) of the microsponges may be calculated consistent with the subsequent equation:

$$\text{Loading efficiency} = \frac{\text{Actual Drug Content in Microsponge} \times 100}{\text{Theoretical Drug Content}}$$

[D] Production Yield:[28]

The manufacturing yield of the micro particles can be determined by calculating accurately the initial weight of the raw materials and the last weight of the microsponge obtained.

$$\text{Manufacturing Yield (MY)} = \frac{\text{Practical Mass of Microsponges} \times 100}{\text{Theoretical mass (Polymer + drug)}}$$

[F] Determination of accurate density:

The accurate thickness of microsponges may be calculated the use of an extremely pycnometer beneath helium gas and is measured from an average of replicated calculations.

[G] Compatibility Studies: [29]

Concordance of medicament with response assistant may be examined via thin layer chromatography (TLC) and Fourier Transform Infrared spectroscopy (FT-IR). Result of polymerization on lucidity of the medicament may be examined via powder X-ray diffraction (XRD) and Differential Scanning Calorimetry (DSC).

[H] Polymer/monomer composition:

Aspects which include microsphere dimension, medicament packing, and polymer constitution control the medication liberate from microspheres. Polymer constitution of the MDS could have an impact on partition coefficient of the trapped medication the various automobile and the microsponge system and because of this posses direct effect on on the release rate of trapped medicament. Discharge of medicament from microsponge systems of numerous polymer constitution can be examined via designed accumulative percentage medication discharge in opposition to time.

2.3 **MECHANISM OF RELEASING: [30]**

Microsponge may be composed to dischraged allowed quantity of active substances through the years in reaction to one or greater outside triggers.

A. Temperature change: At normal temperature, some trapped active substances may be too sticky to passage all of sudden from microsponges onto the pores and epidermis. With improve in pores and epidermis temperature, flow rate is likewise expanded and consequently discharge is likewise increased.

B. Pressure: Rubbing or strain implemented may discharge the active element from microsponges onto pores and epidermis.

C. Pliability: Microsponges packed with aqueous mixable substances such as medicated and cleansers will discharge the element within the existence of aqua. The discharge also may be operated through dispersion however taking into deliberation, the partition coefficient of the element among the microsponges and the outside system.

D. PH triggered systems: Triggering the pH-primarily based totally discharge of the active may be executed through enhancing the covering at the microsponges.

Table 3: List of Marketed Products Using Microsponge Drug Delivery System:[31]

Product name	Content	Application	Manufacture
NeoBenzMicro	Benzoylperoxide, methyl methacrylate/glycol	Antibacterial properties	Intendis Inc. Morristown NJ07962 USA
Ultra Guard	Dimethicone	To conserve a body's epidermis from diaper reckless.	Scott paper Company
Salicylic peel 30	Salicylic acid 30%	All dead cells are released from skin.	Biomedic
Salicylic peel 20	Salicylic acid 20%	Enhances thin lines, pigmentation.	Biophora

3. CONCLUSION:

After have a study of many literatures, it could be concluded that floating drug delivery system offers various functionality advantages for drug with low bioavailability due their absorption is constrained to the pinnacle gastrointestinal tract (GIT) and they will be brought adequately therefore optimizing their consumption and improving absolute pharmacokinetic. Microsponge system gives the capacity to preserve API in a blanketed surroundings and offer managed transport of oral medicine to the decrease gastrointestinal (GI) tract. In oral application, the microsponges system has been demonstrated to growth the discharge of melting of hardly aqua dispersible drug through methods and means of entrapping such drug withinside

the microsponge system's pores. Because the ones pores are extremely small, the drug in effect decreased to microscopic particles with resultant will enhance in surface area and therefore notably will enhance the rate of solubilizing. A brought benefit is that floating microsponge enhance gastric retention time therefore pharmacokinetic of medication is increased.[32]

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