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Colon targeted drug delivery system

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Abstract

For individuals receiving medication, the oral route is often considered to be the most practical. usually dissolves in the stomach as intestinal fluid and is taken up by these GIT regions. When localized drug delivery into the colon is required, it is a major drawback because the medications need to be protected from the abrasive environment of the upper gastrointestinal tract. Targeted drug delivery into the colon is particularly desirable for the local treatment of various gastrointestinal disorders, including ulcerative colitis, cirrhosis disease, amoebiasis, colonic cancer, local treatment of gastrointestinal pathologies, and systemic administration of protein and nutrients. peptide-based medications. In order for the colon specific drug delivery system (CDDS) to transport the medication to the colon and keep it safe.

Introduction

The oral route is thought to be the most practical for patients receiving medication. Normally dissolves as intestinal fluid in the stomach and is absorbed from these GIT areas. It is a significant disadvantage when localized medication administration into the colon is needed since the pharmaceuticals must be shielded from the harsh environment of the upper GIT. For the local treatment of a number of gastrointestinal disorders, such as ulcerative colitis, cirrhosis disease, amoebiasis, colonic cancer, local treatment of gastrointestinal pathologies, and systemic administration of protein and nutrients, targeted drug delivery into the colon is particularly desirable. peptide medicines. The colon specific drug delivery system (CDDS) must be able to protect the drug while it is being delivered to the colon, which means that neither drug release nor absorption should take place in the stomach or small intestine, nor should the bioactive agent be degraded at either of the dissolution sites[1,2,3].

Proteins and peptides can be given regularly by intestinal absorption, including insulin, calcitonin, and vasopressin. Novel peptides that are helpful in treating IBD and GI infections, respectively, include cytokine

inhibitors and antibiotics. Due to its abundance in lymphoid tissue, the colon presents an opportunity for the oral distribution of vaccinations in addition to preserving these labile molecules. It was discovered that a colonic-targeted approach was effective in minimizing undetermined adverse effects Due to its near-neutral pH, prolonged transit time, reduced proteolytic enzymatic activity, and higher reactivity to absorption boosters, the colon provides a number of benefits as a site for medication delivery. Colon-specific delivery systems must have a triggering mechanism to release the drug once it reaches the colon in order to prevent drug release in the upper portion of the GIT.[4]

Why is colon targeted drug delivery needed?

Lower doses and fewer systemic adverse effects are required to enable direct treatment at the site of the disease. The drug delivery time could be extended by using a formulation that is colon- specific. It ought to be regarded as advantageous in the management of colon disorders. Local or systemic medication delivery may be accomplished in the colon. topical medication for inflammatory bowel diseases including Crohn's disease or ulcerative colitis. Sulphasalazine and glucocorticoids are frequently used to treat such inflammatory disorders. If medications were specifically aimed at the colon, a variety of other major diseases of the colon, such as colorectal cancer, might also be able to be treated more successfully. Drugs that are polar or vulnerable to enzymatic and chemical breakdown in the colon can also be delivered using formulas for colonic administration.

Anatomy and Physiology of Colon

The stomach, small intestine, and large intestine make up the GI tract. There are three primary sections that make up the large intestine, which runs from the ileocecal junction to the anus. These are the rectum, the anal canal, and the colon. The colon is separated into five main sections, each measuring around 5 feet (150 cm) in length. Mesentery is the term for the peritoneal folds that are supported by the ascending and descending colon. The cecum, ascending colon, hepatic flexure,

and right part of the transverse colon make up the right colon. The left transverse colon and descending colon are contained in the left colon. sigmoid and splenic flexure. Before the anus, the rectum is the last anatomical component. In Figure 1, the human colon was depicted.The primary duties of the colon include producing an environment favorable for the development of colonic microbes, acting as a reservoir for feces, releasing its contents at the proper time, and absorbing potassium and water from the lumen. The ileocecal valve allows for the entry of around 2000 ml of fluid every time into the colon, where more than 90% of the fluid is absorbed.[5]

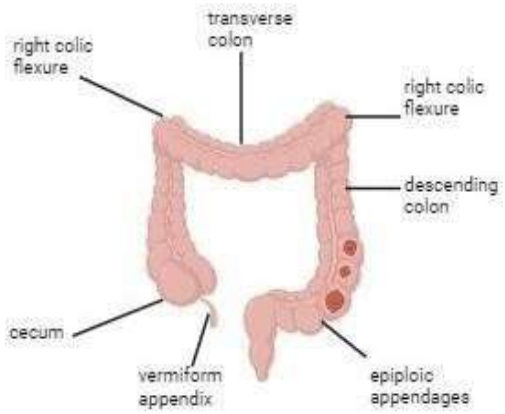

Fig: Anatomy of colon

Advantages of colon targeting drug delivery system:

- Colon is a perfect location for the delivery of treatments for colon disorders that are localized.
- The benefit of local treatment is that it uses less medication.
- reduces the frequency of dosing. Low cost of pricey medications as a result.
- Potentially decreasing the likelihood of adverse effects and drug interactions.
- Poorly absorbed medicinal molecules may have enhanced bioavailability when administered to the colon.
- Reduce the stomach irritability that many medications (like NSAIDS) produce.
- Skip the first pass of metabolism.

- Prolonged midnight or daytime activity.
- It has a longer retention time, appears highly responsive to agents that enhance the absorption of poorly absorbed drugs, and
- has a low hostile environment and less peptidase activity,
- making it possible to administer peptides, oral vaccines, insulin, and growth hormones through this route.[6,7,8,9]

Limitations of colon targeting drug delivery system

- diverse manufacturing processes
- The colon's functionality may also be impacted by the local microflora's metabolic breakdown of the medication.
- Incomplete drug release
- Due to the medicine's propensity for nonspecific binding to food residues, intestinal fluids, mucus, or feces, bioavailability of the drug may be limited.
- Before absorption, the drug should be in solution form; this is the rate-limiting stage for poorly soluble medicines.
- There isn't a suitable in-vitro dissolving testing method available to assess the dosage form.[10]
- The unpredictability of the environment and location in which the coating may begin to dissolve is a significant drawback of the pH sensitive coating technology. Normal in ulcerative colitis patients.[11,12]
- The prodrug technique has some limitations, including the fact that its formulation is dependent on the functional groups accessible on the drug moiety for chemical coupling. Prodrugs are also novel chemical entities that require extensive testing before to being used as carriers.[13]

Factors affecting colon targeted drug delivery

1. Physiological factors

2. Pharmaceutical factors

1. Physiological factors

a. Gastric emptying

After taking a drug orally, the colon receives it mostly during the time it takes for the bowel to transit and empty. The dose form's transit time through the colon is contingent upon the particle size. In comparison to bigger particles, smaller particles have a longer transit time. Patients with diarrhea had shorter transit times, while those with constipation experienced longer transit times. (Table : 1)

Table 1: Transit time of different parts of GIT

Part of GIT	Transit time
Fasted state	10min – 2hr
Fed state	>2hr
Small intestine transit	3-4hr
Colon transit	20-35hr

b. P^H of colon

The GIT's pH changes from person to person.The GIT's pH is influenced by dietary consumption, illness status, and other factors. Colon targeted drug delivery systems are developed on the basis of this variation in pH in different parts of the GIT. To direct the medication to the desired location, coating with various polymers is used.

c. Colonic microflora and enzymes

Numerous bacteria found in the GIT create a wide range of enzymes required for metabolism. Peristalstic motions and the contents of the GIT regulate the growth of this microflora. distinct microorganisms such as E. Coli, Clostridium, Lactobacilli, Eubacteria, and Streptococci release distinct enzymes, which are in charge of different metabolic reactions occurring in the gastrointestinal tract.

2. Pharmaceutical factors

a. Drug candidates

Colon increases the absorption of poorly absorbed substances like peptides and other similar substances because of its long retention duration. Medication used to treat inflammatory bowel conditions, among other conditions, is appropriate for a colon-targeted drug delivery system.

b. Drug carriers

The type of medication and the ailment it is taken for determine which carrier is best for CDDS. The drug's many physical characteristics, such as its chemical make-up, stability, partition coefficient, and functional groups, among others, influence the choice of carriers.[14]

Polymers Used in Colon Targeting

Polymers contain a large number of structural units joined by the same type linkage, form into a chain like structure. These are nowadays used in formulating various pharmaceutical products. Naturally found polymer, which include gummy exudates, proteins, enzymes, muscle fibre, polysaccharides. In olden days natural polymers are widely used in pharmacy but a variety of synthetic polymer are used nowadays for pharmaceutical and cosmetic development, using these polymers many therapeutic system of body namely controlled drug delivery systems, are achieved [15,16].

Natural polymer

Guar gum, Inulin, Pectin, Cyclodextrin, Dextran, Amylase, Chitosan, Chondrotin sulphate, Locust bean gum.

Synthetic polymer

Shellac, Ethyl cellulose, Cellulosw acetate phthalate, Hydroxy propyl methyl cellulose, Eudragit, Poly vinyl acetate Phthalate.

Function of Colon:

1. the storage of feces until they are expelled from the body and the consolidation of the intestinal contents into feces by the absorption of water and electrolytes.
2. to create an atmosphere that is conducive to the development of colonic microbes
3. secretion of K+ and HCO3 and absorption of H2O and Na+ from the lumen. [17,18,19]

Approaches for colonic drug delivery

Covalent Linkage of Drug with Carrier

Prodrug approaches:

A prodrug is a parent molecule that is pharmacologically inactive and needs to undergo enzymatic transformation in the biological environment in order to release the active ingredient at the intended location. In this method, the medication and its carrier are covalently linked so that, when taken orally, the drug's moiety stays intact in the stomach and small intestine and, once it reaches the colon, is renewed by enzymatic cleavage.[20]

a) Azo bond conjugate:

The primary purpose of sulfasalazine is to treat inflammatory bowl disorders. It is a prodrug called 5-Amino Salicylic Acid (5-ASA). As seen in figure 2, 85% of the oral dosage of sulfasalazine enters the colon unabsorbed, where the anaerobic environment breaks it down into 5-ASA and sulphapyridine.[21]

Diagram

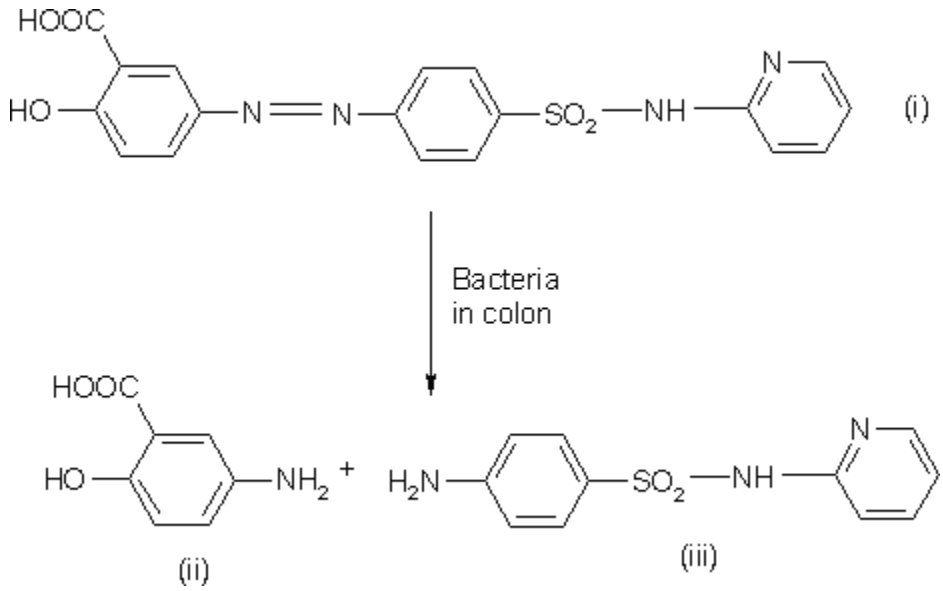

Figure 2. Reduction reaction of sulphasazine in 5-ASA and sulphapyridine

Numerous investigations on sulphapyridine result in the development of further prodrugs such as olanzazine, balsalazine, and 4-amino benzoyl-β-alanine.19] One well-known type of enzyme produced by intestinal microflora is called glycosidase.

Using azo-aromatic and pH-sensitive polymer, the formulation of flurbiprofen specifically for colons was assessed. The results showed that the azoaromatic polymer (poly-methylmethacrylatehydroxy rthylmethacrylate: 1:5) pH sensitive polymer eudragit S can successfully be used for colonic drug delivery. [22,23]

Salbutamol sulphate medication administration using Pulsincap has been studied. Ethyl cellulose was used to cover an empty gelatin capsule, preserving the cap piece intact. A gelatin hydrogel plug was appropriately coated with cellulose acetate phthalate so that it was secured to the body beneath the cap. By using the emulsion solvent evaporation process, Eudragit microspheres containing salbutamol sulphate were created and then added to this particular capsule shell. According to in vitro dissolution data, the medication started to release 7-8 hours after the experiment began. L-histidine and salicylic acid were combined to create a mutual azo prodrug of 5-aminosalicyic acid and histidine that was intended to be delivered specifically to the inflammatory gut tissue. [24,25]

b) Glucuronide conjugate:

One of the main processes involved in the inactivation and preparation of many medications for clearance is the conjugation of glucuronide and sulphate. Lower gastrointestinal tract bacteria release glucuronidase, which glucouronidates a range of medications in the colon. Glucuronide prodrugs would be anticipated to be better for colon focused drug delivery since the glucuronidation mechanism releases the active drug and permits its reabsorption.[26]

c) Cyclodextrin conjugates:

While hydrophobic cyclodextrins can slow the release of water, hydrophilic and ionisable cyclodextrins can function as effective drug carriers in formulations for both immediate and delayed release. Furthermore, the drug carrier's capacity to deliver a medication to a specific location is its most desired quality. Drugs conjugated with cyclodextrins can be a flexible way to create a novel class of colon-targeting soluble prodrugs. Prodrugs of α-, β-, and γ-cyclodextrins containing ibuprofen were studied. Reference [27]

Methotrexate prodrugs of α- and γ-cyclodextrins were also created, with the major goal being to conceal the ulcerogenic potential of the drug. This was accomplished by utilizing equivalent doses of the esters and a 12-fold dose of the standard methotrexate dosage. [28,29,30]

d) Dextran conjugates:

Metronidazole dextran ester prodrugs have been synthesized and described. The effectiveness of dexamethasone and methyl prednisolone dextran ester prodrugs in reaching the colon was demonstrated by their synthesis. A succinate linker was used to covalently connect methyl prednisolone and dexamethasone to the dextran.[31]

e) Amino-acid conjugates:

The hydrophilic properties of polar groups, such as NH2 and COOH, found in proteins and their building blocks, amino acids, cause them to decrease the permeability of proteins' membranes. Drug molecules have been conjugated to these polar amino acids to create a variety of prodrugs. Salicylic acid was coupled to non-essential amino acids like glutamic acid, glycine, tyrosine, and methionine.[32]

F) Polysaccharide Based Delivery Systems

Since these naturally occurring polymers of monosaccharides are widely available, cheap, and come in a variety of forms with different characteristics, their usage in drugs aimed at the colon is gaining a lot of attention. They are very stable, safe, nontoxic, hydrophilic, gel-forming, and biodegradable. They can also be readily altered chemically and biochemically. These include naturally occurring polysaccharides derived from microorganisms (dextran) or plants (guar gum, inulin), animals (chitosan, chondrotin sulphate), or algae (alginates). The intestinal microbiota has the ability to degrade polysaccharides into simple saccharides.21 As a result, they are classified as "generally regarded as safe" (GRAS). Table 5 has an overview of several polysaccharide-based delivery methods.[33]

pH-Dependent Drug Delivery Systems

Colic medication distribution can be targeted to the colon because it has a pH that is comparatively higher than the upper GI tract. As a result, pH-dependent polymers like cellulose acetate phthalates (CAP), hydroxypropyl methyl-cellulose phthalate (HPMCP) 50 and 55, and copolymers of

methacrylic acid and methyl methacrylate (such as Eudragit® S 100, Eudragit® L, Eudragit® FS, and Eudragit® P4135 F) are used in the design of a colon-targeted drug delivery system [34,35]. The most popular synthetic copolymers for colonic drug administration, in particular, are Eudragit® polymers, which provide pH-dependent drug release and mucoadhesiveness [36,37]. The perfect polymer should be soluble in the terminal ileum and colon yet resistant to the low pH of the stomach and the proximal portion of the small intestine. Premature drug release in the upper GI tract prior to reaching colonic locations is therefore

anticipated to be prevented by drug delivery devices coated with pH-dependent polymers with a dissolving threshold of pH 6.0–7.0 [38]. However, because of the wide inter- and intra-subject variability in crucial parameters including pH, fluid volumes, GI transit durations, and motility, this pH-dependent system has shown notable variability in drug release and failure in vivo [39]. Furthermore, food, illness, water intake, and microbial metabolism can all have a substantial impact on the pH ranges of the GI tract [40]. For instance, compared to healthy individuals, ulcerative colitis patients have more acidic colonic pHs, which can cause partial drug release from enteric coated systems at the target location [39]. Therefore, the effectiveness of pH-dependent drug release systems may be diminished by the dynamic pH shift caused by numerous internal and external causes, which frequently results in inadequately site-selective drug release. Ibekwe and others [41] also demonstrated that the Eudragit® S coating was unsuitable for the colon-targeted drug release, either as a result of early drug release prior to the target location or disintegration failure at the target site. In the human research that followed, Ibekwe et al. [42]

Polymer-Based Nano-/Micro-Particles

pH-dependent polymeric nanoparticles have been shown in numerous studies to be effective colonic drug delivery vehicles [43]. Curcumin nanoparticles were delivered to the colon by a unique pH-sensitive hydrolyzed polyacrylamide-grafted xanthan gum (PAAm-g-XG) method developed by Mutalik et al. In acidic circumstances (pH 1.2 and 4.5), there was little drug released from the PAAm-g-XG-modified nanoparticles; at pH 7.2, there was a greater and faster release of drug from the nanoparticles [44].

In IBD rat models, the nanoparticles were therefore successful in reducing intestinal inflammation and weight loss. Furthermore, the drug release rate can be adjusted by blending a mixture of two pH-sensitive polymers. In order to create HBsAg-loaded nanoparticles for effective colonic

immunization, Sahu and Pandey combined Eudragit® L100 and Eudragit® S100. This confirmed the effective distribution of nanoparticles at the colon and the enhanced immune response In order to enhance the colon's site-specificity, Naeem et al. [45,46]

Hydrogels:

Drugs including peptides and proteins can be delivered to particular sites in the colon using hydrogels. The hydrogels consist of azo aromatic crosslinks that can be broken down by enzymes and acidic commoners. Gels exhibit less swelling in an acidic pH, which shields the medication from stomach breakdown. Swelling rises as the environment's pH rises, or becomes more basic. This leads to simple access for enzymes such as azoreductase, which releases the medication in the end.[47]

Delayed (Time controlled release system) release drug delivery to colon

Promising are time-controlled release systems (TCRS) such sustained or delayed release dose formulations. However, this approach's colon arrival time prediction of dosage forms is inaccurate due to the possibly wide variance in

human gastric emptying times, which leads to low colonical availability. Through an extension of the lag period of approximately 5.5 hours (range 5 to 6 hours), the dosage forms may also be applicable as colon targeted dosage forms. Some drawbacks with this system are:

(i) The length of time it takes for the stomach to empty varies significantly depending on the kind and quantity of food consumed by the patient.

(ii) The drug's gastrointestinal transit would alter as a result of gastrointestinal movement, particularly peristalsis or stomach contraction.

(iii) Patients with IBD, carcinoid syndrome, diarrhea, and ulcerative colitis have all been shown to move through the colon's various sections more quickly.

For the specific purpose of treating disorders connected to the colon, time-dependent devices are therefore not the best means of delivering medication to the colon. Drug distribution to the colon may be more site-specific if pH-sensitive and time-release components are appropriately integrated into a single dose form. This is because dose forms have a less variable transit time in the small intestine—roughly three and a half hours. In comparison to the stomach, the small intestine should

have a more effective time-release (or timer) function. Drug release occurs at a predefined period following gastric emptying, with the drug carrier being transferred to the target side of the small intestine. However, a pH detecting mechanism (acid resistance) in the dose form should limit drug release in the stomach, hence reducing variation in gastric residence duration [48]

[B] Newly developed approaches for CDDS

a) Pressure-controlled drug-delivery systems

The colon experiences greater pressures than the small intestine due to peristalsis. Pressure- controlled colon administration capsules made from water-insoluble ethylcellulose were created by Takaya et al. (1995). Under such systems, pressure within the colon's lumen causes a water- insoluble polymer capsule to disintegrate, allowing for the release of the drug. The primary cause of the formulation's breakdown is the thickness of the ethylcellulose membrane [49]. The system also seems to be dependent on the density and size of the capsules. The colon has a higher viscosity of luminal material than the small intestine due to the reabsorption of water from the colon. With regard to colon-specific oral medication delivery systems, it has been determined that drug disintegration in the colon may provide an issue. Within single-unit ethylcellulose capsules with pressure control, the medication is a liquid. When pressure-controlled capsules were given to humans, lag periods of three to five hours were seen in connection to medication absorption [50]

b) Pulsatile colon targeted drug delivery

i) Pulsincap system

The formulation for this system is created as a capsule.

The drug's release is managed by the plug that is inserted into the capsule. The drug's contents are sealed with hydrogels that can swell. When the capsule comes into touch with the dissolving fluid, it swells. The medicine is then released when the plug pushes out from the capsule after a lag period. Hydrogel plugs are made of polymers such polyvinyl acetate, polymethyl methacrylate, and various grades of hydroxyl propyl methyl cellulose (HPMC). The length and point of junction of the plug within the capsule body regulate the lag time [51]

ii) Port system

The semipermeable membrane in this system encloses the capsule body. An insoluble plug made of a medication formulation and an osmotically active ingredient makes up the capsule body. The semi-permeable membrane of the capsule allows fluid to enter it when it comes into touch with the dissolution fluid. This creates pressure inside the capsule body, which causes the plug to eject and releases the medicine. The medication is released on a regular basis, with a gap of time between each release [52]

c) Osmotically controlled colon targeted drug delivery System

Osmotic units make up this system. The osmotic units—which are housed in a hard gelatin capsule—can be used individually or in combination with up to six push pull units. The push pull units consist of an inner semi-permeable membrane and an outside enteric impermeable membrane. The push layer and medication layer make up the internal, or central, portion of the push pull. There is an opening in the semipermeable membrane next to the drug layer through which the drug's contents are released over time. Immediately following administration, the push pull units' capsule body dissolves [53]. The enteric impermeable membrane stops water from penetrating the push-pull units as they transit through the GIT. The small intestine's higher pH (>7) causes the coating to disintegrate once it gets there. The push layer swells when water enters the unit through the semi-permeable membrane. The medication is forced through the aperture and into the surrounding environment by the push compartment's expansion. For up to 24 hours, the medication is delivered at a steady pace using these osmotic controlled drug delivery devices [54]. Figure

Example : For instance, the colon specific drug delivery system (CDDS) is helpful for delivering low molecular weight compounds that are used to treat conditions related to the colon or large intestine, as well as for the oral delivery of proteins and peptide drugs that are broken down by the stomach and small intestine's digestive enzymes.

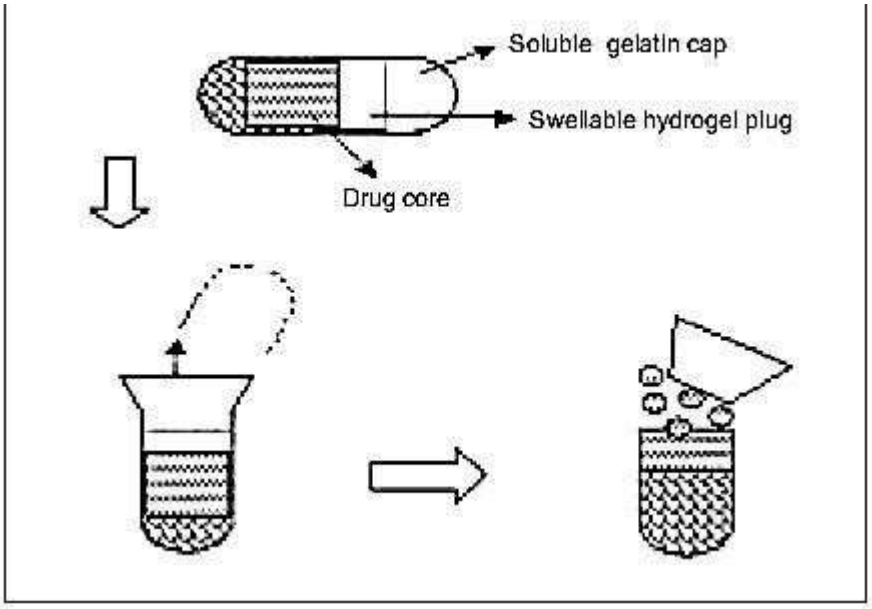

Fig : Pulsincap system

d) CODES technology

The purpose of this technique is to reduce the issues related to pH- and time-dependent drug delivery systems. This approach uses polymers that are sensitive to pH as well as polysaccharides that can only be broken down by particular bacteria found in the intestine. Three layers of polymer coatings cover the core tablet in this technology. The polymer Eudragit L makes up the exterior covering. Once the tablet passes through the duodenum and pyloric, this coating dissolves and reveals the subsequent coating. The coating that comes next is made of Eudragit E. The lactulose found in the inner core can be released thanks to this layer. The lactulose that has been released is broken down into short-chain fatty acids, which decrease the pH of the area around the Eudragit E layer's dissolution. The medication is exposed as a result of Eudragit E dissolving. Mannitol, maltose, and other polysaccharides are employed in the core tablet in addition to the medication. The breakdown of polysaccharides released from the core tablet is carried out by the bacteria that reside in the colon. The production of organic acids as a result of polysaccharide degradation lowers the pH of the liquid around the tablet.

E) Multi particulate system-based drug deliveryMultiparticulate systems have a number of benefits, including improved bioavailability, a lower chance of local discomfort, and a lower chance of systemic toxicity. The different multiparticulate methods include of granules, pellets, microparticles, and nanoparticles. Single unit dosage forms are not recommended in favor of multiparticulate systems since the former allow the medicine to enter the colon more quickly and stay there for longer. Because these systems are smaller, they can easily pass through GIT. Drug absorption is more uniform in the GIT due to the more uniform dispersion of multiparticulate systems.

Nanoparticles

Easy to prepare, nanoparticles can shield protein and peptide medications from enzymatic and chemical breakdown in the gastrointestinal tract, increasing their stability and absorption via the intestinal epithelium. Several methods, including inverse microemulsion, polymerization, and nanoprecipitation, are used to create the polymeric nanoparticles. Heat, agitation, and organic solvents are used in the procedures. These techniques have the problem that agitation and heat damage proteins and peptide medications. The most popular procedure for proteins and peptide medicines is ionic gelation [55]

Evaluation Test of Colon Drug Delivery System:

In-vitro evaluation

There isn't a standardized assessment method available for CDDS evaluation.since the optimal in vitro model should have the same GIT circumstances as the organism in vivo, including pH, volume, stirring, bacteria, enzymes, enzyme activity, and dietary ingredients. Diet and physical stress both have an impact on these diseases. The in-vitro enzymatic test and in-vitro dissolution study are two of the in vitro methods used to evaluate colon targeted drug delivery systems [56]

1. In-vitro dissolution test

The traditional basket method is used for the dissolving tests. The purpose of the dissolution testing is to characterize the behavior of formulations at various pH values in various buffers. Three distinct media are used for the colon targeted drug delivery dissolution testing: pH 1.2 for gastric fluid simulation, pH 6.8 for small intestine simulation, and pH 7.4 for large intestine simulation. The colon-targeted drug delivery systems are tested in 0.1N HCl for two hours, pH 6.8 phosphate

buffer for three hours, and pH 7.4 phosphate buffer for the last hour. To assess the colon-targeted medication delivery systems, buffers with a pH of above are created [57]

2. In-vitro enzymatic test:

The in-vitro enzymatic test comprises two assays. The carrier drug system is cultured in a fermenter with a bacterial medium that is appropriate for it. It is decided how much medicine is released at certain periods. A buffer media comprising the enzymes pectinase and dextranase, as well as the cecal contents of rats, guinea pigs, or rabbits, is used for drug release studies. The rate at which the polymer carrier degrades determines how much medication is delivered in a given amount of time [58]

In- vivo evaluation

As dogs, guinea pigs, rats, and pigs are similar to the anatomical and physiological circumstances, as well as the microflora of the human GIT, these animals are used for the in-vivo evaluation of the CDDS. Rat and rabbit GITs have similar distributions of different enzymes to human GITs [59]

Conclusion:

Drug delivery systems that target the colon produce both systemic and local effects. The colon drug delivery system's primary benefits are its extended transit duration, nearly neutral pH, decreased enzymatic activity, and enhanced susceptibility to absorption enhancers. Preserving the formulation when it passes through the stomach and small intestine is the primary goal of CDDS. Certain innovative approaches, such as pressure-controlled drug delivery systems, pulsincap systems, port systems, colon-targeted delivery systems (CODES), multiparticulate systems, and pro-biotics, are more focused than primary approaches. For the colon targeting, both synthetic polymers and polysaccharides are utilized. Colon targeted drug delivery delivers medications to the target place with the least amount of fluctuation possible in a safe, economical, and effective manner.

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