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COLON SPECIFIC DRUG DELIVERY SYSTEM: AN APPROACH TO TARGET COLONIC DISEASES

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ABSTRACT: Drug as such, may not show the desired therapeutic effect; drug delivery is the method or process of administering a pharmaceutical compound to achieve a therapeutic effect in humans or animals. Targeted drug delivery into the colon is highly desirable for local treatment of a variety of bowel diseases such as ulcerative colitis, Crohn's disease, amoebiasis, colonic cancer, local treatment of colonic pathologies, and systemic delivery of protein and peptide drugs. Colon targeted drug delivery system (CTDDS) can deliver drugs as both local and systemic. Local delivery, in the treatment of inflammatory bowel disease (IBD). Treatment could be enhanced when drug delivered to the target site on the colon. Systemic side effects could also be reduced. Colon-specific systems are the most important delivery of those drugs which are normally inactivated in the upper parts of the gastrointestinal tract (GIT). Primary approaches for CTDDS (Colon Targeted Drug Delivery System), which includes prodrugs, pH and time-dependent systems, bacterial enzyme dependent colonic DDS and pH and bacterial enzyme dependent colonic DDS. The novel approach of CTDDS, which includes pressure controlled colonic delivery capsules (PCDCS), osmotic controlled drug delivery are specific techniques.

INTRODUCTION: The oral route of medication administration is the most advantageous and imperative technique for regulating drugs for systemic effect. About half of the medication conveyance systems accessible in the market are oral medication conveyance system, and these systems have more points of interest because of patient acceptance and simplicity of organization.

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Colonic medication conveyance has increased expanded significance not only for the conveyance of the medications for the treatment of nearby ailments related to the colon like Crohn's illness, ulcerative colitis, irritable bowel syndrome.

Advantages of CDDS:

- Colon is an ideal site for the delivery of agents to cure the local diseases of the colon.
- Local treatment has the advantage of requiring smaller drug quantities.
- Reduces dosage frequency. Hence, the lower cost of expensive drugs.
- Possibly leading to a reduced incidence of side effects and drug interactions.

- The colon is an attractive site where poorly absorbed drug molecules may have improved bioavailability.
- Less diversity and intensity of digestive enzymes.
- Reduce gastric irritation caused by many drugs (*e.g*., NSAIDs).
- Bypass initial first pass metabolism.
- Longer residence time, less peptidase activity and natural absorptive characteristics make the colon as a promising site for the delivery of protein and peptide drug for systemic absorption.
- It has a longer retention time and appears highly responsive to agents that enhance the absorption of poorly absorbed drugs.
- The rapid development of biotechnology and genetic engineering resulting in the availability of protein and peptide drugs at a reasonable cost.
- Less peptidase activity and natural absorptive characteristics make the colon as a promising site for the delivery of protein and peptide drug for systemic absorption.

Limitations of Colon Targeting Drug Delivery System:

- Multiple manufacturing steps.
- The resident microflora could also affect colonic performance *via* metabolic degradation of the drug.
- Incomplete release of the drug.
- Bioavailability of drug may be low due to potentially binding of the drug in a nonspecific way.

Criteria for Selection of Drug for CDDS:

- Drugs poorly absorbed from upper GIT.
- Drugs for colon cancer Drugs that degrade in the stomach and small intestine.
- Drugs that undergo extensive first-pass metabolism.
- Drugs poorly absorbed from upper GIT.

Factors to be affected in the Design of Colon-Targeted Drug Delivery System:

A) Anatomy and Physiology of Colon: The GI tract is isolated into the stomach, small digestive system and internal organ. The internal organ reaching out from the ileocecal intersection to the rear-end is partitioned into three primary parts. These are the colon, the rectum, and the butt-centric trench. The whole colon is around 5 feet (150 cm) long and is separated into five noteworthy sections. The correct colon comprises of the cecum, climbing colon, hepatic flexure and the correct portion of the transverse colon and the qualities appeared table.

1. B) pH in the Colon: The pH of the GI tract is liable to both inter and intrasubject varieties. Diet, sick state and sustenance consumption impacts the pH of the gastrointestinal liquid. The adjustments in the pH along the gastrointestinal tract have been utilized as a method for focused colon sedate conveyance. Radio telemetry demonstrates the most noteworthy pH (7.5 ± 0.5) in the terminal ileum. On section into the colon, the pH drops to 6.4 ± 0.6. The pH in the mid colon is 6.6 ± 0.8 and in the left colon 7.0 ± 0.7. There is a fall in pH on section into the colon because of the nearness of short chain unsaturated fats emerging from bacterial aging of polysaccharides

C) Colonic Microflora and Enzymes: A large number of anaerobic and high-impact microscopic organisms are available in the whole length of the human GI tract. Intestinal chemicals are utilized to trigger medication discharge in different parts of the GI tract. As a rule, these compounds are gotten from gut small scale vegetation dwelling in high numbers in the colon.

These catalysts are utilized to corrupt coatings or networks and to break bonds between a latent bearer and a functioning operator (for example, release of a medication from a prodrug). Over 400 particular bacterial species have been discovered 20-30% of which are of the variety bacteroids. The grouping of microscopic organisms in the human colon is around 1000 CFU/ml.

2. D) Transit of Material in the Colon: The presence of nourishment material, for the most part, increments gastric habitation, and at times with ordinary bolstering, measurement frames have been appeared to live in the stomach for periods more than 12 h. Small intestinal travel is shockingly consistent at 3-4 h and has all the earmarks of being autonomous of the sort of dose shape and whether the subject is in the fasted or nourished state.

Contrasted with different locales of the gastrointestinal tract, development of materials through the colon is moderate. The all-out time for travel will, in general, be profoundly factor and affected by various factors, for example, diet, specifically dietary fiber content, portability, stress, sickness, and medications. Colonic travel times extended from 50 to 70 h. Stool weights expanded essentially with the nearness of dynamic infection probably because of exudates frame kindled epithelium, expanded bodily fluid emission, and the decrease in re-absorption of liquid and electrolytes.

E) Drug Absorption in the Colon: Drugs are absorbed passively by either paracellular or trans-cellular route. Transcellular absorption involves the passage of drugs through cells, and this is the route most lipophilic drugs takes, where paracellular absorption involves the transport of drug through the tight junction between cells and is the route most hydrophilic drug takes. The poor paracellular absorption of many drugs in the colon is because epithelial cell junctions are very tight.

The slow rate if transit in colon lets the drug stay in contact with the mucosa for a longer period than in small intestine which compensates the much lower surface area. The colonic contents become more viscous with progressive absorption of water as one travels further through the colon. This causes a reduced dissolution rate, slow diffusion of dissolved drug through the mucosa.

The oral absorption of the majority of peptide and protein drugs is limited because of the following reasons:

- Degradation in the acidic environment of the stomach.
- Enzymatic degradation in the small and large intestine.
- Rapid small intestine transit.
- Low mucosal permeability.
- Extensive first-pass metabolism by the absorbing membrane and the liver.

Approaches of Colonic Drug Delivery System:

- Transit time-dependent colonic DDS,
- pH-Dependent colonic DDS,
- pH- and time-dependent colonic DDS,
- Bacterial enzyme dependent colonic DDS,
- Prodrug based system,
- Azo Prodrugs,
- Polymeric/Saccharide Prodrugs,
- Amino acid Prodrugs,
- Coating and matrices Based system,
- pH and bacterial enzyme dependent colonic DDS,
- Colonic pressure controlled DDS and
- Osmotic pressure controlled colonic DDS.
  - **a.** Osmet Pump
  - **b.** OROS CT

Mechanism of Colon Targeting: A various scope of systems have been created to accomplish colon focusing of medications. One of the generally utilized instruments is to coat the definition utilizing characteristic or manufactured polymers. In this instrument, the medication is available in the center of the plan which is covered with layers of polymer coatings. The primary covering (by center material) is a corrosive solvent polymer, and external covering is an enteric polymer. The center of the plan is included the dynamic material and other alluring excipients.

The enteric covering begins to break up at pH 5 in the small digestive system. Upon passage into the colon, the polysaccharide covering will begins to break down. The microscopic organisms will enzymatically debase the polysaccharide into natural corrosive. This brings down the pH of the encompassing system and results in the disintegration of the encompassing framework and results in disintegration of corrosive solvent covering and ensuing medication discharge.

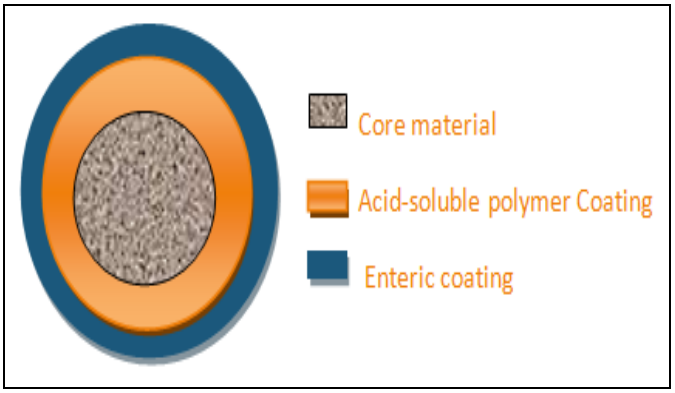

FIG. 1: MECHANISM OF COLON TARGETED DRUG DELIVERY SYSTEM

Drugs Used in Colon Associated Disease Conditions:

TABLE 1: COLON TARGETING SITES, DISEASES, SYMPTOMS, DRUGS, AND THEIR MARKETED FORMULATIONS

Target Site	Disease Condition	Symptoms	Drugs and Active Agents	Marketed Formulations
Systemic Action	Ulcerative Colitis	Fulminant Colitis, Pancolitis, Ulcerative proctits	Metasulfobenzoate, Tixocortol pivalate Fluticasone propionate Prednisolone Beclomethasone	- - - Acticort Tab Salbair B Cap
Topical/Local action	Irritable Bowel Syndrome	Abdominal pain or cramping, bloated feeling, flatulence, diarrhea or constipation people with IBS may also experience alternating bouts of constipation & diarrhea, mucus in stool	Dicyclomine Hyoscine Propantheline Cimetropium Tegaserod	Ah-Spas Tab Biscoats Tab Pro-Banthine Cap - Zelnorm Tab
	Ulcerative Colitis	Inflammation in the rectum, rectal bleeding, rectal pain	Mesalamine Sulfasalazine Mercaptopurine Balsalazide	Inflacol Tab Saaz Tab 6-Mp Tab Balacol Tab
	Colorectal Cancer	A change in bowel habits, narrow stools, rectal bleeding or blood in stool, persistent abdominal discomfort, such as cramps, gas or pain, abdominal pain with a bowel movement, unexplained weight loss	5 Flourouracil Leucovorin Cetuximab	Florac Inj. Leucorine Tab. -
	Diverticulitis	Formation of pouches (diverticula) on the outside of the colon due to bacterial infection	Metronidazole Clindamycin	Flygyl Tab. Dalacine Tab.
	Antibiotic Associated Colitis	Overgrowth of *Clostridium Difficile* and it's subsequent Toxin production	Broad-spectrum penicillins (*e.g*., ampicillin, amoxicillin)	Almox Tab

Criteria for Selection of Drug for CDDS:

Drug Candidate: Drugs which show poor absorption from the stomach or intestine including peptide are most suitable for CDDS. The drugs used in the treatment of IBD, ulcerative colitis, diarrhea and colon cancer are ideal candidates for local colon delivery.

Drug Carrier: The selection of a carrier for a particular drug candidate depends on the physiochemical nature of the drug as well as the disease for which the system is to be used. The factors such as chemical nature, stability and partition coefficient of the drug and the type of absorption enhancer chosen influence the carrier selection. Moreover, the choice of drug carrier depends on the functional groups of the drug molecule [19], for example, aniline or nitro groups on a drug may be used to link it to another benzene group through an Azo bond. The carriers, which contain additives like polymers (may be used as matrices and hydrogels or coating agents) may influence the release properties and efficacy of the systems.

Newly Developed Approaches for CDDS:

Pressure- Controlled Drug- Delivery Systems: Because of peristalsis, higher weights are gone up against in the colon than in the small digestive system. Takaya *et al*., (1995) have created weight controlled colon delivery capsules arranged utilizing ethyl cellulose, which is insoluble in water. In such systems, drug release happens following the disintegration of a water-insoluble polymer container as a result of power for every unit territory in the lumen of the colon. The thickness of the ethyl cellulose film is the essential factor for the disintegration of the formulation [36]. The system additionally seemed to depend upon case size and smallness. As a result of reabsorption of water from the colon, the thickness of luminal content is higher in the colon than in the small digestive system. It has consequently been reasoned that tranquilize disintegration in the colon could show an issue in connection to colon-explicit oral medication conveyance system.

Newly Developed Colon Targeted Delivery System (CODESTM): It is a one of a kind CDDS

innovation which was created to keep away from the constitutional issues related to pH or time subordinate schemes. CODESTM is consolidated methodology of pH subordinate and microbially activated CDDS. It has been delivered by utilizing a one of a kind system including lactulose, which fills in as a trigger for site explicit medication discharge in the colon. The system includes a typical tablet center containing lactulose, which is covered over with Eudragit E (the corrosive dissolvable material) and further covered with Eudragit L (the enteric covering polymer). The intention behind the innovation is that CODES™ stays unblemished in the stomach because of the enteric insurance, yet the enteric and boundary covering will disintegrate in the small digestive tract, where the pH is over 6.

Since Eudragit® E begins to break up at pH-5, the internal Eudragit® E covering is just somewhat penetrable and swellable in a small digestive system. Upon section into the colon, the polysaccharide inside the center tablet will break down and diffuse through the covering. The microscopic organisms will enzymatically corrupt the polysaccharide into natural corrosive. This brings down the pH encompassing the framework adequate to impact the dissolution of the corrosive solvent covering and ensuing medication discharge [8].

Osmotically Controlled Drug Delivery (ORDS-CT): The conveyance system OROS-CT from Alza Corporation is significantly more valuable in focusing on the medication particles to the colonic district for their nearby remedial reaction and additionally fundamental impact [22]. The above system can be either a solitary osmotic unit or can be including a most extreme 5-6 push-pull units, each having the distance across of 4 mm and exemplified in a hard gelatin container. Each bilayer pull-push unit contains a medication layer and an osmotic push layer; the two are encompassed with a semi penetrable film. An opening is bored on the film besides the mediation layer. Following the OROS-CT is gulped, the gelatin case having the force push units gets broke up. Each force push unit is kept from taking-up of water in the acidic fluid condition/ vehicle of the stomach because of the nearness of medication impermeable enteric covering; henceforth no medication discharge had been watched. As the unit goes into the small digestive tract, the covering gets disintegrated in the higher pH condition (pH>7), water begins going into the unit, which prompts swelling of the osmotic push compartment and associatively builds up a significant gel in the medication compartment.

Swelling of the osmotic push compartment helps in driving the medication gel fragment out of the hole at a rate fundamentally controlled by the pace of water entered through the semi-penetrable layer. So, as to treat ulcerative colitis, each draw push unit is structured with a 3-4 h post gastric postponement for keeping the conveyance of medications in the small digestive system. Medication discharge starts when the unit touches base at the colon. OROS-CT units can continue a consistent release rate for up to 24 h in the colon. Assessment of colon explicit disintegration framework. A few *in-vitro / in-vivo* assessment procedures have been created and offered to test the activity and soundness of CDDS [9].

Pulsatile Drug Delivery System:

a) Pulsincap® System: Single-unit system is for the most part created in a container shape. The between time is kept in line by an attachment, which escapes by swelling or disintegration and the medication is removed as a "Heartbeat" from the insoluble container shell. One such framework includes a medication repository captured inside a water-insoluble case. The medication atoms were fixed by a swellable hydrogel plug present in the container body. When the case interacts with the disintegration liquid, it begins swelling, and after a specific slack time, the fitting propels itself outside the case and bringing about the arrival of the medication. Polymers utilized for the hydrogel plug are diverse thickness evaluations of hydroxyl propyl methyl cellulose (HPMC), polymethyl methacrylate, polyvinyl acetic acid derivation, and polyethylene oxide. The length of the attachment and its dimension of presentation into the case controls the slack time [8, 10].

b) The Port® System: The Port® System contains a gelatin case covered with a semipermeable film (*e.g.*, Cellulose acetic acid derivation) containing an insoluble attachment (*e.g.*, lipidic) alongside an osmotically dynamic operator with the medication

definition. By interacting with the fluid medium, water diffuses through the semi-porous film, along these lines bringing about an expanded internal weight which helps in catapulting the fitting after a specific slack time. The between time is controlled by covering thickness [28]. This framework evades the second time dosing [10]. The happening to the pulsatile tranquilize conveyance framework depends on the guideline of deferring of medication discharge until the point when the framework transmits from mouth to colon. The travel time of the small digestive tract is around 3-4 h so the slack time of 5 h is generally trusted, which is similarly invariant.

c) Hydrogels: The presence of pH-touchy monomers and furthermore cross-connecting specialists in the hydrogel structure create colon particularity to the articulation. As these hydrogel goes through the GIT, their swelling limit increments as the pH increments, being most elevated around pH 7.4. The medication entangled in the hydrogel is put out by the dynamic corruption of hydrogen organize using the cleavage of the cross-ties. They can be acquired by cross-connecting polymerization of N-substituted (meth) acrylamides, N-tert-butyl acrylamide and acrylic corrosive with 4,4'- di (methacryloylamino) azobenzene, 4, 4'- di (N-methacryloyl-6-amino-hexanoylamino) or 3,3',5,5'- tetrabromo-4,4, 4',4'-tetrakis (methacryloylamino) azobenzene as the cross connecting specialists. The hydrogels were likewise arranged by polymer-polymer response utilizing the equivalent polymeric forerunner with the relating copolymer containing side chains ending in NH_2 gatherings. The corruption rate of hydrogel was related to the harmony level of swelling and being inversely corresponding to the cross connecting thickness [10, 11].

d) Microspheres: Cross- connected guar gum microspheres containing methotrexate were created and described for their neighborhood discharge in the colon for proficient treatment of colorectal malignant growth. In this technique, glutaraldehyde was utilized as a cross-connecting operator, and guar gum microspheres were created by emulsification strategy. From the consequences of *in-vitro* and *in-vivo* ponders, the methotrexate stacked cross-connected guar gum microspheres conveyed the greater part of the stacked medications (79%) to the colon, whereas the ordinary medication suspensions could ready to convey just 23% of their complete portion to the objective tissue. Colon explicit microspheres of 5-fluorouracil were created and esteemed for the treatment of colon disease. In this strategy center microspheres of alginate were set up by changed emulsification technique in fluid paraffin by utilizing calcium chloride as a cross-connecting operator [16].

e) Nanoparticles: Nanoparticles are expected upon to wind up medication achieving for accomplishing oral peptide delivery. Because of polymeric nanoparticles have the advantages of protecting the protein and peptide drugs from a synthetic and enzymatic degradation in the GIT, so increasing their stability and absorption across the intestinal epithelium and also holding the medication discharge. A daily schedule of strategies, for example, polymerization, nano-precipitation, reverse microemulsion can be used to get ready polymeric nanoparticles, notwithstanding, the vast majority of these techniques require the utilization of natural solvents, warm and vivacious disturbance which might be hurtful to the peptide and protein drugs. All the more as of late the ionic gelation procedure has been utilized as the greatest [10].

f) Self-Microemulsifying Drug Delivery System: Zhang L *et al*., has arranged, portray, and assess an armada altered self-micro emulsifying drug delivery system (FSMEDDS) with the intention for enhancing the solvency of curcumin and also its conveyance to the colon, interceded through endocytosis of FSMEDDS by foliate receptors on colon disease cells. Ternary stage charts were produced to get the best self-emulsification locale, and the detailing of curcumin-stacked SMEDDS was enhanced by a simple cross section analyzes the structure. Thus, three lipophilic foliate subsidiaries (foliate-polyethylene glycol-distearoyl-phosphatidylethanolamine, level poly-ethylene glycol-cholesterol hemisuccinate, and foliate-polyethylene glycol-cholesterol) utilized as a surfactant were joined to curcumin-stacked SMEDDS definitions.

The streamlining of the details of FSMEDDS was brought out through an in situ colon perfusion technique, connected on rodents. Curcumin-stacked

FSMEDDS was then filled into colon-focused on cases, and the *in-vitro* discharge was researched. The ideal definition of FSMEDDS acquired with the built up in situ colon perfusion technique in rodents was included 57.5% cremophor(®) EL, 32.5% transcutol(®) HP, 10% capryol™ 90, and a little measure of folate-polyethylene glycol-cholesteryl hemisuccinate (the load proportion of folate materials to cremophor EL was 1:100). The outcomes got from the *in-vitro* discharge contemplate showed that the detailing of curcumin could achieve the colon effectively and discharge the medication successfully. Cell take-up concentrates broke down by fluorescence microscopy, and stream cytometry demonstrated that the FSMEDDS detailing could proficiently tie to the folate receptors on the outside of positive folate receptor cell lines [12].

g) Multiparticulate Beads: In the ionotropic gelation method, polysaccharides (alginate, gallant and pectin) are dissolved in water or weak acidic medium (Chitosan). These solutions are then added dropwise under constant stirring to the solutions containing other counterions. Due to the complexation between oppositely charged species, polysaccharides undergo ionic gelation and precipitate to form spherical particles. The beads are removed by filtration, rinsed with distilled water and dried [13].

h) Liposomes in CDDS: Liposomes are the bilayered closed vesicular structures comprises of hydrated phospholipids. Liposomes can entrap compounds of different solubilities due to their alternating hydrophilic and hydrophobic structure. Liposomes with a size range from 25 millimeters to several micrometers are usually propagated in an aqueous medium. Liposomes are also can be distinguished according to their size and number of lamellae such as large unilamellar vesicles (LUV), small unilamellar vesicles (SUV), and large multilamellar vesicles or multivesicular vesicles [14].

i) Bioadhesive Systems: Bioadhesion is a procedure by which a dosage form remains in contact with a special organ for an augmented period of the fourth dimension. This longer residence time of the drug results in an increased local concentration. In the case of poorly absorbable drugs, it helps in improving absorption characteristics. This strategy is much more useful in formulating CDDS.

Evaluation Parameters of CDDS: For *in-vitro* evaluation, not any standardized evaluation technique is available for evaluation of CDDS because an ideal *in-vitro* model should possess the *in-vivo* conditions of GIT such as pH, volume, stirring, bacteria, enzymes, enzyme activity, and other components of food. Generally, these conditions are influenced by the diet, physical stress, and these factors make it difficult to design a slandered *in-vitro* model. *In-vitro* models used for CDDS are:

a) *In-vitro* Dissolution Test: Dissolution of controlled-release formulations used for colon-specific drug delivery are usually complex, and the dissolution methods described in the USP cannot fully mimic *in-vivo* conditions such as those relating to pH, bacterial environment and mixing forces [16]. Dissolution tests relating to CDDS may be carried out using the conventional basket method. Parallel dissolution studies in different buffers may be undertaken to characterize the behavior of formulations at different pH levels [17]. The media chosen were, for example, pH 1.2 to simulate gastric fluid, pH 6.8 to simulate the jejunal region of the small intestine, and pH 7.2 to simulate the ileum segment. Enteric-coated capsules for CDDS have been investigated in a gradient dissolution study in three buffers. The capsules were tested for two hours at pH 1.2, then one hour at pH 6.8, and finally at pH 7.4. [18]

b) *In-vitro* Enzymatic Tests: Incubate carrier drug system in fermenter containing a suitable medium for bacteria (*Streptococcus faccium* and *B. ovatus*). The amount of drug released at different time intervals is determined. Drug release study is done in buffer medium containing enzymes (ezypectinase, dextranase), or at or guinea pig or rabbit cecal contents. The amount of drug released at a particular time is determined, which is directly proportional to the rate of degradation of the polymer carrier.

c) *In-vivo* Evaluation: Some animals such as dogs, guinea pigs, rats, and pigs are used to evaluate the delivery of drug to colon because they resemble the anatomic and physiological conditions as well as

the microflora of human GIT. While choosing a model for testing a CDDS, a relative model for the colonic diseases should also be considered. Guinea pigs are commonly used for experimental IBD model. The distribution of azoreductase and glucuronidase activity in the GIT of rat and rabbit is fairly comparable to that in the human [12].

i) Drug Delivery Index (DDI) and Clinical Evaluation of Colon-Specific Drug Delivery Systems: DDI is a determined pharmacokinetic parameter, following single or various portion of oral colonic prodrugs. DDI is the general proportion of RCE (Relative colonic tissue introduction to the medication) to RSC (Relative measure of medication in blood for example that is relative fundamental exposal to the medication). High medication DDI esteem shows better colon tranquilize conveyance. Ingestion of medications from the colon is observed by colonoscopy and intubation. At present, gamma scintigraphy and high recurrence containers are the most favored methods utilized to assess colon medicate conveyance frameworks.

ii) γ–Scintigraphy: With growing complexity in the design of novel drug delivery systems (including colon-specific delivery systems) and associated fabrication process, it is critical to understand the *in-vivo* performance of those delivery systems and demonstrate that the system functions *in-vivo* by the proposed rationale. In most cases, the conventional pharmacokinetic evaluation may not generate sufficient information to elucidate the intended rationale of system design. γ-Scintigraphy is an imaging modality, which enables the *in-vivo* performance of drug delivery systems to be visualized under normal physiological conditions in a non-invasive manner. Since, first employed to investigate the functionality of tablets and capsules *in-vivo* more than two decades ago [15, 16].

γ-scintigraphy has become an established technique and extensively used to monitor the performance of novel drug delivery systems within the human GI tract. The underlying principles of γ-scintigraphy and its applications in pharmaceutical research and s are available in the literature [17, 18]. Through γ-scintigraphy imaging, the following information regarding the performance of a colon-specific delivery system within human GI tract can be obtained: the location as a function of time, the time and location of initial and complete system disintegration, the extent of dispersion, the colon arrival time, stomach residence and small intestine transit times.

CONCLUSION: It was also concluded that more than one testing method is essential to determine the drug release and justify system objective for conducting an *in-vitro* evaluation of a colon-specific drug delivery system. Depending upon the sophistication of colon-specific drug delivery systems and the uncertainty of current dissolution methods in establishing possible *in-vitro*/*in-vivo* correlation, challenges are there for pharmaceutical scientists to train and validate a dissolution method that incorporates the physiological features of the colon and even can be used routinely in an industrial setting for the evaluation of CDDS.

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