1. INTRODUCTION

Oral drug delivery has been known for decades as the most widely extensively utilized route of administration among all the routes that have been explored for the systemic delivery of drugs via various pharmaceutical products of different dosage forms. In fact, the development of a pharmaceutical product for oral delivery, irrespective of its physical form (solid, semisolid, or liquid dosage form), involves varying extent of optimization of dosage form characteristics within the inherent constraints of gastrointestinal tract (GI) physiology.

Pharmaceutical products designed for oral delivery and currently available on the prescription and over-the-counter markets are mostly the immediate release type, which are designed for immediate release of drug for rapid absorption. Because of their clinical advantages over immediate release pharmaceutical products containing the same drugs, sustained release pharmaceutical products, such as those formulated on the basis of spansule coating technology have gained medical assistance and popularity. Recently, a new generation of pharmaceutical products, called controlled release drug delivery system, has received regulatory approval.

All the pharmaceutical products formulated for systemic delivery via the oral route of administration, irrespective of the mode of delivery (immediate, sustained, or controlled release) and the design of dosage forms (solid, dispersion or liquid), must be developed within intrinsic characteristics of GI physiology. The important objective for the development of this system is to furnish an extended duration of action and thus assured greater compliance.

Controlled release delivery systems provide a uniform concentration or amount of drug at absorption site and thus after absorption, allow maintenance of
plasma concentration within a therapeutic range, which minimizes side effects and also reduces frequency of administration.

These products typically provide benefits over immediate release formulations, including greater effectiveness, in the treatment of chronic conditions, reduced side effects, and greater patient convenience due to simplified dosing schedule.\textsuperscript{1-4}

Recent advances in drug delivery technology had laid emphasis on using of natural polysaccharides for controlled drug delivery. Being non toxic, inert, safe, biocompatible and biodegradable they offer priority to synthetic polymers which attract majority of the researchers.

Natural polysaccharides are now extensively used for the development of solid dosage forms for delivery of drug to the lower gastrointestinal part. The rationale for the development of a polysaccharide based delivery system for lower GIT is the presence of large amounts of polysaccharidases in the human colon as the colon is inhabited by a large number and variety of bacteria which secrete many enzymes e.g. D-glucosidase, D galactosidase, amylase, pectinase, xylanase, D-xylosidase, dextranase, etc. A large number of polysaccharides have already been studied for their potential as colon-specific drug carrier systems, such as chitosan, pectin, chondroitin sulphate, cyclodextrin, dextrans, guar gum, inulin, amylose and alginate.

Chitosan is a high molecular weight, polycationic polysaccharide derived from naturally occurring chitin by alkaline deacetylation. Chemically, it is a poly (N-glucosamine). One of the properties that make chitosan versatile in its use is the hydration ability and formation of gels in acidic aqueous environments which makes it suitable to prepare slow release drug delivery systems. Chitosan has favorable biological properties such as nontoxicity, biocompatibility and biodegradability.
Another important property that chitosan posses are the mucoadhesive property (ionic interactions between positively charged amino groups in chitosan and the negatively charged mucus) that makes chitosan a preferred polymer that can be used in developing mucoadhesive drug delivery systems.

Chitosan is a modified natural carbohydrate polymer prepared by the partial N-deacetylation of chitin, a natural biopolymer derived from crustacean shells such as crabs, shrimps and lobsters. Chitosan is also found in some microorganisms, yeast and fungi. The primary unit in the chitin polymer is 2-deoxy-2-(acetylamino) glucose. These units combined by \( \beta \)-(1, 4) glycosidic linkages, forming a long chain linear polymer. Although chitin is insoluble in most solvents, free amino groups of chitosan can undergo protonation hence making it soluble in most organic acidic solutions at pH less than 6.5 including formic, acetic, tartaric, and citric acid. It is insoluble in phosphoric and sulfuric acid. Chitosan is available in a wide range of molecular weight and degree of deacetylation. Molecular weight and degree of deacetylation are the main factors affecting the particle size, particles formation and aggregation.

Chitosan is polycationic in acidic media (pKa 6.5) and can interact with negatively charged species such as STPP and sodium sulfate. This characteristic can be employed to prepare cross-linked chitosan nanoparticles. The interaction of chitosan with STPP leads to formation of biocompatible cross-linked chitosan nanoparticles, which can be efficiently employed in protein and vaccine delivery. The cross-linking density, crystallinity, and hydrophilicity of cross-linked chitosan can allow modulation of drug release and extend its range of potential applications in drug delivery.
Chitosan has a mucoadhesive property, which is utilized in the formulation.

Some of the characteristic properties of chitosan are:

1. Pharmacological properties like antacid and antiulcer activity, hypocholesteremic action and wound healing properties.
2. Haemostatic and spermicidal properties owing to their ability to bind strongly to mammalian cells by virtue of their polycationic character.
3. Presence of reactive functional group and cationic character opens up possibilities for their application in sustained drug delivery.
4. Has gel-forming ability at low pH.
5. The chitosan matrix formulations float and gradually swell in acidic medium.
6. Chitosan has important application in photography due to its resistance to abrasion, its optical characteristics and film forming ability.
7. In cosmetics, chitosan has fungicidal and fungi static properties.
8. Chitosan has structural characteristics similar to glycosamino glucans, could be considered for developing substratum for skin replacement.
9. Chitosan possess all the characteristics required for making an ideal contact lens, optical clarity, mechanical stability, wettability and immunological compatibility.