AN OVERVIEW OF MULTIFACETED SIGNIFICANCE OF EUDRAGIT POLYMERS IN DRUG DELIVERY SYSTEMS

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Received: 23 January 2015, Revised and Accepted: 25 May 2015

INTRODUCTION

Pharmaceutical excipients are non-active ingredients that are mixed with therapeutically active compound to form medicines. Excipients affect the behavior and effectiveness of drug product. Polymers constitute major part of pharmaceutical formulations functionality and significance. Polymer that may be natural or synthetic tends to release the drug in a pre-designed manner [1]. The choice of polymer always suffers from problems of non-biocompatible, non-biodegradable and expensive. Eudragit polymers acts as versatile keystroke tool for fabrication of sustained release formulation and development of novel drug delivery system (NDDS) [2]. The basic objective of sustained drug release is to achieve more effective therapies by eliminating the potential for both under and overdosing. Other advantages include maintenance of drug concentration with in a desired range, fewer administration, optimal drug use and patient compliance [3].

Eudragit polymers are versatile polyacrylate polymers having varying degree of solubility which make it suitable for sustained release formulation [4]. Its production took place at Darmstadt, Weiterstadt and was first marketed in the 1950s by Evonik Industries [5]. It is a trademark of Rohm GmbH and Co. KG, Darmstadt in Germany. It was manufactured by polymerization of acrylic and methacrylic acids or their esters whose physicochemical properties are governed by functional group R. Eudragit has been introduced in USPNF, BP, PhEur and Handbook of Pharmaceutical excipients [6].

CLASSIFICATION OF EUDRAGIT POLYMERS

Eudragit polymers can be classified on the basis of use or type of formulation produced. These include eudragit polymers for [6,7]:

- Time-controlled drug release by sustained release formulations
- Gastro-resistance and gastrointestinal (GI) targeting by enteric formulations
- Moisture protection and odor/taste masking by protective formulations
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- Polymers constitute the major part of pharmaceutical formulations functionality and significance. Development of novel drug delivery system (NDDS) has been made possible by eudragit polymers to modify the release pattern of drug. The basic objective of sustained drug release is to achieve more effective therapies by eliminating the potential for both under and overdosing. Other advantages include maintenance of drug concentration with in desired range, fewer administration, optimal drug use and patient compliance. This review article gives outline of classification, nomenclature, physiological, and pharmaceutical properties of eudragit polymers. Eudragit polymers can be classified on the basis of use or type of formulation produced and includes time-controlled drug release by sustained release formulations, gastro-resistance and GI targeting by enteric formulations and moisture protection and odor/taste masking by protective formulations. Eudragit polymers are available in wide range of physical forms viz. aqueous dispersion, granule and powder with varying degrees of solubility. Eudragit polymers have numerous drug release mechanism and wide applications in different drug delivery systems i.e. ophthalmic, buccal, sublingual, enteric, oral, colon, vaccine, gene, vaginal and transdermal drug delivery. It has been concluded that eudragit polymers have multifaceted applications in pharmacy and drug delivery system.

Keywords: Eudragit, Time-controlled, Sublingual.

EUDRAGIT FOR TIME-CONTROLLED DRUG RELEASE

Eudragit polymers can be used to produce formulations which allow custom-tailored release profiles and releases over a specific period of time. Drug delivery can be controlled throughout the entire GI tract (GIT) to increase the therapeutic effect and patient compliance. Different polymer combinations of eudragitRL and RS grades allow custom-tailored release profiles to achieve the desired drug delivery performance [7]. Various characteristics of eudragit RL (eudragit RL 100, eudragit RL PO, eudragit RL 30 D, and eudragit RL 12.5) and eudragit RS (eudragit RS 100, eudragit RS PO, eudragit RS 30 D, and eudragit RS 12.5) has been given in Table 1. EudragitRLNE an NM grades are neutral ester dispersions, which do not require additional plasticizers. Various characteristics of eudragit NE 30 D, eudragit NE 40 D and eudragit NM 30 D has been given in Fig. 2.

The distinguishing characteristics of various grades of eudragit RL, eudragit RS, eudragit NE and eudragit NM has been given in Table 1. Benefit from eudragit coatings with sustained release include time-
Table 1: Distinguishing characteristics of various grades of eudragit RL, eudragit RS, eudragit NE and eudragit NM

<table>
<thead>
<tr>
<th>Trade name</th>
<th>MFT (°C)</th>
<th>Tg (°C)</th>
<th>Form and permeability</th>
<th>Physical properties</th>
<th>IUPAC name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eudragit RL 100</td>
<td>~40</td>
<td>63±5</td>
<td>Granule</td>
<td>Colorless, clear to cloudy granules, faint amine-like odor</td>
<td>Poly (ethyl acrylate-co-methyl methacrylate-co-trimethyl aminoethyl methacrylate chloride) 1:2:0.2</td>
</tr>
<tr>
<td>Eudragit RL PO</td>
<td>~40</td>
<td>63±5</td>
<td>Powder</td>
<td>White powder with a faint amine like odor</td>
<td></td>
</tr>
<tr>
<td>Eudragit RL 30 D</td>
<td>~40</td>
<td>55</td>
<td>30% aq. dispersion</td>
<td>Milky-white liquid of low viscosity with a faint odor</td>
<td></td>
</tr>
<tr>
<td>Eudragit RL 12.5</td>
<td>~40</td>
<td>55</td>
<td>12.5% organic solution</td>
<td>Light yellow liquid of low viscosity, clear to slightly cloudy with odor of solvents</td>
<td></td>
</tr>
<tr>
<td>Eudragit RS 100</td>
<td>~40</td>
<td>65</td>
<td>Granule</td>
<td>Colorless, clear to cloudy granule, faint amine like odor</td>
<td>Poly (ethyl acrylate-co-methyl methacrylate-co-trimethylaminoethyl methacrylate chloride) 1:2:0.1</td>
</tr>
<tr>
<td>Eudragit RS PO</td>
<td>~40</td>
<td>65</td>
<td>Powder</td>
<td>White powder with a faint amine like odor</td>
<td></td>
</tr>
<tr>
<td>Eudragit RS 30 D</td>
<td>~40</td>
<td>55</td>
<td>30% aq. dispersion</td>
<td>Milky-white liquid of low viscosity with a faint odor</td>
<td></td>
</tr>
<tr>
<td>Eudragit RS 12.5</td>
<td>~40</td>
<td>55</td>
<td>12.5% organic solution</td>
<td>Light yellow liquid of low viscosity, clear to slightly cloudy with odor of solvents</td>
<td></td>
</tr>
<tr>
<td>Eudragit NE 30 D</td>
<td>~40</td>
<td>5–8</td>
<td>30% aq. dispersion</td>
<td>Milky-white liquid of low viscosity with a faint odor</td>
<td></td>
</tr>
<tr>
<td>Eudragit NE 40 D</td>
<td>~40</td>
<td>5–8</td>
<td>40% aq. dispersion</td>
<td>Milky-white liquid of low viscosity with a faint odor</td>
<td></td>
</tr>
<tr>
<td>Eudragit NM 30 D</td>
<td>~40</td>
<td>5–11</td>
<td>30% aq. dispersion</td>
<td>Milky-white liquid of low viscosity with a faint odor</td>
<td></td>
</tr>
</tbody>
</table>

controlled release of active ingredients, therapeutically customized release profiles, higher patient compliance due to reduced number of doses to be taken, cost-effective processing.

**EUDRAGIT FOR GASTRO-RESISTANCE AND GI TARGETING**

It protects the active ingredient from gastric fluid and will improve drug effectiveness. Eudragit L and S polymers are the preferred choices of coating polymers. They enable targeting specific areas of the intestine. These anionic eudragit grades dissolve at rising pH values. In addition, different grades can be combined with each other, making it possible to adjust the dissolution pH and thus to achieve required GI targeting for drug [7]. Eudragit offers valuable advantages for enteric coatings, include pH-dependent drug release, increase in drug effectiveness, good storage stability, colon targeting and protection of actives sensitive to gastric fluid.

Eudragit L and S polymers are copolymer based on methacrylic acid and ethyl acrylates. These are anionic, white free flowing powder with a weight average molar mass of approximately 125,000 g/mol. The various characteristics of eudragit L and eudragit S include effective and stable enteric coatings with a fast dissolution in the upper bowel, granulation of drug substances in powder form for controlled release, site-specific drug delivery in intestine by combination with eudragit S grades, variable release profiles.

Chemical structure of eudragit L (Eudragit L 100, Eudragit L 12.5), eudragit S (Eudragit S 100 and Eudragit S 12.5), eudragit L 30D-55 and eudragit L 100-55 has been depicted in Fig. 3.

The distinguishing characteristics of various grades of eudragit L (Eudragit L 100, Eudragit L 12.5, Eudragit L 30D-55 and Eudragit L 100-55) and eudragit S (Eudragit S 100 and Eudragit S 12.5) has been given in Table 2.

**EUDRAGIT FOR MOISTURE PROTECTION AND TASTE MASKING**

Eudragit offers a strong protection of sensitive contents and improved patient compliance. These polymers protect active ingredients from moisture or light and increase patient compliance. Eudragit E polymers help seal sensitive actives and increase patient compliance by taste and odor masking. Even thin layers of eudragit E provide the desired effect, making it an extremely economical application. Various cationic eudragit E grades with dimethyl-aminoethyl methacrylate as functional group provide protective coatings [6,7]. Various characteristics of eudragit E (Eudragit E 12.5, Eudragit E 100 and Eudragit E PO) has been given in Fig. 4. The distinguishing characteristics of various grades of eudragit E has been given in Table 3.

Advantage of protective eudragit coatings include pH-dependent drug release, taste and odor, masking, protection of sensitive actives against moisture, economical application, improved, transit of the dosage form, excellent color coating and smooth glossy surfaces.

**DRUG RELEASE MECHANISM FROM EUDRAGIT POLYMERS**

Drug release from oral sustained preparation of eudragit polymers is governed by following principles [4]:

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DISSOLUTION

The rate-limiting step to absorption of drugs from the GIT is often dissolution from dosage form. Dissolution is the process by which a solid substance solubilizes in a given solvent i.e., mass transfer from the solid surface to the liquid phase. Dissolution controlled dosage forms can be divided into reservoir and matrix systems. Eudragit S coated 5-ASA has dissolution to be the responsible mechanism of controlling drug release [8]. Dissolution release pattern is shown in Fig. 5 (a).

Diffusion

Diffusion is the movement of a substance down to concentration gradient i.e. drug molecules diffuse from high concentration to lower concentration in gastro intestinal fluids. Several factors that affect the rate of diffusion include temperature, density of the diffusing substance, medium of diffusion and concentration gradient. The release of propranolol HCL from monolithic matrix of eudragit NE 30 D was by a combination of diffusion through polymer and pores [9]. A desirable release profile of diphenhydramine was achieved by incorporating eudragit L in a carnauba wax matrix. The drug release from polymer-wax matrices is described by a combination diffusion/erosion mechanism [10]. Eudragit RS PO releases carbamazepine drug by complex mixture of diffusion and erosion mechanism [11]. Diffusion release pattern is shown in Fig. 5 (b).

Osmosis

Osmosis refers to the process of movement of solvent molecules from a lower concentration to higher concentration across semi-permeable membrane. The osmotic pressure created due to imbibitions of fluid from the external environment into dosage form regulates delivery of the drug from the osmotic device [12]. The release rate of drugs from osmotic dispensing devices is dependent on solubility and molecular weight and activity coefficient of solute. The osmotic release pattern is shown in Fig. 5 (c).

Table 2: Distinguishing characteristics of various grades of eudragit L and eudragit S

<table>
<thead>
<tr>
<th>Trade name</th>
<th>Form</th>
<th>Tg (°C)</th>
<th>Target drug release area</th>
<th>Physical properties</th>
<th>IUPAC name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eudragit L 100</td>
<td>Powder</td>
<td>&gt;130</td>
<td>Jejunum</td>
<td>White powder with faint odor</td>
<td>Poly [methacrylic acid-co-methyl methacrylate] 1:1</td>
</tr>
<tr>
<td>Eudragit L 12.5</td>
<td>12.5% organic solution</td>
<td>&gt;130</td>
<td>Jejunum</td>
<td>Colorless to slightly cloudy</td>
<td>Poly [methacrylic acid-co-methyl methacrylate] 1:2</td>
</tr>
<tr>
<td>Eudragit S 100</td>
<td>Powder</td>
<td>&gt;130</td>
<td>Colon</td>
<td>White powder with a faint odor</td>
<td>Poly [methacrylic acid-co-ethyl acrylate] 1:1</td>
</tr>
<tr>
<td>Eudragit S 12.5</td>
<td>12.5% organic solution</td>
<td>&gt;130</td>
<td>Colon</td>
<td>Colorless to slightly cloudy</td>
<td>Poly [methacrylic acid-co-ethyl acrylate] 1:1</td>
</tr>
<tr>
<td>Eudragit L 30D-55</td>
<td>30% Aq. Dispersion</td>
<td>96</td>
<td>Duodenum</td>
<td>Milky-white liquid of low viscosity with faint odor</td>
<td>Poly [methacrylic acid-co-ethyl acrylate] 1:1</td>
</tr>
<tr>
<td>Eudragit L 100-55</td>
<td>Powder</td>
<td>96</td>
<td>Duodenum</td>
<td>White powder with faint odor</td>
<td>Poly [methacrylic acid-co-ethyl acrylate] 1:1</td>
</tr>
</tbody>
</table>

Table 3: Distinguishing characteristics of various grades of eudragit E

<table>
<thead>
<tr>
<th>Trade name</th>
<th>Form</th>
<th>Physical properties</th>
<th>IUPAC name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eudragit E 100</td>
<td>Granules</td>
<td>Colorless to yellow tinged granules with a characteristic amine-like odor</td>
<td>Poly (butyl methacrylate-co-(2-dimethylaminoethyl) methacrylate-co-methyl methacrylate) 1:2:1</td>
</tr>
<tr>
<td>Eudragit E 12.5</td>
<td>12.5% organic solution</td>
<td>Light yellow liquid of low viscosity, clear to slightly cloudy, characteristic odor of the solvents</td>
<td>Poly (butyl methacrylate-co-(2-dimethylaminoethyl) methacrylate-co-methyl methacrylate) 1:2:1</td>
</tr>
<tr>
<td>Eudragit E PO</td>
<td>Powder</td>
<td>White powder with characteristic amine-like odor</td>
<td>Poly (butyl methacrylate-co-(2-dimethylaminoethyl) methacrylate-co-methyl methacrylate) 1:2:1</td>
</tr>
</tbody>
</table>

Fig. 4: Characteristics of various grades of eudragit E

- Dissolution
- Diffusion
- Osmotic pressure
- Ion-exchange.

Fig. 5: Drug release mechanisms from polyacrylate polymers
(a) dissolution release pattern (b) diffusion release pattern (c) osmotic release pattern

RS PO releases carbamazepine drug by complex mixture of diffusion and erosion mechanism [11]. Diffusion release pattern is shown in Fig 5 (b).

Osmosis

Osmosis refers to the process of movement of solvent molecules from a lower concentration to higher concentration across semi-permeable membrane. The osmotic pressure created due to imbibitions of fluid from the external environment into dosage form regulates delivery of the drug from the osmotic device [12]. The release rate of drugs from osmotic dispensing devices is dependent on solubility and molecular weight and activity coefficient of solute. The osmotic release pattern is shown in Fig. 5 (c).
Ion-exchange
The use of ion exchange resins into drug delivery systems have been encouraged because of their physical-chemical stability, inert nature, uniform size, spherical shape assisting coating and equilibrium driven reproducible drug release in the ionic environment. Ion exchange resins are cross-linked; water insoluble, polymer-carrying, ionizable functional groups. The drug is released from drug-resin complexes by exchanging with ions in the GI fluid, followed by drug diffusion. Eudragit RS 30 D-coated theophylline beads proved ion exchange to be a responsible mechanism of controlling polymer permeability as a function of anionic species and concentration [13].

EUDRAGIT POLYMERS IN DRUG DELIVERY SYSTEM

Ophthalmic drug delivery
A major problem usually faced in ocular therapeutics is attainment of an optimal concentration at the site of action. Poor bioavailability of drugs from ocular dosage forms is mainly due to tear production, non-productive absorption, transient residence time, and impermeability of corneal epithelium. Eudragit exhibits favorable behavior, such as no toxicity, positive charge and controlled release profile this make them suitable for ophthalmic application. Ana Rita et al. prepared ophthalmic drug delivery systems of acetazolamide using eudragit RS 100 and RL 100 by compressed anti-solvent technology. The prepared micro particles exhibited a slower release than the single drug. Drug release rate was controlled by a diffusion mechanism, however; polymer swelling also contributes to the overall transport mechanism [14].

Verma et al. prepared acetazolamide-loaded eudragit RL 100 nanoparticle suspension by nano-precipitation method to increase topical ocular bioavailability and to sustain the release of drug for a longer time [15]. Zhang et al. (2014) studied the ocular performance of a cationic eudragit (EDU) RS 100-coated genistein encapsulated NLC (GEN-NLC) produced by melt-emulsification technique followed by surface absorption of EDU RS 100. The obtained EDU RS 100-GEN-NLC showed extended precorneal clearance and significantly increased corneal penetration. The results indicate that NLC surface modified by EDU RS 100 significantly improves NLC properties and exhibits many advantages for ocular use [16].

Buccal and sublingual drug delivery
It is estimated that permeability of buccal mucosa is 4-4000 times greater than that of skin. Sublingual delivery gives rapid absorption and good bioavailability for some small molecules, although this site is not well suited to sustained-delivery systems. The buccal mucosa, by comparison, is considerably less permeable, but is probably better suited to the development of sustained-delivery systems. For these reasons, the buccal mucosa may have potential for delivering some of the growing number of peptide drugs, particularly those of low molecular weight, high potency and long biological half-life [17]. In general, permeabilities of oral mucosa decrease in order of sublingual greater than buccal and buccal greater than palatal [18]. At physiological pH the mucus network carries a negative charge (due to the sialic acid and sulfate residues) which may play a role in mucusadhesion. At this pH, mucus can form a strongly cohesive gel structure that will bind to the epithelial cell surface as a gelatinous layer [19].

Consequently, bioadhesive polymers have extensively been employed in buccal drug delivery systems. Polymers which can adhere to either hard or soft tissue have been used for many years in surgery and dentistry. An ideal buccal film should be flexible, elastic and soft yet strong enough to withstand breakage due to stress from activities in the mouth. Moreover, it must also possess good mucus adhesive strength so that it is retained in mouth for the desired duration. To prevent discomfort, swelling of film should not be too extensive. The mechanical, bio adhesive, and swelling properties of buccal films are critical [20]. For systemic drug therapy, buccal and sublingual routes are commonly used due to their trans mucosal permeability [21]. Sublingual mucosa is more permeable, thinner with a richer blood supply compared to buccal mucosa, producing a rapid onset of action which makes it appropriate for drugs with a short delivery period [22,23]. However the buccal mucosa is less permeable than the sublingual mucosa and it does not yield a rapid onset of action as seen with sublingual delivery. The mucosa of the buccal area has a large, smooth and relatively immobile surface, which is suitable for the placement of a retentive system and it offers sustained and controlled drug delivery [24,25]. Diarra et al. developed a fluoride controlled release delivering system for intra-buccal use by formulating tablets that have a granular matrix composed of pure hydroxyapatite, eudragit (R) and ethyl cellulose. The matrix permits to reach high enough local concentrations for desirable therapeutic effect with minimal side effects [26].

Enteric delivery
Hao et al. prepared enteric eudragit L100-55 nanoparticles of omeprazole by ultrasonic dispersion and diffusion solidification. The prepared nanoparticles were in spherical shape and showed a strong pH-sensitive release in-vitro. These results indicated that the enteric eudragit L 100-55 nanoparticle could be synthesized successfully via ultrasonic solidification method [27].

ORAL DRUG DELIVERY
The high frequency of administration and severe adverse effects of active drug molecule by the oral route can be overcome by sustained release formulation. Eudragit polymers can be used in the sustained release tablet formulation due to its property of formation of a matrix system. Badir et al. prepared and evaluated eudragit vancomycin (VCM) nanoparticles by w/o/w double emulsion solvent evaporation method using eudragit RS as a retardant material. In-vitro release study showed biphasic release pattern; an initial burst for 0.5 hrs followed by a very slow release pattern during a period of 24 hrs. It was concluded that VCM nanoparticle preparations can be successfully utilized for oral sustained administrations [29].

Jingling et al. improved the oral bioavailability of genistein by preparing nanoparticles of genistein by nanoprecipitation technique using eudragit E100 as carriers. The release of drug from genistein nanoparticles was two times greater than that from the conventional capsules [29]. Momoh et al. formulated and evaluated eudragit RS100/RL100 microspheres by a solvent-evaporation technique for improved delivery of diclofenac sodium. Effective clinical utilization of non-steroidal anti-inflammatory drugs such as diclofenac sodium is significantly limited by ulcerogenic potential and poor bioavailability after oral administration. It was found that microsphere formulations based on eudragit® polymers would likely offer a reliable and alternative means of delivering DS orally [30].

Meltem et al. formulated and characterized eudragit L100 and eudragit L100-poly (lactic-co-glycolic acid) (PLGA) nanoparticles containing diclofenac sodium. Diclofenac generates severe adverse effects with risks of toxicity. It was demonstrated that efficacy of eudragit nanoparticles were efficacious in sustaining diclofenac sodium release profile [31].

Colon drug delivery
The pH-sensitive polymers that dissolve, or above pH 7 are used for colonic drug delivery. Daniela et al. designed and evaluated colonic drug delivery system containing mesalamine [M]. To facilitate this, a tablet core was coated with two thin layers. The first compounded by chitosan, which was responsible for core protection in the small intestine until it reached the colon. Once at the colon, microbiological enzymatic activity of the caecal content would degrade the Ch layer; thus triggering drug release. The second layer, outer one, was compounded with Eudragit L100 (RL), with its function being to avoid the dissolution of Ch-covered core along the GIT [32].
VACCINE DELIVERY

Lee et al. carried in-vivo studied of a vaccine delivery system based on thiolated eudragit microsphere for its ability to elicit mucosal immunity against enterotoxigenic Escherichia coli. The results suggested that thiolated eudragit microsphere may be a promising candidate for an oral vaccine delivery system to elicit systemic and mucosal immunity [33]. Dea-Ayuela et al. formulated microcapsules by spray drying method using eudragit L100 for oral delivery of vaccines against enteral/parenteral nematode parasite Trichinella spiralis. The results indicated that microcapsules formulated with eudragit L100 may be useful for oral vaccination against nematode infections [34].

Vollant et al. aimed to develop novel core-shell poly (methyl methacrylate) (PMMA) nanoparticles as a delivery system for protein vaccine candidates. Anionic nanoparticles consisting of a core of PMMA and a shell deriving from eudragit L100/55 were prepared by an innovative synthetic method based on emulsion polymerization. These nanoparticles can provide a versatile platform for protein surface adsorption and promising delivery system for vaccine delivery [35].

GENE DELIVERY

The course of many hereditary diseases could be reversed by gene delivery. In addition, many acquired diseases such as multigenetic disorders and those diseases caused by viral genes could be treated by the genetic therapy. Basakar et al. prepared nanoparticles by blending PLGA with methacrylate copolymer (eudragit E100) which can efficiently and safely deliver plasmid DNA encoding mouse interleukin-10 leading for the prevention of autoimmune diabetes [36].

Wang et al. 2003 investigated the possibility of polymethacrylate nanoparticles for antisense oligodeoxynucleotides delivery system. The nanoparticles were prepared by evaporating ethanol solution containing eudragit RL100 or RS100 mixture with oligonucleotides. The polymethacrylate nanoparticles appeared to be a promising vehicle for gene delivery [37].

Gargouri et al. developed a new tool for DNA delivery composed of methacrylic polymer (eudragit RS and RL) nanoparticles. These nanoparticles were prepared by nanoprecipitation and double emulsion technique. It was found that eudragit RS and RL nanoparticles could introduce transgene into different types of cells [38].

VAGINAL DRUG DELIVERY

Drug delivery via vaginal epithelium has suffered from lack of stability due to acidic and enzymatic environments. Yoo et al. developed biocompatible pH-sensitive nanoparticles containing sodium fluorescein or nile red using eudragit S-100 (ES) by modified quasi-emulsion solvent diffusion method. Prepared nanoparticles protected loaded compounds from being degraded under rigorous vaginal conditions and achieved their therapeutically effective concentrations in mucosal epithelium. It was concluded that pH-sensitive eudragit nanoparticles would be promising carrier for vaginal-specific delivery of various therapeutic drugs including microbicides and peptides/proteins [39]. Değim et al. prepared sildenafl-containing suppositories prepared using eudragit RS100 and witepsol H15. Among various formulations, the most suitable sildenafl release was found to be with sildenafl-containing suppositories prepared using eudragit RS100 and witepsol H15 [40].

TRANSDERMAL DRUG DELIVERY

Verma and Iyer developed a matrix-dispersion-type transdermal drug delivery system of propranolol using different ratios of mixed polymeric grades of Eudragit [41]. Baviskar et al. designed a matrix-type transdermal drug delivery system of lornoxicam was prepared with ethyl cellulose: Polyvinylpyrrolidone and eudragit RL 100: Eudragit RS 100 in different ratios with propylene glycol as plasticizer (5%) and Tween 80 as permeation enhancer using the solvent evaporation technique. Evaluation of these formulations was performed through mechanical characterization and in-vitro permeation studies. It was found that ethyl cellulose: Polyvinylpyrrolidone and Eudragit RL 100: Eudragit RS 100 can be successfully utilized for formulating transdermal patches of lornoxicam to sustain its release characteristics and to avoid disadvantages of oral routes [42].

Lade et al. prepared polymeric films containing budesonide using eudragit RL 100: eudragit RS: drug (7:3:1, 7:2:1) and ethyl cellulose: PVP: Drug (7:3:1, 7:2:1) by mercury substrate method employing polyethylene glycol-400 as plasticizer. Budesonide is highly potent synthetic, a non-halogenated corticosteroid. It was found that polyvinyl alcohol and eudragit RL 100 patches provides best resistance to water vapor and may provide more occlusion to water vapor loss from skin thus making atmosphere beneath the skin more humid that aid in drug permeation [43].

Chandak et al. developed a matrix-type transdermal formulation of pentaozone using mixed polymeric grades of eudragit RL/RS. The matrix transdermal films of pentaozone were evaluated for physical parameters and in-vitro dissolution characteristic using cygnus’ sandwich patch holder. In-vitro dissolution study revealed that, with an increase in the proportion of eudragit RS (slightly permeable) type polymer; dissolution half-life (t_{1/2}) increases and dissolution rate constant value decreases [44].

CONCLUSION

Eudragit polymers can produce sustained release formulations for time-controlled drug release, enteric formulations for GI targeting and protective formulations for moisture protection and odor/taste masking. These multifaceted applications of eudragit polymers in NDDS have made significant contributions to NDDS. It has been concluded that eudragit polymers can be significantly utilized as novel and versatile keystroke tool for fabrication of pharmaceutical formulation in future.

REFERENCES


