ISSN 2582-6441 [Online]
RESEARCH JOURNAL OF PHARMACY AND LIFE SCIENCES
LET OTHERS KNOW YOUR RESEARCH
RJPLS
An International Peer Reviewed Journal

Review Article

Eudragit: Versatile Polymer for Controlled Drug Delivery

G.Anusha

Viswalab Singapore Pvt. Ltd., Laboratory Analyst II, 80 Tagore Lane, Singapore 787501

ARTICLE INFO

Date of submission: 12-03-2022
Date of Revision: 29-03-2022
Date of acceptance: 17-04-2022

Key Words:
Eudragit, enteric effect, modified release, coating

ABSTRACT

Poly (meth) acrylates are known worldwide in the industry under the trade name Eudragit. These polymers allow the active ingredients in solid dosage form to perform during the passage of the human body. The flexibility to combine the different polymers enables to achieve the desired drug release profile by releasing the drug at the right place and at the right time over a desired period of time. Other important functions are protection from external environments like pH, moisture or taste/odor masking to increase patient compliance. The range of product portfolio provides full flexibility for targeted drug release profiles by offering best performance for enteric, protective or sustained-release properties.

***Corresponding author:**
G.Anusha
Viswalab Singapore Pvt. Ltd.
Laboratory Analyst II,
80 Tagore Lane, Singapore 787501
E.mail.: anusha05.gottipai@gmail.com, Mobile: +65 96185745

INTRODUCTION:

Polymers are widely used as film formers to coat solid pharmaceutical dosage forms whereas cellulose derivatives are mainly employed for unspecific film-coatings. Poly (meth) acrylates predominate in applications for functional pharmaceutical coatings. Furthermore, they are applied as matrix formers in all common granulation techniques as well as in direct compression.

Eudragit is trademark of Rohm GmbH & Co. KG. Darmstadt in Germany, first marketed in 1950s. Eudragit prepared by the polymerization of acrylic and methacrylic acids or their esters, e.g., butyl ester or dimethylaminoethyl ester (1). The eudragit acrylic polymers have a long history of use, the individual types and grades being introduced in the following chronological order:

Table 1: **Year of introduction and Eudragit Grade**

Year of introduction	Eudragit Grade
1954	Eudragit L 12.5 & S 12.5
1959	Eudragit E 12.5
1961	Eudragit E 100
1968	Eudragit RL 100 & RS 100
1972	Eudragit NE 30D, RSPO, RL PO & L 30D-55
1977	Eudragit L 100
1983	Eudragit NE 40 D
1985	Eudragit L 100-55
1986	Eudragit RL 30 D& RS30D
1999	Eudragit E PO & FS30D

TYPES OF EUDRAGIT POLYMERS

1. Soluble Poly (meth) acrylates

These polymers with acidic or alkaline groups enable pH-dependent release of the active ingredient. They are soluble in digestive fluids by salt formation. Examples are- Eudragit L, S, FS and E polymers. The main application is simple taste masking through gastric resistance to control drug release in all sections of the intestine (2).

2. Insoluble Poly (meth) acrylates

These are insoluble but permeable in digestive fluids. Some of the examples are- Eudragit RL and RS polymers with alkaline and Eudragit NE polymers with neutral groups enable controlled time release of the active ingredient by pH-independent swelling.

Mainly these polymers are used as rate controlling agents in delayed and sustained release dosage forms (2).

Table 1: Different grades of Eudragit in oral dosage formulation.

Types of Formulation	Region of GIT	pH	Eudragit granules
Enteric Formulation	Duodenum	pH> 5.5	Eudragit L 30 D-55
			Eudragit L 100-55
	Ileum, Colon	pH> 7.0	Eudragit S 100
			Eudragit S 12.5
			Eudragit FS 30 D
	Jejunum	pH 6-7	Eudragit L 100
			Eudragit L 12.5
Protective Formulation	Stomach	pH 1-5	Eudragit E 100
			Eudragit E 12.5
			Eudragit E PO
Sustained-release Formulation	Time Controlled release	pH Independent	Eudragit RL 30 D
			Eudragit RL PO
			Eudragit RL 100
			Eudragit RL 12.5
			Eudragit RS 30 D
			Eudragit RS PO
			Eudragit RS 100
			Eudragit RS 12.5
			Eudragit NE 30 D
			Eudragit NE 40 D
			Eudragit NM 30 D

PHYSICO-CHEMICAL PROPERTIES OF EUDRAGITS: [2] [3] [4]

1. Molar mass/molar mass distribution:

Molar mass distributions are calculated by calibrating polymers of known molar mass. In methacrylate chemistry, calibrated polymethyl poly (meth) acrylates (PMMA) are most commonly used.

Table 2: Weight average molar masses of EUDRAGIT® grades in relation to PMMA standard

EUDRAGIT® grade	Mw [g/mole]
EUDRAGIT® S 100	~ 123 000
EUDRAGIT® L 100	~ 123 000
EUDRAGIT® L 100-55	~ 278 000
EUDRAGIT® FS 30 D	~ 283 000
EUDRAGIT® NM 30 D	~ 600 000
EUDRAGIT® NE 30 D	~ 800 000
EUDRAGIT® E 100	~ 47 000
EUDRAGIT® RL 100	~ 31 000
EUDRAGIT® RS 100	~ 30 000

2. Glass transition temperature:

The glass transition temperature is an important factor for describing the physical properties of polymers. On a macroscopic level, it describes the solidification of an anisotropic polymer melt. When a polymer is heated from the glassy state, it passes beyond the viscoelastic range to a viscous flow. Initially, this leads to molecular movement in the side chains, followed by movement in the main chains and polymer chain sliding, which is connected with a change in specific heat. One standard method for determining the glass transition temperature is differential scanning calorimetry (DSC), in which the change in temperature is measured as a function of the heating rate against a reference. It is not possible to determine values for EUDRAGIT® S 100 and L 100, because of the overlapping with the damage of the functional groups at temperatures of more than 150°C.

Table 3: Glass transition temperatures of EUDRAGIT® grades

EUDRAGIT® grade	Tg,m [°C]
EUDRAGIT® E 100 / E PO	~ 48
EUDRAGIT® L 100-55/ L 30 D-55	~ 110
EUDRAGIT® FS 30 D	~ 48
EUDRAGIT® RL 100 / RL PO	~ 70
EUDRAGIT® RS 100 / RS PO	~ 65
EUDRAGIT® NE 30 D	~ 9
EUDRAGIT® NM 30 D	~ 11

The glass transition temperature has far-reaching consequences, e.g., for film formation, melt processing and storage of finished pharmaceutical dosage forms. Plasticizers, solvents or residual solvents (including water) that act as plasticizers usually cause a reduction in glass transition temperature, which is specifically exploited in application formulations. Most common plasticizer for EUDRAGIT® polymers is triethyl citrate (TEC).

3. Minimum film forming temperature:

To be able to form a film, the polymer chains must be mobile. Films are usually formed from a solution or dispersion, but may also be obtained from polymer melt by spreading out or film extrusion processes. The film-forming mechanism of a solution is fundamentally different to that of dispersion. Film formation of a solution takes place through evaporation of the solvent, So that the polymer chains move closer and closer until they enter into contact. The plasticizing effect of the solvent is usually sufficient to obtain the required elasticity for film formation without cracking. In some cases, additional plasticizers can be added to influence the properties of the resulting film. Aqueous dispersions contain polymer latex particles rather than individual dissolved polymer molecules. Upon evaporation of the water, only the individual particles move closer, without interpenetration. Only when the particles collide and given adequate elasticity of the polymer spheres, the particles coalesce due to their surface tension, giving rise to the formation of a homogenous film. The temperature at which film formation takes place is the minimum film-forming temperature (MFT/ MFFT) that is characteristic of the dispersion. Naturally, this can be influenced by adding plasticizers.

Table 4: MFT/MFFT values of EUDRAGIT® dispersions

EUDRAGIT® dispersion	MFT [°C]
EUDRAGIT® L 30 D-55	~ 25
EUDRAGIT® FS 30 D	~ 14
EUDRAGIT® RL 30 D	~ 40
EUDRAGIT® RS 30 D	~ 45
EUDRAGIT® NE 30 D	~ 5
EUDRAGIT® NM 30 D	~ 5

It is important to know or adjust the minimum film-forming temperature of coating formulations because; this makes it possible to establish the temperatures for coating processes. As a rule, the product temperature should be at least 10 or better 20°C above the minimum film-forming temperature. In practice, this often means

that the MFT has to be reduced by adding plasticizers. The choice of plasticizer depends on its effectiveness and influence on the permeability of the resulting polymer films. An example for the influence of hydrophilic and hydrophobic Plasticizers on the minimum film-forming temperature of EUDRAGIT® L 30 D-55. It shows why triethylcitrate (TEC) is recommended as an effective plasticizer for use of this EUDRAGIT® grade.

4. Particle size of dispersions:

The size of the dispersed particles plays an important role in the coalescence process for film formation. There are many different modern methods for determining the particle sizes of dispersions. The most common are laser scanning methods, but these deviate from each other due to different geometric setups and calculation algorithms and thus prevent direct comparison. The mean particle diameters of EUDRAGIT® dispersions are around 100 nm and can be made visible by scanning electron microscopy of dried dispersions.

5. Water vapor transmission rate

The water vapor transmission rate of polymer films may have a decisive influence on the storage stability of moisture-sensitive actives and their formulations. To achieve controlled improvement, it is very useful to determine and understand the water vapor transmission rate.

Table 5: Water vapor permeability rates of EUDRAGIT® films

EUDRAGIT® grade	**Water vapor permeability rate [g/m2•d]**
EUDRAGIT® E 10(organic)	~ 350
EUDRAGIT® E PO (stearic acid formulation)	~ 100
EUDRAGIT® L 100 / S 100 (redispersed)	~ 150
EUDRAGIT® L 30 D-55 (10%TEC)	~ 100
EUDRAGIT® FS 30D (3% TEC).	~ 100
EUDRAGIT® NE30D	~ 300
EUDRAGIT® NM30D	~ 300
EUDRAGIT® RS 100 (organic)	~ 250
EUDRAGIT® RL 100 (organic)	~ 450

Comparison of these values with the value for hydroxypropyl methyl cellulose (HPMC) of 900 g/m2•d illustrates the superiority of poly (meth) acrylates for this application field. The water vapor transmission rates can

be influenced via the choice of further excipients in the film coating formulations. The WVTR of EUDRAGIT® E 100 is reduced in the stearic acid containing formulation with EUDRAGIT® E PO to much lower values than in an organic application of the pure polymer (see Table 5).

6. Elongation at break:

Film coatings of adequate flexibility are the prerequisite for the compressibility of coated particles and also for preventing film damage when tablets are dropped. The elastic properties can be described by various physical methods such as the modulus of elasticity. This can readily be illustrated by the elongation at break of test specimens made from sections of fully formed films. It allows statements to be made on the failure of polymer films under tensile stress. Plasticizers simultaneously reduce the glass transition temperature and increase the elasticity. Another elegant way to increase elongation at break is to mix highly elastic and compatible polymers, as shown in the example below of a mixture of EUDRAGIT® L 30 D-55 and EUDRAGIT® NE 30 D. Such mixtures obviate the need for large quantities of plasticizers.

7. Thermal stability:

In past years, melt extrusion has become increasingly important in the development of solid pharmaceutical dosage forms. Being poly (meth)acrylates, all EUDRAGIT® grades are thermoplastic polymers and therefore in principle suitable for such applications. The thermal integrity is a factor that is just as important as the active ingredients that are to be compounded with the polymers. The thermal stability levels as a function of temperature and time can be examined via thermo gravimetric determination and if necessary, it can be identified by combination with mass spectroscopy. Tests such as these have shown that depolymerization reactions occur at temperatures higher than 250°C. Even at lower temperatures there was damage to the functional groups on the side chains. The maximum temperatures (T_{max}) in the following illustration were calculated for a time of 4.5 minutes (an average dwell time in an extrusion process) and with damage to 1% of the functional groups. These values also indicate that for many EUDRAGIT® grades it makes sense to use plasticizers for melt applications, although the actives to be incorporated frequently provide the extrusion mixture with enough of a plasticizing effect.

Drug Release Mechanism:

- Dissolution controlled dosage forms can be divided into reservoir and matrix system. Reservoir principle is given by a controlled release formulation comprising 400mg 5-ASA within an acrylic resin coat, eudragit S [5].
- Mechanism of drug release from pellets coated with polymer eudragit E30D was governed by diffusion through water-filled pores in the film coat[6].
- The release of propranolol HCL from a monolithic matrix (Eudragit NE 30 D) by a combination of diffusion through the polymer and pores or channels [7].
- A desirable release profile of diphenhydramine was achieved by incorporating Eudragit L in a carnauba wax matrix. The drug release from these polymer-waxmatrices is described by a combination diffusion/erosion mechanism (8).
- Eudragit RSPO release the carbamazepine drug by complex mixture of diffusion and erosion mechanism (9).
- Eudragit RS 30 D-coated theophylline beads proved ion exchange to be the responsible mechanism of controlling polymer permeability as a function of anionic species and concentration [10].

Enteric formulations[11],[12]

Gastro resistance and GI Targeting

To protect the active ingredient from the gastric fluid and to improve drug effectiveness– Eudragit L and S polymers are preferred choice of coating polymers. They enable targeting specific areas of the intestine. Pharma Polymers offers a broad product portfolio of anionic Eudragit grades which dissolve at rising pH values. In addition, the different grades can be combined with each other, making it possible to adjust the dissolution pH, and thus to achieve the required GI targeting for the drug. Targeted drug release in the colon is required for local treatment of intestinal disorders such as Crohn's disease, ulcerative colitis or intestinal cancer. It is also required for drugs that are poorly soluble in the upper gastrointestinal tract. Moreover, the gastro résistance of the coating ensures that the oral dosage form is patient compliance. The preferred coating is EUDRAGIT FS 30 D, which combines release in the colon with the following technical advantages:

- ✓ aqueous processing
- ✓ highly flexible coatings

- ✓ suitable for multi particulate tablet preparation

EUDRAGIT® offers valuable advantages for enteric coatings such as:

- PH-dependent drug release
- Protection of actives sensitive to gastric fluid
- Protection of gastric mucosa from aggressive actives
- Increase in drug effectiveness
- Good storage stability
- GI and colon targeting

Protective Formulations:

Moisture Protection and Odor/Taste Masking

The active ingredient needs to protect from moisture or light to increase patient compliance. Eudragit E polymers help to seal sensitive actives and increase patient compliance by masking tastes and odors. Even thin layers of Eudragit provide the desired effect, making it an extremely economical application.

Sustained-release formulations:

Time-controlled drug release

When drug release is needed over a specific period of time or one would like to benefit from the advantages of multi particulate or matrix formulations, Eudragit polymers can help to achieve desired release profile. Drug delivery can be controlled throughout the entire gastro intestinal tract to increase therapeutic effect and patient compliance. Different polymer combinations of Eudragit RL and RS grades as shown in Table 4 allow custom tailored release profiles to achieve the desired drug delivery performance. Eudragit NE and NM grades are neutral ester dispersions which do not require addition of plasticizer.

Formulation methods for time controlled drug release

1. Matrix formulation

Eudragit serves as a matrix within which the active ingredient is embedded. The matrix structure is obtained by direct compression, granulation, or melt extrusion. Eudragit NM 30 D is particularly suitable for granulation processes in the manufacture of matrix tablets.

2. Multiparticulate formulations

Eudragit is employed as a coating material, usually for the coating of pellets or particles that are filled into capsules or compressed into tablets. These pellets or particles act as diffusion cells in the digestive tract and release a constant drug quantity per unit of time (multi-unit dosage forms).

Benefit from EUDRAGIT® coatings with sustained release:

- ✓ Time-controlled release of active ingredients
- ✓ Therapeutically customized release profiles
- ✓ Higher patient compliance due to reduced number of doses to be taken

Table 6: Various Eudragit Polymers, availability and dissolution Properties

Polymer	Availability	Dissolution Properties
EUDRAGIT® RL 100	Granules	Insoluble **High permeability** pH-independent swelling
EUDRAGIT® RL PO	Powder	
EUDRAGIT® RL 30 D	30% Aqueous Dispersion	
EUDRAGIT® RL 12,5	12,5% Organic Solution	
EUDRAGIT® RS 100	Granules	Insoluble **Low permeability** pH-independent swelling
EUDRAGIT® RS PO	Powder	
EUDRAGIT® RS 30 D	30% Aqueous Dispersion	
EUDRAGIT® RS 12,5	12,5% Organic Solution	
EUDRAGIT® NE 30 D	30% Aqueous Dispersion	Insoluble, low permeability, pH-independent swelling **No plasticizer required** Highly flexible
EUDRAGIT® NE 40 D	40% Aqueous Dispersion	
EUDRAGIT® NM 30 D	30% Aqueous Dispersion	

Applications of Eudragit polymers:

Colonic drug delivery:

For colonic drug delivery , anionic Eudragits like eudragit S and FS have been widely used. These are soluble above pH 7. Colonic drug delivery is a approach for the treatment of diseases like ulcerative colitis, crohn's disease and irritable bowel syndrome.

F.J.O Varum *et. al.* developed a concept of a novel double coating system, based on enteric polymers , which release drug in the ileo-colonic region. Prednisolone tablets were coated with a double coated with a double coating formulation by applying an inner layer composed of EUDRAGIT S neutralized to pH 8.0 and a buffer salt (10%KH2PO4),which was over coated with

layer of standard EUDRAGIT S organic solution.[13]

A.Akhgari *et. al.* evaluated the effect of two factors (ratio of Eudragit S100 to Eudragit L100 and the coating level)on indomethacin release from pellets in order to optimize coating formulation for colonic delivery. It was shown that coating formulation consisted of Eudragit S100 to Eudragit L100 in 4:1 ratio at 20% coating level has potential for colonic delivery of indomethacin loaded pellets.[14]

Transdermal Drug Delivery:

Chandak AR *et. al.* developed a matrix-type transdermal formulation of pentazocine using mixed polymeric grades of Eudragit RL/RS. The matrix transdermal films of pentazocine were evaluated for physical parameters and in vitro dissolution characteristic using Cygnus' sandwich patch holder. Irrespective of the grades of Eudragit polymer used, the thickness and weight per patch were similar. In vitro dissolution study revealed that, with an increase in the proportion of Eudragit RS (slightly permeable) type polymer, dissolution half-life (t(50%)) increases and dissolution rate constant value decreases.[15]

S.Amin *et. al.* designed the polymeric patches of metaclopromide with rate controlling polymers like Eudragit RS100 to Eudragit RL100 using DMSO as penetration enhancer. The final optimized film composition of Eudragit RL100: Eudragit RS100: PEG 4000: DMSO in 7:5:5:10 ratio was found to have best physicochemical properties and in vitro performance and was free from skin irritation.[16]

Vaginal Drug Delivery:

Yoo JW *et. al.* developed a drug delivery via vaginal epithelium has suffered from lack of stability due to acidic and enzymatic environments. The biocompatible pH-sensitive nanoparticles composed of Eudragit S-100 (ES) were developed to protect loaded compounds from being degraded under the rigorous vaginal conditions and achieve their therapeutically effective concentrations in the mucosal epithelium. ES nanoparticles containing a model compound (sodium fluorescein (FNa) or nile red (NR)) were prepared by the modified quasi-emulsion solvent diffusion method. Loading efficiencies were found to be 26% and 71% for a hydrophilic and a hydrophobic compound, respectively. [17]

Vaccine Delivery

Microcapsules using the copolymer of methacrylic acid (Eudragit L100) were formulated for oral delivery of vaccines against the enteral/parenteral nematode parasite Trichinella spiralis. Antigenic

preparations from first stage larvae (L1) of T. spiralis were microencapsulated in Eudragit L100. The microcapsules prepared by the spray drying method were resistant to acid pH, although the antigen was rapidly released under neutral and basic environmental conditions. The native protein conformation and biological activity was preserved in the microcapsules, as assessed by SDS-PAGE and ELISA. When administered to NIH mice, the antigen loaded microcapsules protected against infection by T. spiralis at both the intestinal and muscular levels, the worm burden diminishing by 45.58 and 53.33%, respectively. Furthermore, following administration of the micro particles an increase of the serum IgG1 response, a marker for the Th2 type response, was evident. These results indicate that microcapsules formulated with anionic biocompatible polymers such as Eudragit may be useful for oral vaccination against nematode infections.[18]

Gene Delivery

Deepti Jain *et .al.* investigated whether Eudragit S100 microspheres have the potential to serve as an oral carrier for peptide drugs like insulin. Microspheres were prepared using water-in oil-in water emulsion solvent evaporation technique with polysorbate 20 as a dispersing agent in the internal aqueous phase and polyvinyl alcohol (PVA)/polyvinyl pyrrolidone as a stabilizer in the external aqueous phase. The release of drug from microspheres followed Higuchi kinetics. Oral administration of PVA stabilized microspheres in normal albino rabbits (equivalent to 6.6 IU insulin/kg of animal weight) demonstrated a 24% reduction in blood glucose level, with maximum plasma glucose reduction of 76±3.0% in 2 hours and effect continuing up to 6 hours. The area under the percentage glucose reduction-time curve was 93.75%. Thus, our results indicate that Eudragit S100 microspheres on oral administration can protect insulin from proteolytic degradation in the gastrointestinal tract and produce hypoglycemic effect.[19]

Ophthalmic Drug Delivery:

A major challenge in ocular therapeutics is the improvement of ocular drug bioavailability. As indicated before, conventional aqueous solutions topically applied to the eye have the inherent disadvantage that most of the instilled drug is lost within the first 15–30 s after instillation, due to reflex tearing and drainage via the nasolacrimal duct. Hence, many of the efforts at improving ocular drug delivery the incorporation of viscosity

building agents such as polyvinyl alcohol and methyl cellulose.[20] Eudragit nanoparticles in ocular drug delivery [21]

Table 7: Polymer Loaded drug/ gene/ protein Comments

Polymer	Loaded drug/ gene/ protein	Comments
Eudragit RS 100, RL 100	Ibuprofen Flurbiprofen Cloricromene Diclofenac diethyl ammonium Piroxicam Methylprednisolone	Drug level was improved in the aqueous humor after application of the drug-loaded nanosuspensions which did not show toxicity in ocular tissues. Improved the stability of cloricrome in ophthalmic formulations and its drug availability at the ocular level. Excellent encapsulation efficiency.

Gastrointestinal Drug Delivery:

The need for gastroretentive dosage forms has led to extensive efforts in both academia and industry towards the development of such drug delivery systems. These efforts resulted in gastroretentive dosage forms that were designed, in large part, based on the following approaches,Low density form of the dosage form that causes buoyancy in gastric fluid, High density dosage form that is retained in the bottom of the stomach, Bioadhesion to stomach mucosa, Slowed motility of the gastrointestinal tract by concomitant administration of drugs or pharmaceutical excipients, Expansion by swelling or unfolding to a large size which limits emptying of the dosage form through the pyloric sphincter . All these techniques we can achieved with different grades of eudragit. [22]

Kale *et. al.* found that the microspheres of eudragit S100 float continuously in the acidic solution and successfully release drug in a predetermined rate. [22]

Gloria *et.al.* formulated bioadhesive two layers controlled release tablets with combination of Carrageenan 934 and Eudragit RL PO in 1:1 ratio. The drug release was 96.3% in phosphate buffer pH 7.4; 59.1% in 0.1 N HCl and 46.4% in distilled water. [23]

Intestinal Drug Delivery:

Sustained intestine delivery of drugs was developed that could bypass the stomach and release the loaded drug for long periods into the intestine by coating of eudragit polymer. Eudragit L & Eudragit S are two

forms of commercially available enteric acrylic resins. Both of them produce films resistant to gastric fluid. Eudragit L & S are soluble in intestinal fluid at pH 6 & 7 respectively. Eudragit L is available as an organic solution (Isopropanol), solid or aqueous dispersion. Eudragit S is available only as an organic solution (Isopropanol) and solid.

Rahman *et. al.* prepared sodium para aminosalicylate Pellets were coated with Eudragit L 30 D-55 using fluidized bed processor and evaluated for *in vitro* dissolution behavior in 0.1 N HCl for two hours and then media was changed to phosphate buffer pH 6.8. A 60% w/w coating level of Eudragit L30 D 55 has produced the most acceptable results against the gastric attack. [24]

Table 8: Medications containing Eudragits:

Drug	Trade name	Eudragit type
Carvedilol	COREG controlled release tablets	Eudragit L
Aspirin	ENPRIN 75 mg gastro resistant tablets	Eudragit L 100-55
Mesalamine	ASACOL delayed release tablets	Eudragit S
Nifidipine	ADANIF 30 mg tablets	Eudragit E
Benzafibrate	BEZALIP 400mg tablets	Eudragit NE
Budesonide	BUDENOFALK 3mg gastro resistant capsules	Eudragit RL
Brompheniramine maleate	BROMAX ER tablets	Eudragit RS

References:

1. Rowe Ray C, Sheskey Paul J, Weller Paul J. Hand Book of Pharmaceutical excipients, 6th ed. American Pharmaceutical Association Washington DC, USA & Pharmaceutical press, London U.K. 525-533.
1. http://eudragit.evonik.com/product/eudragit/en/contact/guidelines/Pages/contact.aspx
2. Evonik Industries. Eudragit. http://www.pharma-polymers.com/pharmapolymers/en/eudragit/ (accessed 4 March 2009).
3. Petereit HU et .al. Eudragit Application Guidelines, 11th edn. Darmstadt, Germany: Evonik Industries AG, 2008.
4. Riley, S.A., Tavares, I.A., Bennett, A. Mani, V., Br. Delayed-release mesalazine (5-aminosalicylic acid):

coat dissolution and excretion in ileostomy subjects. J. clin. Pharmac. 1988, 26 (2):173-177.

5. Gheber-Sellassie I., Gordon R.H., Nesbitt R.U. Fawzi M.B. Evaluation of acrylic-based modified-release film coatings. Int. J. Pharm., 1987, 37(3) :211-218.
6. Bodmeier, R., Paeratakul O., Evaluation of Drug-Containing Polymer Films Prepared from Aqueous Latexes. Pharmaceutical Research. Res., 1989, 6: 725-730.
7. Hua-Pin Huang, Surendra C. Mehta , Galen W. Radebaugh, Mahdi B. Fawzi., J.Pharm. Sci., 2006, :795 – 797.
8. Apurba Sarker Apu, Atiqul Haque Pathan, Dilashan Shrestha, Golam Kibria andReza- ul Jalil., Investigation of In vitro Release Kinetics of Carbamazepine from Eudragit® RS PO and RL PO Matrix Tablets. Trop. J. Pharm. Res., 2009, 8 (2): 145-152.
9. Karl G. Wagner., James W. McGinity**.**, Influence of chloride ion exchange on the permeability and drug release of Eudragit RS 30 D films. J.Controlled Release, 2002, 82 (2-3): 385-397.
10. 11.Meenakshi joshi. Role of eudragit in targeted drug delivery, Int J Curr Pharm Res, 2013, 5 (2) , 58-62.
11. 12.http://www.pharmainfo.net/satish singhkadian/publications/eudragit-and-its-pharmaceutical-significance 10/2009;
12. 13.F.J.O Varum,G.B Hatton,A.C.Freire,A.W.Basit,A novel coating concept for ileo-colonic drug targeting, European Journal of Pharmaceutics and Biopharmaceutics. 2013, 84, 573-577.
13. A.Akhgari, H.Afrasiabi Garekani, F.Sadeghi, M.Azimaie; statistical optimization of indomethacinpellets coated with pH depended methacrylic polymers for colonic drug delivery; international journal of pharmaceutics, 2005, 305, 22-30.
14. 15.Chandak AR, Prasad Verma PR; Eudragit-based transdermal delivery system of pentazocine: Physico-chemical, in vitro and in vivo evaluations., Pharm Dev Technol. 2009 Aug 17.
15. S. Amin, S.R Mir, K. Kohli, A. Ali; Novel polymeric matrix films for transdermal delivery of metoclopramide; International

Journal of Pharmaceutical Frontier Research;2012;2(1);48-60.

16. Yoo JW, Giri N, Lee CH.,pH-sensitive Eudragit nanoparticles for mucosal drug delivery., Int J Pharm. 2011 Jan 17;403(1-2):262-7.
17. Dea-Ayuela MA, Rama-Iñiguez S, Torrado-Santiago S, Bolas-Fernandez F. Microcapsules formulated in the enteric coating copolymer Eudragit L100 as delivery systems for oral vaccination against infections by gastrointestinal nematode parasites., J Drug Target. 2006 Sep;14(8):567-75.
18. Deepti Jain, Amulya K. Panda, and Dipak K. Majumdar., Eudragit S100 entrapped insulin microspheres for oral delivery .AAPS pharmscitech.2005 march; 6(1):E100-E107.
19. T.F. Patton, J.R. Robinson, Ocular evaluation ofpolyvinyl alcohol vehicle in rabbits, J. Pharm. Sci. 64(1975) 1312–1316.
20. Himanshu Pandey, Upendra Kumar Sharma, Avinash C. Pandey., eudragit-based nanostructures: a potential approach for ocular drug delivery International Journal of Research and Development in Pharmacy and Life Sciences June - July, 2012, 1(2), pp. 40-43
21. R Garg., GD Gupta., Progress in Controlled Gastroretentive Delivery Systems. Trop. J. Pharm. Res. , 2008; 7 (3): 1055-1066.
22. RD Kale., PT Tayade., A multiple unit floating drug delivery system of piroxicam using eudragit polymer. Ind. J. Pharm. Sci., 2007; 69 (1):120-123.
23. Mona Semalty, A Semalty, G Kumar., Formulation and Characterization of Mucoadhesive Buccal Films of Glipizide. Ind. J. Pharm. sci. 2008; 70 (1). 43-48.
24. Md A Rahman, J Ali., Development and in vitro Evaluation of Enteric Coated Multiparticulate System for Resistant Tuberculosis. Ind. J. Pharm. Sci., 2008; 70 (4): 477-481