LIST OF FIGURES

		Page No.
Fig. 2.1	Schematic of nasal drug delivery	8
Fig. 2.2	Schematic of a sagittal section of human nasal cavity	11
Fig. 2.3	Cell types of the nasal epithelium	12
Fig. 2.4	Schematic representation of transport routes across nasal respiratory epithelium	20
Fig. 2.5	The physicochemical, anatomical, physiological and formulation factors affecting the nasal absorption of drugs	21
Fig. 3.1	Standard Curve of Carvedilol in pH 6.2 phosphate buffer and methanol (9:1)	70
Fig. 3.2	Standard Curve of Carvedilol in methanol and 0.1N HCl (3:2)	73
Fig. 3.3	Standard Curve of Nitrendipine in pH 6.2 phosphate buffer containing 1% Tween 80	77
Fig. 3.4	Standard Curve of Nitrendipine in methanol and 0.1N HCl (3:2)	80
Fig. 4.1	Effect of chitosan concentration on particle size of microspheres	94
Fig. 4.2	Effect of aqueous to oil phase on particle size of microspheres	95
Fig. 4.3	Effect of stirring rate on particle size of microspheres	96
Fig. 4.4	Photomicrograph of CRV loaded chitosan microspheres	99
Fig. 4.5	SEM photograph of CRV loaded chitosan microspheres	99
Fig. 4.6	Adsorption of mucin on different microspheres with respect to the amount of mucin added	101
Fig. 4.7A	Freundlich adsorption isotherms for mucin adsorbed on chitosan microspheres (Batches CHCR1 to CHCR4)	102
Fig. 4.7B	Freundlich adsorption isotherms for mucin adsorbed on chitosan microspheres (Batches CHCR5 to CHCR8)	102
Fig. 4.8A	Langmuir adsorption isotherms of mucin adsorbed on chitosan microspheres (Batches CHCR1 to CHCR4)	103
Fig. 4.8B	Langmuir adsorption isotherms of mucin adsorbed on	103

	chitosan microspheres (Batches CHCR1 to CHCR4)	
Fig. 4.9	Percentage in vitro mucoadhesion for different batches of	105
	microspheres	
Fig. 4.10A	In vitro drug release profile of chitosan microspheres of CRV	106
· .	(Batches CHCR1 to CHCR4).	
Fig. 4.10B	In vitro drug release profile of chitosan microspheres of CRV	106
	(Batches CHCR5 to CHCR8).	
Fig. 4.11	DSC thermograms of (A) pure carvedilol; (B) drug loaded	110
	microspheres; and (C) placebo microspheres	
Fig. 4.12	DSC thermograms of (A) pure carvedilol; (B) drug loaded	111
	microspheres; and (C) placebo microspheres	
Fig. 4.13	Histology evaluations of sections of sheep nasal mucosa	112
Fig. 5.1	SEM Photograph of placebo alginate microspheres	123
Fig. 5.2	SEM Photograph of CRV loaded alginate microspheres	123
Fig. 5.3	Percentage in vitro mucoadhesion for different batches of	125
	microspheres	
Fig. 5.4	DSC thermograms of (A) pure carvedilol; (B) placebo	126
	microspheres; (C) drug loaded microspheres	
Fig. 5.5	Powder X-ray diffraction patterns of (A) pure carvedilol; (B)	127
	placebo microspheres; (C) drug loaded microspheres	
Fig. 5.6	In vitro drug release profile of alginate microspheres of CRV	128
	(Batches ALCR1 to ALCR4)	
Fig. 5.7	In vitro drug release profile of alginate microspheres of	129
	CRV (Batches ALCR5 to ALCR8)	
Fig. 5.8	Response surface plots for the (a) effects of drug: polymer	134
	ratio (X1) and $CaCl_2$ concentration (X2) on particle size	
	(Y1).	
Fig. 5.9	Response surface plots for the effects of CaCl ₂ concentration	134
	(X2) and cross linking time (X3) on particle size (Y1)	
Fig. 5.10	Response surface plots for the effects of drug: polymer ratio	135
	(X1) and cross linking time (X3) on particle size (Y1)	
Fig. 5.11	Contour plots for the effects of drug: polymer ratio (X1) and	135
	CaCl ₂ concentration (X2) on particle size (Y1)	

•

xi

Fig. 5.12	Contour plots for the effects of $CaCl_2$ concentration (X2) and	136
	cross linking time (X3) on particle size (Y1)	
Fig. 5.13	Contour plots for the effects of drug: polymer ratio (X1) and	136
	cross linking time (X3) on particle size (Y1)	
Fig. 5.14	Response surface plots for the effects of drug: polymer ratio	137
	(X1) and CaCl2 concentration (X2) on in vitro	
	mucoadhesion (Y2)	
Fig. 5.15	Response surface plots for the effects of CaCl ₂ concentration	138
	(X2) and cross linking time (X3) on in vitro mucoadhesion	
	(Y2)	
Fig. 5.16	Response surface plots for the effects of drug: polymer ratio	138
	(X1) and cross linking time (X3) on in vitro mucoadhesion	
	(Y2)	
Fig. 5.17	Contour plots for the effects of drug: polymer ratio (X1) and	139
	CaCl ₂ concentration (X2) on in vitro mucoadhesion (Y2).	
Fig. 5.18	Contour plots for the effects of $CaCl_2$ concentration (X2) and	139
	cross linking time (X3) on in vitro mucoadhesion (Y2)	
Fig. 5.19	Contour plots for the effects of drug: polymer ratio (X1) and	140
	cross linking time (X3) on in vitro mucoadhesion (Y2)	
Fig. 5.20	Correlation between actual and predicted values for particle	142
	size	
Fig. 5.21	Correlation between actual and predicted values for in vitro	142
	mucoadhesion	
Fig. 5.22	Histology evaluations of sections of sheep nasal mucosa	144
Fig. 6.1	Photomicrograph of NTD loaded chitosan microspheres	153
Fig. 6.2	SEM photograph of NTD loaded chitosan microspheres	153
Fig. 6.3	Cross linking process of chitosan treated with glutaraldehyde	154
Fig. 6.4	Adsorption of mucin on different microspheres with respect	156
	to the amount of mucin added	
Fig. 6.5A	Freundlich adsorption isotherms for mucin adsorbed on	157
	chitosan microspheres (Batches CHCR1 to CHCR4)	
Fig. 6.5B	Freundlich adsorption isotherms for mucin adsorbed on	157
	chitosan microspheres (Batches CHCR5 to CHCR8)	

.

.

Fig. 6.6A	Langmuir adsorption isotherms of mucin adsorbed on	158
	chitosan microspheres (Batches CHCR1 to CHCR4)	
Fig. 6.6B	Langmuir adsorption isotherms of mucin adsorbed on	158
	chitosan microspheres (Batches CHCR5 to CHCR8)	
Fig. 6.7	Percentage in vitro mucoadhesion for different batches of	160
	microspheres	
Fig. 6.8A	In vitro drug release profile of chitosan microspheres of	161
	NTD (Batches CHNT1 to CHNT4)	
Fig. 6.8B	In vitro drug release profile of chitosan microspheres of NTD	161
	(Batches CHNT5 to CHNT8)	
Fig. 6.9	DSC thermograms of (A) pure nitrendipine; (B) placebo	164
	microspheres; and (C) NTD loaded microspheres	
Fig. 6.10	Powder X-ray diffraction patterns of (A) pure nitrendipine;	165
	(B) placebo microspheres; and (C) nitrendipine loaded	
	microspheres	
Fig. 6.11	Histology evaluations of sections of sheep nasal mucosa	167
Fig. 7.1	The structure of alginate	177
Fig. 7.2	SEM Photograph NTD loaded alginate microspheres at	178
	2000X	
Fig. 7.3	SEM Photograph of NTD loaded alginate microspheres at	178
	100X	
Fig. 7.4	Percentage in vitro mucoadhesion for different batches of	180
	microspheres	
Fig. 7.5	DSC thermograms of (A) pure NTD; (B) placebo	181
	microspheres; (C) drug loaded microspheres.	
Fig. 7.6	Powder X-ray diffraction patterns of (A) pure NTD; (B)	182
	placebo microspheres; (C) NTD loaded microspheres	
Fig. 7.7	In vitro drug release profile of alginate microspheres of NTD	183
	(Batches ALNT1 to ALNT4)	
Fig. 7.8	In vitro drug release profile of alginate microspheres of NTD	183
	(Batches ALNT5 to ALNT8)	
Fig. 7.9	Response surface plots for the (a) effects of drug: polymer	188
	ratio (X1) and $CaCl_2$ concentration (X2) on particle size (Y1)	

xiii [·]

Fig. 7.10	Response surface plots for the effects of CaCl ₂ concentration	188
	(X2) and cross linking time (X3) on particle size (Y1).	
Fig. 7.11	Response surface plots for the effects of drug: polymer ratio	189
	(X1) and cross linking time (X3) on particle size (Y1)	
Fig. 7.12	Contour plots for the effects of drug: polymer ratio (X1) and	189
	$CaCl_2$ concentration (X2) on particle size (Y1)	
Fig. 7.13	Contour plots for the effects of $CaCl_2$ concentration (X2) and	190
	cross linking time (X3) on particle size (Y1).	
Fig. 7.14	Contour plots for the effects of drug: polymer ratio (X1) and	190
	cross linking time (X3) on particle size (Y1).	
Fig. 7.15	Response surface plots for the effects of drug: polymer ratio	191
	(X1) and CaCl2 concentration (X2) on in vitro	
	mucoadhesion (Y2)	
Fig. 7.16	Response surface plots for the effects of CaCl ₂ concentration	192
	(X2) and cross linking time (X3) on in vitro mucoadhesion	
	(Y2)	
Fig. 7.17	Response surface plots for the effects of drug: polymer ratio	192
	(X1) and cross linking time (X3) on in vitro mucoadhesion	
	(Y2)	
Fig. 7.18	Contour plots for the effects of drug: polymer ratio (X1) and	193
	$CaCl_2$ concentration (X2) on in vitro mucoadhesion (Y2)	
Fig. 7.19	Contour plots for the effects of $CaCl_2$ concentration (X2) and	193
	cross linking time (X3) on in vitro mucoadhesion (Y2)	
Fig. 7.20	Contour plots for the effects of drug: polymer ratio (X1) and	194
	cross linking time (X3) on in vitro mucoadhesion (Y2)	
Fig. 7.21	Correlation between actual and predicted values for particle	196
	size	
Fig. 7.22	Correlation between actual and predicted values for in vitro	196
	mucoadhesion	
Fig. 7.23	Histology evaluations of sections of sheep nasal mucosa	198
Fig. 8.1	MIAT [®] monodose nasal insufflator	203
Fig. 8.2	The spray pattern (shape) of CRV loaded chitosan	209
	microspheres from MIAT [®] nasal monodose insufflator	

xiv

- Fig. 8.3 The spray pattern (shape) of NTD loaded chitosan 209 microspheres from MIAT[®] nasal monodose insufflator
- Fig. 8.4 The spray pattern (shape) of CRV loaded alginate 210 microspheres from MIAT[®] nasal monodose insufflator
- Fig. 8.5 The spray pattern (shape) of NTD loaded alginate 210 microspheres from MIAT[®] nasal monodose insufflator
- Fig. 9.1 Blood radioactivity time profiles of CRV after administration 223 of microspheres intranasally (IN) (1 mg kg⁻¹) and CRV solution intravenously (IV) (0.17 mg kg⁻¹) in rabbits
- Fig. 9.2 The clearance characteristics of radiolabeled chitosan 227 microspheres (CHCR) and alginate microspheres (ALCR) from the rabbit nasal cavity as compared to lactose powder a control
- Fig. 9.3 Scintigraphic rabbit whole body images showing 229 radioactivity in the nasal cavity after administration of ^{99m}Tc labeled chitosan microspheres of carvedilol (CHCR) at different times of 0 h (A), 1 h (B), 2 h (C), 3 h (D) and 4 h (E) post insufflation
- Fig. 9.4 Scintigraphic rabbit whole body images showing 230 radioactivity in the nasal cavity after administration of ^{99m}Tc labeled alginate microspheres of carvedilol (ALCR) at different times of 0 h (A), 1 h (B), 2 h (C), 3 h (D) and 4 h (E) post insufflation
- Fig. 9.5 Scintigraphic rabbit whole body images showing 231 radioactivity in the nasal cavity after administration of ^{99m}Tc labeled lactose powder (control) at different times of 0 h (A), 1 h (B) and 2 h (C) post insufflation
- Fig. 10.1 Blood radioactivity time profiles of NTD after administration 242 of microspheres intranasally (IN) (1.25 mg kg⁻¹) and NTD solution intravenously (IV) (0.2 mg kg⁻¹) in rabbits
- Fig. 10.2 The clearance characteristics of radiolabeled chitosan 245 microspheres (CHNT) and alginate microspheres (ALNT) from the rabbit nasal cavity as compared to lactose powder a

XV.

control

- Fig. 10.3 Scintigraphic rabbit whole body images showing 247 radioactivity in the nasal cavity after administration of ^{99m}Tc labeled chitosan microspheres of nitrendipine (CHNT) at different times of 0 h (A), 1 h (B), 2 h (C), 3 h (D) and 4 h (E) post insufflation
- Fig. 10.4 Scintigraphic rabbit whole body images showing 248 radioactivity in the nasal cavity after administration of ^{99m}Tc labeled alginate microspheres of nitrendipine (ALNT) at different times of 0 h (A), 1 h (B), 2 h (C), 3 h (D) and 4 h (E) post insufflation
- Fig. 10.5 Scintigraphic rabbit whole body images showing radioactivity in the nasal cavity after administration of ^{99m}Tc labeled lactose powder (control) at different times of 0 h (A), 1 h (B) and 2 h (C) post insufflation

249