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Formulation, Development and Evaluation of Anti-Viral Microspheres Using Ionotopic Gelatin Method

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ABSTRACT

Objective: Maraviroc is a small-molecule drug that inhibits HIV-1 access through blockading the interplay among HIV-1 and the chemokine receptor CCR5 on host cells. Maraviroc through Ionotropic gelation approach through using sodium alginate as mucoadhesive polymer in diverse proportions for keeping the dosage shape continue to be in location of absorption site for prolonged time period to deal with HIV contamination and to keep away from first pass metabolism. Maraviroc is an antiretroviral drug which can exactly manipulate viral load in HIV/AIDS patients. Maraviroc publicity is altered through sellers that modulate the interest of CYP3A4 and, in a few circumstances, maraviroc dose adjustment is necessary.

Results - The optimal maraviroc microspheres had particles size of 434.82 um , Mucoadhesion of 93.3% and encapsulation efficiency 92.80% . The satisfactory batch F9 exhibited drug entrapment performance of 84.22%, and the drug launch from the microspheres become additionally sustained for extra than 10 hrs (96.48%). There have been no compatibility problems and the crystallinity of maraviroc drug become observed to be decreased in prepared maraviroc mucoadhesive microspheres, which have been showed via way of means of IR, DSC and XRD studies .The Stability of Maraviroc mucoadhesive microspheres become decided in 40°C/75% RH; it become observed that each Maraviroc and mucoadhesive microspheres have been strong in 40°C/75% RH for three months.

Conclusion - The sodium alginate primarily based totally mucoadhesive microspheres have been organized through Ionotropic gelation technique for the managed release of maraviroc . Drug release observed the anomalous delivery and tremendous case-II delivery mechanism. Thus, it could be concluded that successfully designed to give controlled drug delivery, minimizing the drug related side effects and improved oral bioavailability.

Keywords : Maraviroc , Mucoadhesion , Iontopic Gelatin , Microspheres And Sodium Alginate

I. INTRODUCTION

Maraviroc, an inhibitor of the interplay among the chemokine receptor CCR5 and HIV-1 gp120, become accredited for remedy of sufferers already experiencing virologic failure due to resistance to different antiretroviral sellers.

A new magnificence of antiretroviral sellers that objectives a number protein, the chemokine receptor CCR5, in preference to a viral goal. Binding of maraviroc to this mobileular-floor protein effects in blockading human immunodeficiency virus kind 1 (HIV-1) attachment to the coreceptor and stops the virus from getting into CD4+ cells. Inhibition of viral access isn't a brand new concept. It is, after all, one of the precept mechanisms of viral inhibition via way of the obtained immune reaction to contamination, and viral access is the step in viral lifestyles cycles that vaccine-brought about antibodies are designed to block. Therefore, inhibition of viral access become a logical goal withinside the case of HIV-1.

When the CD4 receptor become decided to be the number one receptor for HIV-1 binding to CD4+ cells in 1984 [1], there have been severa tries via way of researchers and the pharmaceutical enterprise to increase inhibitors of the binding step. It become obvious from experiments with hybrid murine cells expressing human CD4+ cells that CD4+ mobileular binding on my own did now no longer bring about viral access into cells and that every other step become necessary [2]. The coreceptors CCR5 and CXCR4 have been found some years later via way of 2 distinct studies groups [3, 4]. These chemokine receptors have been the lacking piece of the puzzle that defined viral access into CD4+ cells, and blockading those cells with their herbal ligands (MIP-1α, MIP-1β, and RANTES for CCR5; SDF-1 for CXCR4) led to profound inhibition of HIV-1 contamination in vitro [5]. Because CCR5 is utilized by almost all viral isolates located in new or early infections and is gift in the course of the direction of >50% of infections, this coreceptor supplied a ability vulnerability withinside the viral lifestyles cycle. An attempt to locate powerful inhibitors of the interplay among the viral envelope and CCR5 become for that reason released via way of numerous pharmaceutical companies. The maximum a hit of those efforts led to the medication maraviroc, vicriviroc, and aplaviroc.

Mucoadhesion has been a subject of hobby for remaining a long time withinside the layout of drug transport structures to lengthen the house time of the dosage shape on the site of software or absorption [1].Mucoadhesive micro provider structures using bioadhesive assets of a few polymers, which come to be adhesive on hydration, and therefore may be used for localizing the bioactives to a selected place of gastrointestinal tract for prolonged durations of time[2, 3]. Bioadhesioc is an interfacial phenomenon wherein one can be artificial or organic macromolecules and 2d substances is organic floor (epithelial tissue or the mucus coat at the floor of tissue) are held collectively by interfacial forces, while the related organic floor is mucin layer of a mucosal tissue, it's miles referred to as mucoadhesion. Mucoadhesive microspheres transport machine is an appealing concept, because of their capacity to stick to the mucosal floor and launch the entrapped drug in a sustained manner. Mucoadhesive microspheres have blessings like green absorption, stronger bioavailability of the bioactives because of excessive floor to extent ratio, a whole lot greater intimate touch with the mucin layer of a mucosal tissue and placement unique concentrated on of the bioactives to absorption webweb page may be performed via way of the use of appropriate plant lectins, micro organism and antibodies at the floor of mucoadhesive micro carriers .

II. MTHOD AMD METHODOLOGY

Method -

The maraviroc mucoadhesive microspheres was successfully developed by Ionotropic gelation technique, using sodium alginate, pectin, HPMC as mucoadhesive polymer in various proportions in combination. Further, the prepared maraviroc mucoadhesive microspheres were characterized for particle size, morphology, micrometric studies, entrapment efficiency, mucoadhesion . Fourteen batches of Maraviroc loaded mucoadhesive microspheres had been formulated to research the impact of certain method variables, including special crosslinking agent (Ca chloride, barium chloride, aluminium sulphate), Maraviroc to sodium alginate polymer ratio (0.5, 1, 1.5 and 2), attention of cross-linking agent (five,10 and 15%), curing time (15, 30 and

60 min),Maraviroc ratios (0.5, 1.0 and 1.5) and stirring rate (200,400 and 600 rpm) at the suggest particle size, yield, drug entrapment efficiency, mucoadhesion , percent swelling index and in-vitro drug release.

1. PREPARATION OF MARAVIROC MUCOADHESION MICROSPHERES

The Maraviroc mucoadhesive microspheres have been organized through ionotropic outside gelation method the composition of the numerous Maraviroc mucoadhesive microspheres formulations have been referred to in Table1. Maraviroc and sodium alginate polymers have been in my view handed thru sieve ≠ 60. The required portions of sodium alginate have been dissolved in purified water to shape a homogenous polymer answer. The drug maraviroc became brought to the polymer answer and combined very well with a stirrer to shape a viscous dispersion. The ensuing dispersion became sonicated for 30 min to put off any air bubbles. The bubble unfastened dispersion became then brought manually drop smart into crosslinking ion answer the use of polyethylene syringe (needle length 22 G) and stirred at 200-six hundred rpm.Fourteen batches of Maraviroc loaded mucoadhesive microspheres have been organized to research the impact of sure formula and procedure variables, inclusive of exclusive crosslinking agent (Calcium chloride, barium chloride, aluminium sulphate), Maraviroc to polymer ratio (zero.five, 1, 1.five and 2), awareness of move-linking agent (five,10 and 15%), curing time (15, 30 and 60 min),Maraviroc ratios (zero.five, 1.zero and 1.five) and stirring fee (200-six hundred rpm) at the imply particle length, yield, drug entrapment efficiency, mucoadhesion and in-vitro drug launch. The received microspheres have been amassed through decantation, washed again and again with distilled water and dried at 45°C for12 hour .

Determination of Optimum Cross-linker Concentration

Serial concentrations i.e. five%, 10% ,15% w/v, of move linker answer (aluminum sulphate) have been organized and used to formulate maraviroc mucoadhesive microspheres whilst preserving sodium alginate awareness, curing time and stirring pace at constant values i.e. 1:1 drug polymer ratio,30 min curing time and four hundred rpm respectively .

1.1 Determination Of Optimum Curing Time

Different cross linker solution 1 i.e. calcium chloride, barium chloride and aluminum sulphate have been organized and used to formulate maraviroc mucoadhesive microspheres whilst preserving sodium alginate awareness, move linker awareness, curing time and stirring pace at constant values i.e. 1:1 drug polymer ratio, 10percentw/v move linker awareness, 30 min curing time and four hundred rpm respectively [13].

1.2 Determination Of Optimum Curing

The Sodium alginate, drug Maraviroc 1:1 ratio have been combined and stirred properly until homogenous answer formed. This answer became brought drop smart to move linker answer (i.e. aluminum sulphate 10% w/v) the use of polyethylene syringe (needle length 22 G) and stored for 15, 30, 60 mins in cross linking solution whilst preserving move linking agent awareness, sodium alginate polymer awareness, and stirring pace at constant values i.e. 1:1 drug polymer ratio, 10percentw/v move linker answer and four hundred rpm respectively [14

1.3 Percentage Yield

The percent yield of Maraviroc microsphere became calculated through weighing after drying. The weight of dried microspheres (W1) became divided through the entire quantity of all preliminary dry weight of beginning materials (W2) used for the practise of the Maraviroc microspheres, which gave the entire percent yield of Maraviroc microspheres [18].

1.4 Particle Size

Particle length of the Maraviroc micro debris became decided through the use of an optical microscope approach and the imply particle length became calculated through measuring 50-a hundred debris in every batch with the assist of a precalibrated ocular micrometer. The imply Maraviroc microspheres particle length and widespread deviation values have been calculated and reported [19].

1.5 Morphology Of Microspheres

The floor morphology and form of the Maraviroc microspheres became tested through scanning electron microscopy. The pattern became established directly to an aluminum stub and sputter-lined with platinum debris in an argon atmosphere [20].

1.6 Drug Entrapment Efficiency

the quantity of drug entrapped became anticipated through crushing 100mg of maraviroc mucoadhesive microspheres and extracting with a hundred ml of zero.1 N HCl for twenty-four hr in rotary shaker. The answer became filtered and the absorbance became measured after appropriate dilution spectrophotometrically (LABINDIA UV-3092 PC) at 210 nm in opposition to zero.1N HCl as a blank. The quantity of Maraviroc entrapped withinside the Microspheres became calculated through the subsequent formula [21].Percentage entrapment efficiency = Observed Drug Content x a hundred /calculated drug content .

Table 1: Composition of Maraviroc mucoadhesive microspheres

Formulation Code	Drug : Alginate	Electrolyte	Percentage Electrolyte	Curing time	Stirring Speed
F1	1.0 : 1.0	CaCl2	10	35	450
F2	1.0 1.0	BaCl2	10	34	450
F3	1.0 : 1.0	Al2(S04)3	10	30	400
F4	1.0 : 1.0	Al2(S04)3	5	30	400
F5	1.0 : 1.0	Al2(S04)3	15	30	400
F6	1.0 : 1.0	Al2(S04)3	10	16	400
F7	1.0 : 1.0	Al2(S04)3	10	56	450
F8	1.0 : 0.5	Al2(S04)3	10	34	500
F9	1.0 : 1.5	Al2(S04)3	10	34	400
F10	1.0 : 2.0	Al2(S04)3	10	34	450
F11	0.5 : 1.0	Al2(S04)3	10	34	460
F12	1.5 : 1.0	Al2(S04)3	10	35	150
F13	1.0 : 1.0	Al2(S04)3	10	35	400
F14	1.0 : 1.0	Al2(S04)3	10	35	640

Table 2 : Kinetic parameter of Maraviroc mucoadhesive microspheres

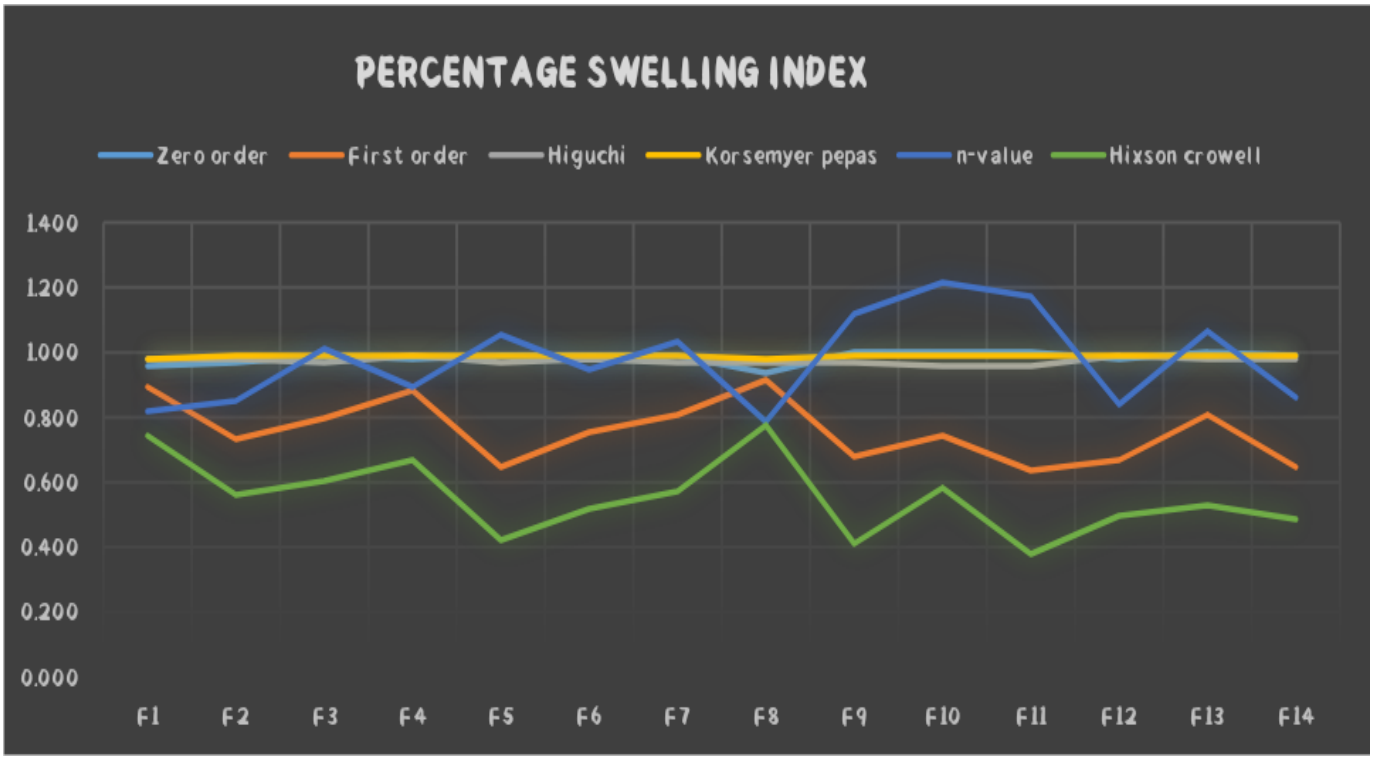
Formulation code	Zero Order	First Order	Higuchi	Korsemyer pepas	n - value	Hixson Crowell
F1	0.950	0.886	0.972	0.977	0.811	0.742
F2	0.966	0.728	0.977	0.983	0.847	0.555
F3	0.985	0.790	0.967	0.985	1.004	0.601
F4	0.976	0.875	0.981	0.989	0.885	0.666
F5	0.989	0.637	0.968	0.986	1.047	0.420
F6	0.985	0.747	0.976	0.989	0.947	0.509
F7	0.988	0.800	0.965	0.980	1.030	0.566
F8	0.934	0.913	0.966	0.973	0.778	0.766
F9	0.992	0.669	0 .966	0.987	1.110	0.405
F10	0.990	0.743	0.952	0.983	1.208	0.575
F11	0.991	0.626	0.95	0.983	1.169	0.368
F12	0.978	0.662	0.981	0.985	0.834	0.492
F13	0.990	0.806	0.969	0.982	1.065	0.523
F14	0.982	0.637	0.975	0.983	0.851	0.477

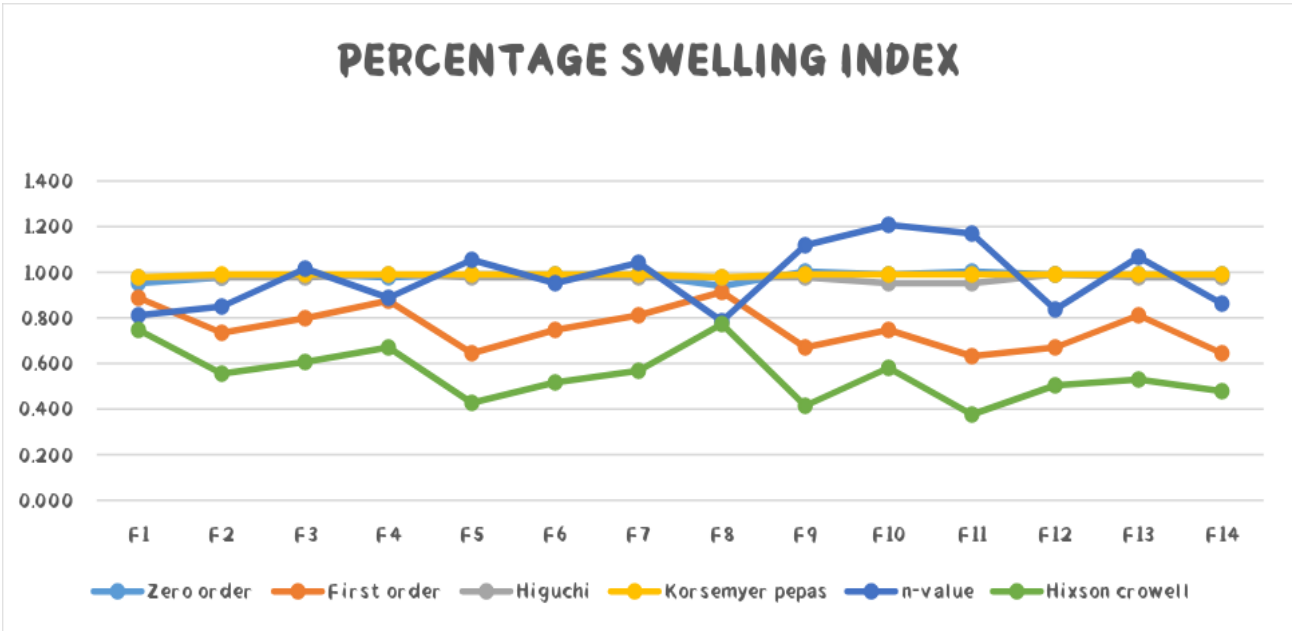
1.7 Swelling Study of Microsphere

A 100mg of Maraviroc mucoadhesive microspheres from every batch became located in 500ml of zero.1 N HCL and allowed to swelled for the require length of time, at 37± zero.50C the use of USP dissolution equipment 2 at 100rpm.The Maraviroc microparticles have been eliminated each hour c programming language up to eight hour, blotted cautiously with clear out out paper and their modifications in weight have been measured at some stage in the swelling till equilibrium became received [22]. Finally, the swelling ratio (SR) of every microsphere formula became calculated in step with the subsequent equation

SR= (We-W0)/W0

Where W0 is the preliminary weight of the dry Maraviroc microparticles and We is the load of swollen Maraviroc microparticles at equilibrium swelling withinside the media.





1.8 Mucoadhesive Test

The mucoadhesive assets of Maraviroc microspheres became evaluated through in vitro wash off check. A Piece of goat intestinal mucosa became tied at the glass slide the use of a thread. About a hundred microspheres have been unfold onto every moist rinsed tissue specimen and at once consequently the assist became hung onto

the arm of USP disintegration equipment. Now working the disintegration check machine, the goat intestinal mucosa became given a sluggish everyday up and down motion in 900ml of zero.1N HCL buffer at 37±zero.50C. At the quit of one hr and at hourly periods up to eight hrs the gadget became stopped and the wide variety of Maraviroc microspheres nevertheless sticking onto the intestinal mucosa became counted [23].Percent mucoadhesion became calculated through the the use of following fformul % MUCOADHESION = (No. of particle stays on mucosa/ No. of implemented microsphere) ×a hundred

1.9 In Vitro Dissolution

The in vitro dissolution research of organized Maraviroc microspheres have been achieved the use of USP kind II (paddle) dissolution check equipment. Weighed quantity of Maraviroc loaded microspheres have been delivered into 900 ml dissolution medium of zero.1N HCl for eight hrs at 37±zero.five°C at a rotation pace of fifty rpm. 5ml of aliquots have been withdrawn at predetermined time periods and an equal extent of clean zero.1N HCl became changed to hold extent constant. The samples have been analyzed spectrophotometrically at 210 nm after appropriate dilution to decide the Cumulative percent of Maraviroc launch [24]. Release kinetic and mechanism of Maraviroc drug launch the Maraviroc launch facts from all of the mucoadhesive microspheres formula have been geared up in numerous kinetic fashions like 0 order; first order, Higuchi's version and korsemeyer- peppas equations to decide the corresponding launch fee and mechanism of drug launch. A criterion for choosing the exceptional match version became primarily based totally on goodness of match, excessive R2(regression coefficient) value [25].

2.0 Stabillity Dissolution

To determine the Maraviroc and mucoadhesive formula balance,improved balance research have been carried out in step with ICH guidelines.The optimized mucoadhesive microspheres formula (F9) became decided on for balance have a look at on the idea of in vitro drug dissolution research; drug entrapment efficacy and invitro wash off check. In the investigation, balance research have been achieved at 40 ± 20C/ 75 ± five% in closed excessive density polyethylene bottles for three months. The samples have been eliminated each month interval up to three months and evaluated for bodily modifications, drug launch, entrapment efficiency,at some stage in the stableness research [28].

III. RESULT AND DISCUSSION

Maraviroc loaded mucoadhesive microspheres were prepared by ionotropic gelation technique employing calcium chloride, barium chloride and aluminium sulphate as cross linking agent. The obtained Maraviroc microspheres were discrete, spherical in shape and freely flowing. The percentage yield of the different alginate mucoadhesive microsphere formulations were found to be 87.96% for calcium-alginate microspheres and 87.13 % for Barium alginate and 87.25% to 92.75 % for aluminium alginate (Table 2). It was observed that as the Maraviroc to sodium alginate concentration increases, the product yield also increases .The particle size were found to be 730.67 ± 13 µm for calcium-alginate microspheres and 715.33 ± 14µm for barium-alginate microspheres whereas in case of aluminium-alginate, particle size were found within the range of 642.33 ± 36µm to 806.67 ± 38µm respectively. The mean particle size of the prepared Maraviroc Microspheres in presented in Table 3.

Table 3 : Results of in vitro wash off test in 0.1N hydrochloric acid

F1	92 ± 1.53	72 ±2.52	60 ± 2.08	47 ± 1.53	38 ± 2.52	25 ± 2.08	12 ± 1.53	2 ± 0.58
F2	94 ± 0.58	73 ± 2.08	61 ± 1.53	50 ± 0.58	42 ± 1.53	30 ± 2.52	19 ± 1.53	5 ± 0.588

F3	96 ± 1.53	75 ± 2.08	61 ± 2.52	55 ±3.51	51 ± 2.52	31 ± 1.53	22 ±2.52	6 ± 1.53
F4	97 ± 0.58	64 ± 2.52	32 ± 3.06	29 ±2.08	21 ± 2.52	03 ± 2.08	0	0
F5	95 ± 1.53	73 ± 2.52	58 ± 2.08	45 ± 3.51	33 ± 2.52	21 ± 1.53	16 ± 2.52	3 ± 2.08
F6	94 ± 2.52	56 ± 3.06	28 ± 3.51	14 ± 3.06	06 ± 2.08	03 ± 2.31	0	0
F7	97 ± 1.53	80 ± 4.51	73 ± 3.51	45 ± 2.52	32 ± 1.53	25 ± 2.52	17 ± 1.53	4 ± 0.57
F8	91 ± 2.52	56 ± 3.06	38 ± 3.51	23 ± 3.06	15 ± 3.21	06 ± 2.65	0	0
F9	97 ± 1.53	86 ± 2.52	74 ± 2.89	64 ± 3.06	55 ± 3.06	45 ± 2.52	34 ± 3.06	25 ± 2.52
F10	99 ± 0.58	94 ± 2.08	86 ± 3.06	78 ±.08	62 ± 2.52	54 ± 1.53	43 ± 2.08	37 ± 2.52
F11	96 ± 1.53	82 ± 2.52	74 ± 3.51	64 ± 2.52	56 ± 3.06	41 ± 3.51	35 ± 2.08	20 ± 2.52
F12	92 ± 2.52	63 ± 3.51	45 ± 2.52	34 ± 1.53	26 ± 2.08	17 ± 25.6	03 ± 1.53	0
F13	95 ± 2.52	72 ± 2.08	60 ± 2.52	51 ± 3.51	45 ± 3.06	27 ± 2.08	13 ± 2.52	2 ± 1.15
F14	97 ± 1.53	78 ± 3.06	67 ± 1.53	57 ± 2.52	50 ± 3.21	35 ± 3.51	29 ± 2.08	11 ± 1.53

2.2 Release Behavior

The Maraviroc release behavior of alginate mucoadhesive microspheres, produced by ionotropic internal gelation with different cross-linking agents depend upon the valency and size of the cations of the respective cross-linking agent. Their release profiles in 0.1N HCl pH 1.2 were depicted in Figure 1-2. Calcium alginate and barium-alginate microspheres (F1 and F2) were able to sustain the maraviroc release up to 8 hours whereas aluminiumalginate microspheres were able to sustain the drug released up to 10 hours. It has been observed that calcium, barium-alginate microsphere showed comparatively rapid Maraviroc release as compared to aluminium-alginate formulations. The results obtained can be explained on the basis of the extent of cross-linking in the microspheres. Ca^{2+} and Ba^{2+} being divalent, form two-dimensional bonding structure with sodium alginate inside the alginate matrices. But since Ba^{2+} has the largest size as compared to the other two cations (Ca^{2+} and for Al^{3+}), it is expected to form strong alginate mucoadhesive microspheres with smaller voids and low water uptake. Therefore, the exchange of larger Ba^{2+} in the microspheres with Cl^{+} of dissolution medium (Hydrochloric acid, pH 1.2) and also their removal was hindered, thus resulting in delayed swelling where as in case of Ca^{2+} alginate microspheres, the smaller size of Ca^{2+} as compared to Ba^{2+} ensure rapid removal of Ca^{2+} from the microspheres due to ion exchange process with Cl^{+} of hydrochloric acid buffer medium and thus leading to greater water uptake and rapid release In case of Al^{3+} alginate Maraviroc microspheres, the delay was due to the capacity of Al^{3+} ion to form three-dimensional bonding structure with the sodium alginate inside the mucoadhesive microspheres. This strong three dimensional bonding results in an extended cross linking throughout the mucoadhesive microspheres, producing hard alginate mucoadhesive microspheres with low water uptake and thus leading to slow removal of Al^{3+}due to ion exchange with Cl^{+} in the hydrochloric acid. As a result, the swelling of the microsphere are delayed leading to slow disintegration as well as slow dissolution. Consequently increasing the concentration of alginate and Al^{3+} ion as cross-linking agent, prolonged the maraviroc release was observed up to 10 hours because alginate could form more rigid coat with trivalent (Al^{3+}) ion as compared to divalent (Ba^{2+}).The order of decreasing Maraviroc release rate observed with different cross linking agents was as follows

Aluminum sulphate > Barium chloride > Calcium chloride

Drug release kinetic data for maraviroc mucoadhesive microspheres was shown in Table No. 1. All the formulations (F1 to F14) follow zero order release kinetics with regression values ranging from 0.950 to 0.992. All the formulations were subjected to KorsmeyerPeppas plots, 'n' value ranges from 0.811 to 1.208 indicating that the maraviroc drug release was from the microspheres followed the anomalous transport and super case-II

transport mechanism

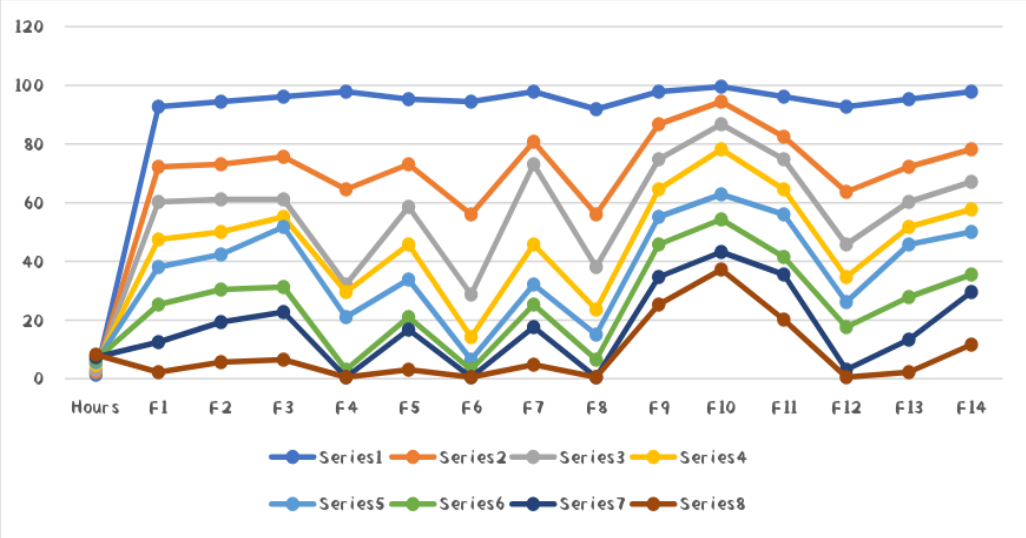


Fig. 4: Swelling behavior of formulation F8 to F14 in 0.1 N HCL

IV. CONCLUSION

The sodium alginate based mucoadhesive microspheres were prepared by Ionotropic gelation method for the controlled release of maraviroc. The swelling of microsphere and drug release depends upon the polymer concentration and extent of crosslinking in the polymer matrix. The effect of polymer, cross linking agent and its concentration and curing time on in vitro release of sodium alginate mucoadhesive microspheres was well investigated. The results show that as the concentration of sodium alginate and cross linking agent increases, entrapment efficiency increases and Maraviroc release rate decrease. Drug release followed the anomalous transport and super case-II transport mechanism. Thus, it can be concluded that this technique could be used to prepare multiparticulate drug delivery system for oral controlled release of Maraviroc.

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VI. REFERENCES

[1]. Kurana S, Madav NV.Review article on mucoadhesive drug Delivery: mechanism and method of evaluation. Int J Pharm BioSci 2011; 2 (1): 458-67.

[2]. Yellanki SK, Singh J, Syed JA, Bigala R, Goranti S, Nerella NK. Design and characterization of amoxicillin Trihydrate Mucoadhesive microspheres for prolonged gastric retention. International journal of Pharmaceutical Sciences and Drug Research 2010; 2(2): 112-114.

[3]. Chakraborty S, Dinda SC, -carbopol micropPatra N, Khandai M. Fabrication and Characterization of alginoarticulate system of aceclofenac for oral sustained drug delivery. Int J Pharm. Sci Rev Res 2010; 4(2): 192-199.

[4]. Dhaliwal S, Jain S, Singh HP, Tiwary AK. Mucoadhesive microspheres for gastroretentive delivery of acyclovir: In Vitro and In Vivo evaluation. American Association of Pharmaceutical Scientists 2008; 10(2): 322-330.

[5]. Talukder R, Fassihi R. Gastro-retentive drug delivery systems: A Mini Review. Drug Development and Industrial Pharmacy 2004; 30(10): 1019-1028.

[6]. NK. Sachan, A Bhattacharya. Basics and Therapeutic potential of oral mucoadhesive microparticulate drug delivery systems. International Journal of Pharmaceutical and Clinical Research 2009; 1: 10-14.

[7]. CP Rama kora, SY Arraguntla Rao. Mucoadhesive microspheres For controlled drug delivery. Biol Pharm Bull 2004; 27(11):1717-1724.

[8]. Kalyankar TM. Formulation and evaluation of mucoadhesive Pioglitazone HCL microspheres. Int J Pharma World Res 2010; 1(3): 1-14.

[9]. Vandekerckhove L, Verhofstede C, Vogelaers D. Maraviroc: inte Gration of a new antiretroviral drug class into clinical practice.Journal of Antimicrobial Chemotherapy 2008; 61: 1187-1190.

[10]. MacArthur RD, Novak RM. Reviews of anti-infective agents: Maraviroc: the first of a new class of antiretroviral agents. Clin Infect Dis 2008; 47: 236-241.

[11]. Carter NJ, Keating GM: Maraviroc. Drugs 2007; 67: 2277-2290.

[12]. Samantha abel,David J back and Manoli vourvahis. Maraviroc: pharmacokinetics and drug interactions. Antiviral therapy 2009; 14:607-618.

[13]. Soni, M.L., M. Kumar, M., and Namdeo, K.P. Sodium alginate microspheres for extending drug release: formulation and in vitro Evaluation. International Journal of Drug Delivery 2010; 2: 64-68.

[14]. Manjanna, K.M., Shivakumar, B., and Kumar, P. Formulation of oral Sustained release aceclofenac sodium microbeads. International Journal of PharmTech Research 2009; 1: 940-952.

[15]. Prajapati, S.K., Tripathi, P., Ubaidulla, U., and Anand, V. Design and Development of Gliclazide Mucoadhesive Microcapsules: In Vitro and In Vivo Evaluation. AAPS PharmSci Tech 2008; 9: 224-230. 16. Lucinda-Silva, R.M., Salgadob, H.RN., and Evangelista, R.C. Alginate-chitosan systems: In vitro controlled release of triamcinolone and in vivo gastrointestinal transit. Carbohydrate Polymers 2010; 81(2):260-268. 17. Al-Kassas, R.S., Al-Gohary, O.M., and Al-Faadhel, M.M. Controlling of systemic absorption of gliclazide through incorporation into alginate beads. International Journal of Pharmaceutics 2007; 341:230- 237. 18. Prasant R, Amitava G, Udaya N. et al. Effect Of Method Of Preparation On Physical Properties And In Vitro Drug Release Profile Of Losartan Microspheres - A Comparative Study,International Journal of Pharmacy and Pharmaceutical Sciences 2009; 1(1): 108-118.

[16]. Patel JK, Bodar MS, Amin, Patel MM. Formulation and optimization of mucoadhesive microspheres of metoclopramide. Indian J Pharm Sci 2004; 66(3): 300-5. 20. Lehr CM, Bouwstra JA, Schacht EH, Junginger HE. In vitro evaluation of mucoadhesive properties of chitosan and some other natural polymers. International Journal of Pharmaceutics 1992; 78:43-48. 21. Ahuja A and Khar RK. Ali J.,Mucoadhesive drug delivery system. Drug. Dev.Ind. Pharm. 1997; 23(5):489-515. 22. Yeole, P.G., Galgatee, U.C., Babla, I.B. and Nakhat, P.D. 2006. Design and evaluation of xanthan gum based sustained release matrix tablets of Diclofenac Na. Indian J. Pharm.Sci 2006; 68:185-189.

[17]. Chowdary KPR and Srinivas L., Mucoadhesive drug delivery systems: A review of current status. Indian Drugs. 2000; 37(9): 400-406. 24. SM Setter, L Jason, J Thams, RK Campbell. Metformin Hydrochloride in the Treatment of Type 2 Diabetes Mellitus: A clinical review with a focus on dual therapy. Clinical Therapeutics 2003; 25(12):2991-3026. 25. VTA Ibrahm, B senthil kumar , KG Parthiban, R. Manivannan. Novel drug delivery system : formulation and characterization of exemestane microspheres by chemical cross linking method , Res J Pharm Biol Chem Sci 2010;1(4):83-90. 26. Arya RKK, Juyal V, Singh RD. Development and Evaluation of Gastro resistant Microsphere of Pantoprazole. International Journal of Pharmacy and Pharmaceutical Sciences 2010; 2(3): 112-16. 27. Kavitha.K, Chintagunta pavanveena, Anil kumar.S.N, Tamizh mani.T. Formulation and evaluation of trimetazidine hydrochloride loaded gelatin microspheres. International Journal of Pharmacy and Pharmaceutical Sciences 2010; 2(3): 67-70.

[18]. Shah P, Rajshree M, Rane Y. Stability testing of pharmaceuticals - A global perspective. Journal of Pharmacy Research 2007; 6(1):1-9. 29. Rastogi, R., Sultana, Y., Aqil, M., Ali, A., Kumar, S.,N

Chuttani, K., and Mishra, A.K. Alginate microspheres of isoniazid for oral sustained drug delivery. International Journal of Pharmaceutics 2007; 334: 71-77. 30. Shankar, N.B., Kumar, N.U., and Balakrishna, P.K. Formulation Design, Preparation and In vitro Evaluation of Mucoadhesive Microcapsule employing control release Polymers to enhance gastro retention for Oral delivery of Famotidine. Int J Pharm SciTech 2009; 2: 22-29. 31. Chen, L., and Subirade, M. Alginate-whey protein granular microspheres as oral delivery vehicles for bioactive compounds. Biomaterials 2006; 27:4646-4654. 32. Silva, C.M., Ribeiro, A.J., Figueiredo, M., Ferreira, D., and Veiga, F. Microencapsulation of Hemoglobin in Chitosan-coated Alginate Microspheres Prepared by Emulsification/Internal Gelation. The AAPS Journal 2006; 7: 903-913.

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