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Original Research Article

Formulation and Evaluation of Polymeric Nanoparticles by Precipitation Method

Mangla Nand Singh[1*], Dr. Manish Kumar Thimmaraju[1], Dr. Jitendra Kumar Malik[1]

[1]Faculty of Pharmacy, P.K. University, Shivpuri, Madhya Pradesh, India

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Abstract: Acyclovir is used for treatment of viral infection, particularly for treatment of herpes simplex viral infection. These are taken for month during treatment of herpes simplex viral infection. The acyclovir is poorly water-soluble drug. Due to that main aim is to increase the solubility of acyclovir in other solvent. The bioavailability of acyclovir is very less about (15-35%) because it has less oral route absorption. Due to that the acyclovir are given in intravenous route. When acyclovir is taken in oral route, the peak plasma concentration occurs after 1-2 hrs. The acyclovir having 9-33% of plasma protein binding. The BCS class of acyclovir are Class third (high solubility and Low permeability). Due to that acyclovir are formulate in the form of nanoparticle. Chitosan are the polymers which are used for the formulation of nanoparticle. The chitosan is found to be compatible with acyclovir. Formulation of acyclovir nanoparticle was done by Nano-precipitation method. Many evaluation tests performed during the formulation of Acyclovir nanoparticle mainly zetasizer isuse for the determination of particle size, zeta potential and PDI (poly disperse index) also performed evaluation of loading efficiency and % Drug entrapment.

Keywords: Acyclovir, Chitosan, Zetasizer and Nanoparticle.

INTRODUCTION

Nano is a metric measurement of one billionth of a meter. Nanoparticles are the simplest form of structure, occurring in the nm range. Nano-precipitation is used to create nanoparticles. Several methods are available for nanoparticle precipitation. For the creation of acyclovir nanoparticles, the nano-precipitation method was used. Several polymers are used to create nanoparticles, including bovine serum albumin, chitosan, and gelatin. Chitosan was used to create acyclovir nanoparticles. Chitosan is used clinically to treat herpes simplex viral infections. Acyclovir belongs to the BCS class III group, characterized by low permeability and high solubility. The elimination half-life of acyclovir is approximately 3 hours.

Acyclovir is currently available in capsule (200 mg) and tablet (200, 400, and 800 mg) forms, as well as suspensions, topical ointments, and intravenous injections. Oral acyclovir tablets, which are taken approximately 5 times a day, have a very slow absorption rate. Acyclovir has a narrow absorption window. The primary objective of the current study was to increase the bioavailability of acyclovir by preparing nanoparticles.

Nanoparticles have a diameter of approximately 10–1000 nanometers, and are therefore called nanoparticles because of their size. They are used as targeted drug delivery systems by altering their size, pharmacokinetic, and pharmacodynamic properties. Nanoparticle formation is a process in which an active ingredient is dissolved and encapsulated in a matrix substance such as a polymer. They are prepared from various polymers that have therapeutic activity and can reduce toxic effects. 1,2 Both synthetic and non-synthetic polymers are used to prepare nanoparticles.

There are two main subtypes of nanoparticles: 1) nanospheres and 2) nanocapsules.

Nanospheres are complex polymer structures in which drug molecules are interconnected. In the case of nanocapsules, the drug is present in the hollow space between the polymer layers3,4. Chitosan is the most important polymer in the manufacture of nanoparticles, and its main advantages are its biocompatibility, biodegradability, and low immunogenicity. Chitosan also has very low toxicity5.

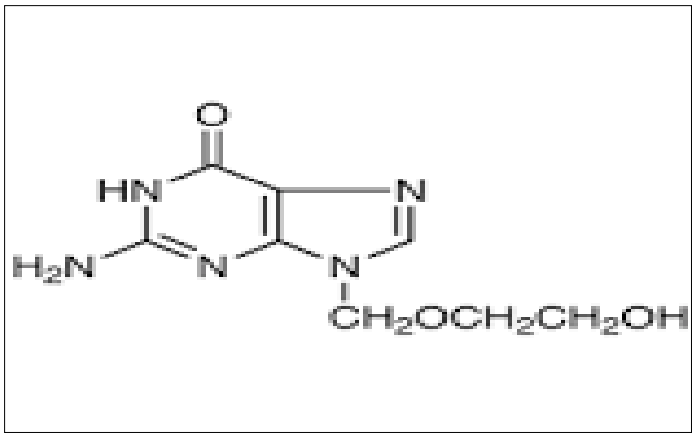
***Corresponding Author:** Mangla Nand Singh
Faculty of Pharmacy, P.K. University, Shivpuri, Madhya Pradesh, India

MATERIAL AND METHOD

Table-1: List of material used for the study

S.N.	Ingredients	Supplier
1	Acyclovir	ModernLaboratories(Indore, India)
2	Chitosan	Indianseafood(CochinIndia)
3	Dimethylsulfoxide	Laboratory
4	Rotaryflash evaporator	KNF
5	Ultra-centrifugation	Beckman Coulter
6	Zetasizer	Malvern
7	Magneticstirrer	REMI
8	WeighingBalance	Jepson's

Drug Profile



Acyclovir is a guanosine derivative and it has 100 times potent than other antiviral drugs. It has antiviral activity against the herpes virus, particularly against herpes simplex. It is 10 time more active than idoxuridine. Acyclovir selectively inhibits the herpes virus DNA Replication. Acyclovir tri phosphate is the active antiviral agent that inhibits the host cell DNA Polymerase.

Preparation of Nanoparticle:

The nanoparticles were prepared using a nano-precipitation method. 200 mg of a polymer, such as chitosan, was dissolved separately in 25 ml of acetone. 100 mg of acyclovir was then dissolved separately in 2 ml of dimethyl sulfoxide (DMSO). After mixing the two solutions, 50 ml of water was added and the solution was stirred for 30 minutes. This solution was then transferred to a rotary flash evaporator to evaporate the acetone under reduced pressure. Finally, the suspension volume was adjusted to 10 ml. This final 10 ml volume of the suspension was centrifuged at 15,000 rpm for 30 minutes at 4°C. After centrifugation, the supernatant was discarded, and the precipitate was washed three times with water.

Table 2: Composition of Acyclovir Nanoparticle.

Sr. No.	BatchCode	Amount of Drug (mg)	Chitosan(mg)
1.	F1	50	100
2.	F2	100	200
3.	F3	150	250
4.	F4	200	200
5	F5	250	250

Characterization of Acyclovir Nanoparticle: -
Particle Size:

Particle size mainly determines by zeta sizer instrument. The instrument equipped with Malvern PCS software. Before taking result of sample, the sample solution was diluted with water (mainly take distilled water) and then takes a reading. In Result average particle size obtained. The particle sizes for nanoparticle are must be required in nano range. The particle size of sample solution was determined using light scattering technique and by Transmission electron microscope. Increased in particle size then decreased in uptake and bioavailability.

Analysis was carried out for 60s at 165^0 C scattering angle of detection. Particle size are more

important because micro particle has been less effective drug delivery as compared to nanoparticle. The large particle having more care area and which fill more drugs in it. But release pattern is very slow. Large particle resists the fast drug release and polymer degradation. The particle size and its distribution pattern are most important characterization of nanoparticle. The particle size of nanoparticle also influences the drug loading, drug release and stability. Particle size distribution is also called as PDI. Different technique used for determination of size of nanoparticle such as SEM, TEM, XRD, AFM and dynamic light scattering (DLS)

Poly Disperse Index (PDI):

PDI is also called as particles size distribution. The sample having very broad size distribution then poly disperses index value >0.7.1 PDI of nanoparticle is obtained by photon correlation spectroscopic analysis. Poly disperse is composed of non-uniform molecular mass if its chain length very over a wide range of molecular mass. During formulation of nanoparticle the effort of manufacturer is to achieve lowest poly disperse index

Zeta Potential: -

During taking zeta potential two samples must be diluted with distilled water in ration 1:1000. Zeta sizer (Malvern instrument) was used. The analysis was carried out at 25 ^{0}Cwith the angle of detection of 900. The zeta potential in which we study the charge which are present on a surface of nanoparticle. In nanoparticle the drug molecule is covered with polymer, indirectly in zeta potential in which we study the charge present on surface of polymer. The ideal zeta potential value is must be required in range of above +30 to -30Mv and this range prevent the aggregation of particle. The zeta potential of Acyclovir nanoparticle containing chitosan was observed -20Mv

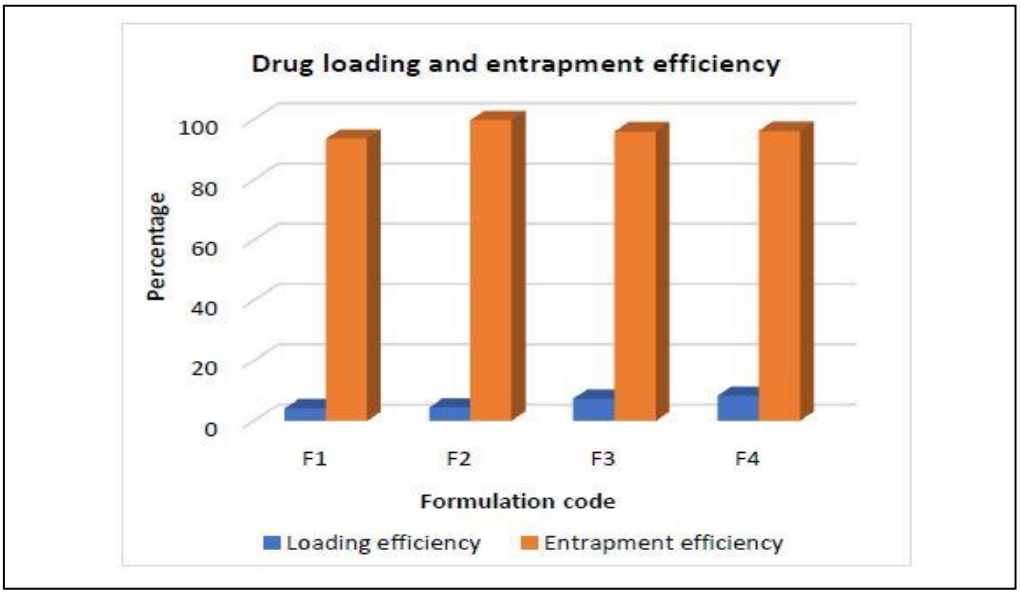
RESULT AND DISCUSSION

Zeta Potential:

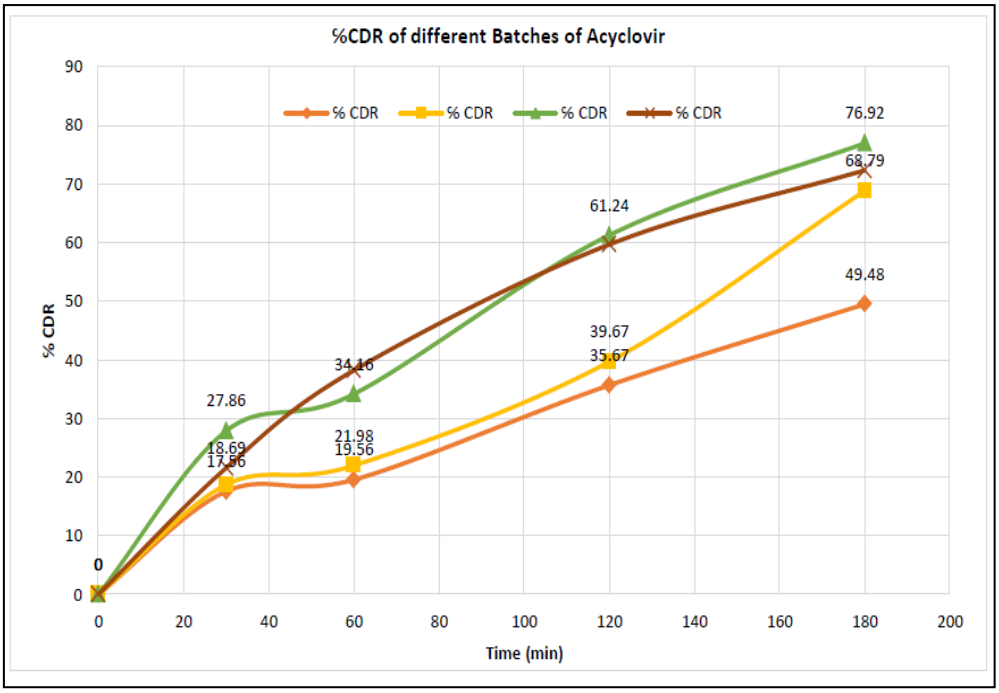
The zeta potential is most important Evaluation parameter. There are many drugs which are affecting the zeta potential value of Nanoparticle. Due to some drug means those drugs in corporate in Nanoparticle which are causes the charge on the surface of Nanoparticle. Here in this work also observed that as amount of Acyclovir increases then zeta potential also increases. If zeta potential value is not in range of -30 mV to +30 mV then the aggregation of nanoparticle take place in formulation.

Table 3: Evaluation Parameter of Nanoparticle

Sr. No.	Evaluation Test	F1	F2	F3	F4
1.	Entrapment Efficiency (%)	93.64	99.76%	96.04	97.12
2.	Loading Efficiency (%)	4.2	4.48	7.41	8.49
3.	Particle Size (nm)	185.9	195.6	200.4	253.8
4.	Poly disperse Index (PDI)	0.245	0.447	0.569	0.698
5.	Zeta Potential(mV)	-15.4	-20.9	-22.3	-27.6



Graph 1: Effect of drug and polymer on loading efficiency and Entrapment efficiency



Graph 2: % CDR of Different batches of Acyclovir

CONCLUSION

During formulation of polymeric nanoparticle thus the polymer is most important. By using Chitosan as polymers for formulation of nanoparticle the result are obtains in well manner. The entrapment efficiency was 99.76 %. Loading efficiency was 4.48, Particle size-195.6nm, Poly disperse index was 0.447 and zeta potential was obtained in between -30 to +30 mV and that was -20.9mV.

REFERENCES

1. Kharia AA, Singhai AK, Varma R Formulation and Evaluation of Polymeric Nanoparticle of an Antiviral Drug of Gastroretention. International Journal of Pharmaceutical Science and Nanotechnology 2012; 4(4):1557-1559.
2. Kharia AA, Singhai AK. Formulation and Evaluation of Gastroprotective Drug Delivery System of Acyclovir as Mucoadhesive Nanoparticles. International Journal of Pharm Tech Research 2013; 5(4):1539-1545.
3. Garg A, Visht S, Sharma PK, Kumar N. Formulation, Characterization and Application on Nanoparticle A Review. Pelagia Research Library 2011; 2(2):17-20.
4. Krishna A, Amareshwar P, Chakrawarty P. Different Technique used for the preparation of Nanoparticle using natural Polymer and Their application. International Journal of Pharmacy and Pharmaceutical Sciences 2011; 3(2):45-46.
5. Seetharaman S, Balya H, Kuppusamy G. Preparation and Evaluation of Cefixime Nanoparticles Prepared Using Fenugreek Seed Mucilage and Chitosan as Natural Polymers. International Journal of Pharmaceutical and Clinical Research 2016; 8(3):179-188.
6. Nadaroglu H, Ince S, Alayli A. Synthesis of Nanoparticles by Green Synthesis Method. International Journal of Innovative Research and Reviews 2017; 1(1):6-7.
7. Nagarajan E, Shanmugasundaram P, Ravichandiran V, Vijayalakshmi A, Senthilnathan B, et al. Development and Evaluation of Chitosan Based Polymeric Nanoparticles of an Antiulcer Drug Lansoprazole. Journal of Applied Pharmaceutical Science 2015; 5(4):20-25.
8. Ravi Varma J.N, Kumar S, Prasanthi B, ratna V. Formulation and Characterization of Pyrazinamide Polymeric Nanoparticles for Pulmonary Tuberculosis. Efficiency for Alveolar Macrophage Targeting; Indian Journal of Pharmaceutical Sciences 2015; 77(3):258-266.
9. Agnieszka Z, Wilczewska, Niemirowicz K, Karolina H, Markiewicz, Car H Nanoparticles as drug delivery systems. Nanoparticles as drug delivery systems 2012; 64:1020-1037.
10. Christian P, Kammer F.V, Baalousha M, Hofmann T. Nanoparticles: structure, properties, preparation and behaviour in environmental media. Ecotoxicology 2008; 2(1):24-26.
11. Heera P, Shanmugam S. Nanoparticle Characterization and Application: An Overview. International Journal of current Microbiology and Applied Science 2015; 4(8):379-386.
12. Hasan S. A Review on Nanoparticles: Their Synthesis and Types. Research Journal of Recent Sciences 2015; 4:1-3.
13. Kaushik A, Sharma HK. Formulation and Evaluation of Cetuximab Loaded Polymeric Nanoparticle. International Journal of

pharmaceutical science and research 2019; 10(1):266-271.
14. Betala SN, Varma MM, Abbulu K. Formulation and evaluation of polymeric nanoparticles of an antihypertensive drug for Gastroretention. Journal of Drug Delivery and Therapeutics 2018; 8(6):83-84.
15. Nesalin AJ., Gowthamrajan K, Somasekhara CM (2009) Formulation and Evalution of Nanoparticles containing Flutamide. International Journal of Chemtech Research 2009; 1(4):1331-1334.
16. Abdulla J.M.A. Formulation and Evalution of Rifampicin Loaded Polymeric Nanoparticle for pulmonary Delivery. J.Pharm 2006;5(2):40-42.
17. Mohanraj VJ, Chen Y. Nanoparticles- A Review. Tropical Journal of Pharmaceutical Research 2006;5(1):561-573.
18. Pal SL, Jana U, Manna PK, Mohanta GP, Manavalan R. Nanoparticle: An overview of preparation and characterization. Journal of applied Pharmaceutical Science 2011; 1(06):228-234.

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