

Utility of Different Lipids and Effect of Soya Lecithin on Sustained Delivery of Zidovudine via Biodegradable Solid Lipid Microparticles: Formulation and *in-vitro* Characterization

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ABSTRACT

Background: Zidovudine (Azidothymidine, AZT) is widely used in the treatment of Acquired Immuno Deficiency Syndrome (AIDS) and related conditions, either alone or in combination with other antiviral agents to combat HIV. AZT is a Biopharmaceutical Classification System (BCS) class III drug and has various disadvantages. Thus, AZT is a potential candidate for delivery *via* lipid-based drug delivery system. **Materials and Methods:** In the present work, solid lipid microparticles (SLMs) of Zidovudine were developed for sustaining the drug release, to overcome or to reduce the hepatic metabolism and to ensure optimal bioavailability. A total of sixteen formulations of Zidovudine loaded solid lipid microparticles in two groups viz., one with tripalmitin and another with trimyristin were prepared by emulsion-solvent evaporation method. **Results:** The average particle size and entrapment efficiency of the prepared SLM varied between 5.48 μ m-10.64 μ m and 46.92 % and 58.39% respectively. The release of zidovudine from the SLM varied between 70.47% and 100% at the end of 24 hrs. 80% of the drug release which is required for obtaining the optimal therapeutic concentration was achieved by SLM 8. **Conclusion:** Formulation SLM 8 was considered best with maximum sustainability in the drug release along with maintaining therapeutic optimum. The formulation was found stable under stressed conditions.

Keywords: Zidovudine, Azidothymidine, AIDS, Solid lipid microparticles, Tripalmitin, Trimyristin.

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INTRODUCTION

Solid lipid particles were first presented in the early 1990s as an alternative to emulsions, liposomes, and polymeric microparticles as a drug delivery mechanism.¹ Solid Lipid Microparticles (SLMs) are solid lipid particles that are roughly spherical and range in size from 1 to 1000 μ m.² Solid lipid microparticles have a better physicochemical stability than other lipid-based drug carriers, such as liposomes, and are easier to sterilize and scale-up.³ The formulation of solid lipid microparticles (SLMs) for effective oral administration of biological medicines

begins with the selection of appropriate lipid excipients with the right hydrophobicity and lipolysis propensity.⁴ Zidovudine is a synthetic nucleoside analogue that is increasingly being employed as the cornerstone of antiretroviral therapy for HIV infection. Zidovudine is a nucleoside analogue that inhibits HIV reverse transcriptase. It is the (-)- enantiomer of 2', 3'-dideoxy-3'-thiacytidine.^{5,6} Zidovudine (Azidothymidine, AZT) is widely used in the treatment of AIDS and similar illnesses, either alone or in combination



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with other antiviral medicines.⁷ AZT is a Biopharmaceutical Classification System (BCS) class III medication (high solubility and low permeability), with a water solubility of 20.1 mg/ml and a log P of 0.05, limiting its use.^{8,9} The medicine also has a number of drawbacks, including a short biological half-life¹⁰ (0.5 to 3 hr) due to significant first-pass metabolism, as well as dose-related bone marrow toxicity, which causes anaemia and leukopenia.¹¹⁻¹³ Various attempts were made by researchers to counter the short duration of action of AZT by employing different types of delivery systems. Formulation of matrix tablets of AZT using different combinations of rate controlling polymers was frequently investigated where the drug diffused through the matrix in a controlled fashion.¹⁴⁻¹⁶ Alginate microspheres of AZT was prepared by ionotropic gelation technique which were coated with drug release modifiers to prolong the release over 12 hr.⁶ Ethyl cellulose microspheres of AZT were prepared using solvent evaporation technique to sustain the release of drug over 24 hr.¹⁷ Microspheres were also fabricated using HPMC, chitosan, eudragit S100 as rate controlling polymers to control the release of AZT and thereby achieve better bioavailability.¹⁸⁻²⁰ Lipids can be an possible alternative to polymers in designing delivery devices for AZT as they would make a less biotoxic and efficient in providing spatial placement and temporal release.²¹ The purpose of this study was to assess the utility of various lipids such as tripalmitin, trimyristin, and glyceryl monostearate in the formulation of solid lipid microparticles for zidovudine release stability, as well as the effect of soya lecithin on various properties of formulated zidovudine loaded solid lipid microparticles.

MATERIALS AND METHODS

Materials

Athos Chemicals provided the Zidovudine standard medication (Surat, Gujrat, India). All other ingredients, such as ethanol (Anton Scientists, Madurai, TN, India), chloroform (J.J Fine Chemicals, Hyderabad, India), Span 80 (Excel Organic Private Ltd., Chennai, India), Polyvinyl alcohol (KVR Polymers and Chemicals, Hyderabad, India), Glyceryl monostearate (R M Chemicals, Chennai, India), Tripalmitin and Trimyristin (Otto Chemie Pvt. Ltd., Mumbai, India).

Methods

Preparation of Solid Lipid Microparticles of Zidovudine

A single emulsion solvent evaporation process was used to produce zidovudine-loaded SLMs.²² A 1:5

ratio of zidovudine and lipids was added to a solvent combination of ethanol and chloroform (1:1) containing 0.1 percent v/v of span 80 and agitated until a uniform dispersion was obtained. In 50 mL of 0.5 percent w/v polyvinyl alcohol, the drug polymer dispersion was gradually added. The final mixture was agitated for 30 min at room temperature using a mechanical stirrer (RQ122, Remi, India) at 1000 rpm, before being transferred to a magnetic stirrer. Stirring is continued for 3 hr to ensure full evaporation of the organic solvent and assist the production of solid lipid microparticles. Various batches of solid lipid microparticle formulations were made utilizing different amounts of lipids including glyceryl monostearate, tripalmitin, and trimyristin alone and in conjunction with soya lecithin. Table 1 shows how the formulation was created.

Evaluation of Zidovudine Solid Lipid Microparticles

Determination of Particle Size

Particle size was determined using an optical microscopy approach utilizing an eye piece micrometer calibrated with a stage micrometer on 200 SLMs from each batch. The average particle size was estimated using the frequency data.²¹

Surface morphology

Scanning electron microscopy was used to examine the surface morphology of solid lipid microparticles. To create a 20nm layer, the synthesised microparticles were

Table 1: Composition of Zidovudine loaded solid lipid microparticle formulations.

Formulation	TPM (mg)	TMS (mg)	GMS (mg)	Ratio (T:G)	Soya lecithin (mg)
SLM 1	1000	-	-	-	-
SLM 2	500	-	500	1:1	-
SLM 3	333.33	-	666.66	1:2	-
SLM 4	200	-	800	1:4	-
SLM 5	1000	-	-	-	250
SLM 6	500	-	500	1:1	250
SLM 7	333.33	-	666.66	1:2	250
SLM 8	200	-	800	1:4	250
SLM 9	-	1000	-	-	-
SLM 10	-	500	500	1:1	-
SLM 11	-	333.33	666.66	1:2	-
SLM 12	-	200	800	1:4	-
SLM 13	-	1000	-	-	250
SLM 14	-	500	500	1:1	250
SLM 15	-	333.33	666.66	1:2	250
SLM 16	-	200	800	1:4	250

coated with gold palladium under an air environment for 150 sec. SEM (JSM 840 A, Jeol) was used to investigate the coated sample.²¹

Entrapment efficiency

The quantity of Zidovudine contained in the SLM formulations of varying composition was measured by dispersing 2ml of the SLM dispersed in 15ml of benzene using Uronnachi *et al.*, 2014's approach.²³ The drug that has now been exposed from the lipids is separated with 0.1M hydrochloric acid by shaking the contents on an orbital incubator shaker (CIS 24 BL, Remi) for 2 hr. The aqueous and organic layers were isolated, centrifuged if necessary, and the precipitate was diluted to the desired volume. Using 0.1M hydrochloric acid as a blank, the drug concentration was measured using UV spectrophotometry (SL-210, Elico) at 266nm. The following equation was used to calculate the encapsulation efficiency of the produced solid lipid microparticles:

$$\text{Encapsulation efficiency} = \frac{\text{Estimated percentage drug content}}{\text{theoretical percentage drug content}} \times 100$$

In vitro Dissolution studies

In-vitro release investigations were carried out utilizing modified Franz diffusion cells (Figure 1) with donor and receptor chambers and a sampling port to allow for the removal of ml samples. The membrane utilized was dialysis membrane (molecular weight cut-off 12000-14000 Da, Himedia). Before mounting in the cell, the filament was soaked in distilled water for 12 hr. In the donor compartment, a 5ml drug-loaded SLM dispersion was inserted, and the recipient compartment was filled with dialysis medium (phosphate buffer of pH 7.4). At 37°C, the contents of the cell were agitated using

a magnetic stirrer. 1 ml of sample was extracted from the receiver compartment through the side tube at predetermined intervals. To keep the volume constant, a new phosphate buffer with a pH of 7.4 was added. UV Spectrophotometry at 266 nm was used to evaluate the samples, with phosphate buffer at pH 7.4 serving as a blank.²⁴

Drug Excipient Compatibility studies

IR spectroscopy

A FT-IR spectrophotometer was used to acquire the infrared absorption spectra of zidovudine, glyceryl monostearate, tripalmitin, trimyristin, and SLM formulations (Spectrum RX1, Perkin Elmer). Before evaluating their infrared absorption spectra, the materials were crushed into a pellet. A few milligrams of the material were combined with around 100 times the amount of KBr in a mortar to make the pellets. A stainless-steel die received the finely ground powder. The powder was then squeezed with a pressure of around 10 t/in in the die between polished stainless-steel anvils.²⁵

Thermal (DSC) analysis

The thermal behaviour of the various components of the bead was studied using differential scanning calorimetry (DSC). This method of analysis was used on isolated compounds and their physical mixtures. An automated thermal analyzer equipment was used to acquire DSC thermograms (Netzsch 200 F3 DSC). For all of the specimens, sealed and pierced aluminium pans were employed in the studies. Indium was used as a reference for temperature calibrations. As a control, an empty pan was sealed in the same way as the sample. From 40 to 400°C, all scans were performed at a rate of 10°C/min.²³

Kinetic Modeling of Drug Release

To determine the selecting, the most appropriate model for predicting the mechanism of drug release, the dissolution profiles of all batches were fitted to zero-order [1], first-order [2], Higuchi [3], Hixson-Crowell [4], and Korsmeyer–Peppas [5] kinetic models.²⁶

$$Q = kt \quad [1]$$

$$Q = 100 (1 - e^{-kt}) \quad [2]$$

$$Q = k(t)^{0.5} \quad [3]$$

$$(100 - Q)^{1/3} = 100^{1/3} - kt \quad [4]$$

$$Mt/M_{\infty} = kt^n \quad [5]$$

In the above equations, Q represents the percentage at time (t) and k represents rate constant of zero-order, first-order, Higuchi, Hixson-Crowell models. The Peppas and Korsmeyer equation [5] was also used in

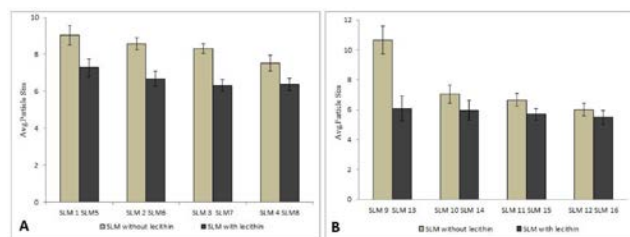


Figure 1: Effect of soya lecithin on particle size of formulations (A) SLM 1 to SLM 8;(B) SLM 9 to SLM 16. Results stand for the mean \pm standard deviation obtained for experiments carried out in triplicate.

which M_t is the amount of drug released at time t and M_∞ is the drug release at time ∞ , n is the diffusional exponent which indicates the mechanism of drug release. If $n \leq 0.43$, represents a Fickian diffusion (Case I); $0.43 \leq n \leq 0.89$, denotes a non – Fickian transport and if $n \geq 0.89$, characterizes a case II transport drug release mechanism.

Stability Study

At 4°C, 25°C, and 50°C, the prepared formulations were kept in screw-capped tiny glass bottles. After 15, 30, 45, 60, and 90 days, samples were tested.²²

RESULTS AND DISCUSSION

Preparation of SLM using emulsion solvent evaporation technique

Solid lipid carriers are shown to display superior advantages over polymer based drug carriers owing to their biocompatibility and absence of cytotoxicity. They hold capability to immobilize the drug within the lipid core and release them in a sustained manner.²⁷ The solid lipid microparticles were prepared by emulsion solvent evaporation method. The method was adopted for the simplicity and reproducibility. The SLMs of zidovudine were prepared using two different triglycerides viz., tripalmitin, trimyristin and glyceryl monostearate in varying concentrations. The above lipids are taken up for the investigation due to their biocompatibility and rate controlling ability. SLMs were prepared with and without the inclusion of Soya lecithin, to investigate the influence of its emulsifying effect up on the formation of SLM formulations. Polyvinyl alcohol (0.5%w/v) was used as the external aqueous phase to aid the emulsification process. Span 80 is used as a surfactant/co-surfactant in the organic phase.

Particle size analysis

Optical microscopic approach employing a calibrated eye piece micrometer was used to determine the average particle size and particle sizes of the manufactured solid lipid microparticles. The prepared SLM has a particle size range of 5.48 μ m to 10.64 μ m on average. SLM 16 had the lowest particle size of 5.48 μ m. Glyceryl monostearate concentrations were shown to have a negative effect on particle size, i.e., the particle size was reduced as the concentration of glyceryl monostearate was increased. Cortesi *et al.*, 2002 found similar findings when they made lipospheres from tripalmitin and glyceryl monostearate.²⁸ The addition of soya lecithin reduced particle size by successfully promoting emulsification by lowering surface tension and facilitation of the droplet

division during mechanical stirring that was attributed by the soya lecithin.

Effect of Soya lecithin on the particle size

When compared to SLM formulations without soya lecithin, the average particle size of the SLM formulations dropped much more for SLM 5 to SLM 8. (SLM 1 to SLM 4). This finding might be explained by the soya lecithin's ability to reduce surface tension and facilitate droplet splitting during mechanical stirring.²⁹ When compared to SLM formulations manufactured without soya lecithin, the average particle size of the SLM formulations dropped even more for formulations SLM 13 to SLM 16. (SLM 9 to SLM 12). This behavior is comparable to that of SLMs made with tripalmitin, glyceryl monostearate, and lecithin and might be explained by the same factors (Figure 1).

Surface Morphology

SEM was used to examine the morphology of the zidovudine-incorporated solid lipid microparticles. Solid lipid microparticles made with tripalmitin and glyceryl monostearate with and without soya lecithin had a spherical shape with a thorny surface, whereas lipid microparticles made with trimyristin and glyceryl monostearate with and without soya lecithin had a rough spherical shape with wrinkles on the surface (Figure 2).

Entrapment Efficiency

The effectiveness of trapping ranged from 46.92 to 58.39 percent. Formulation SLM 8 was found to have the maximum entrapment efficiency (58.39 percent). Glyceryl monostearate concentrations increased had a beneficial effect on drug entrapment, i.e., the entrapment efficiency reduced as the concentration increased. Due to the partial embedment of the medication in the surfactant layer, the addition of soya lecithin further improved entrapment efficiency. This might be because a portion of the medicine is embedded in the surfactant layer (Figure 3).³⁰⁻³¹

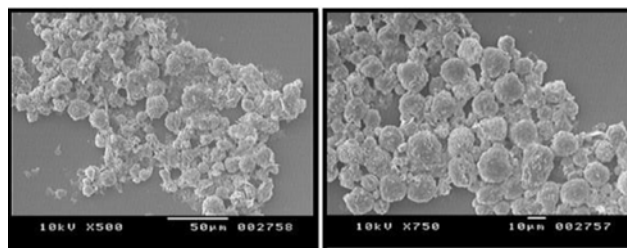


Figure 2: Microphotographs of SLM formulations SLM 8 (left) and SLM 16 (right).

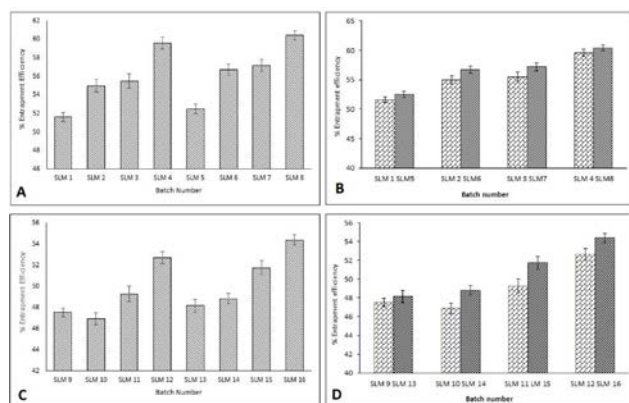


Figure 3: Entrapment efficiencies of SLM formulations SLM 1 to SLM 8 and Effect of soya lecithin on entrapment efficiency on SLM formulations SLM 1 to SLM 8; C & D) Entrapment efficiencies of SLM formulations SLM 9 to SLM 16 and Effect of soya lecithin on entrapment efficiency of SLM formulations SLM 9 to SLM 16. Results stand for the mean \pm standard deviation obtained for experiments carried out in triplicate.

***In vitro* Dissolution studies**

Using a modified Franz diffusion cell and pH 7.4 pH phosphate buffer as the dissolving medium, the *in vitro* release analysis of the produced SLM formulations was carried out. The drug release from all SLM formulations was found to be biphasic release. Approximately 11-28 percent of the medication was delivered in a burst phase during the first hour, with the remainder released gradually over the next 24 hr. The initial burst release could be attributed to the presence of free drug in the external phase and drug adsorbed on the surface of the microparticles while the slow release was due to drug encapsulated within the lipid matrix. Zidovudine released from the microparticles was decreased with an increase in amount of glyceryl monostearate in the microparticle formulation. Diffusional route length is lengthened when the density of the polymer matrix increases at greater concentrations. Overall medication release from the polymer matrix may be reduced as a result of this effect.³² At the conclusion of the 24-hr period, zidovudine release from the SLM ranged from 70.47 percent to 100 percent. SLM 8 was able to achieve the needed 80 percent medication release for the best therapeutic concentration. Boosted glyceryl monostearate concentrations inhibited drug release, but soya lecithin increased drug release, owing to reduced particle size and increased surface area aided by its surfactant effect (Figure 4).

Following the characterization and evaluation of various formulations, formulations belonging to SLM 4, SLM 8, SLM 12, and SLM 16 were found to have the most potential in terms of particle size uniformity,

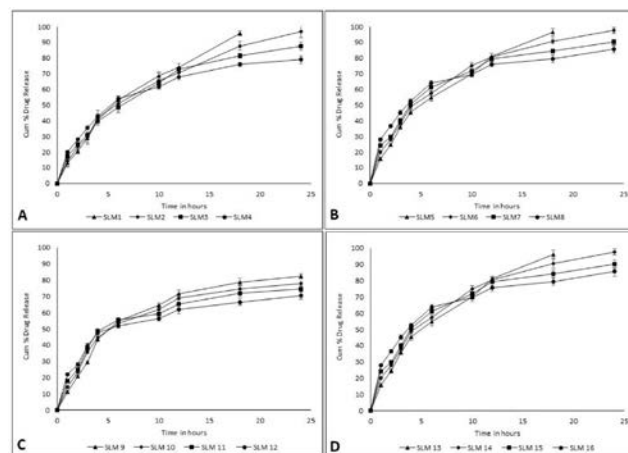


Figure 4: Comparative release profile of formulations; (A) SLM 1 to SLM 8; (B) SLM 5 to SLM 8; (C) SLM 9 to SLM 12; (D) SLM 13 to SLM 16. Data points represent the mean \pm standard deviation ($n = 6$).

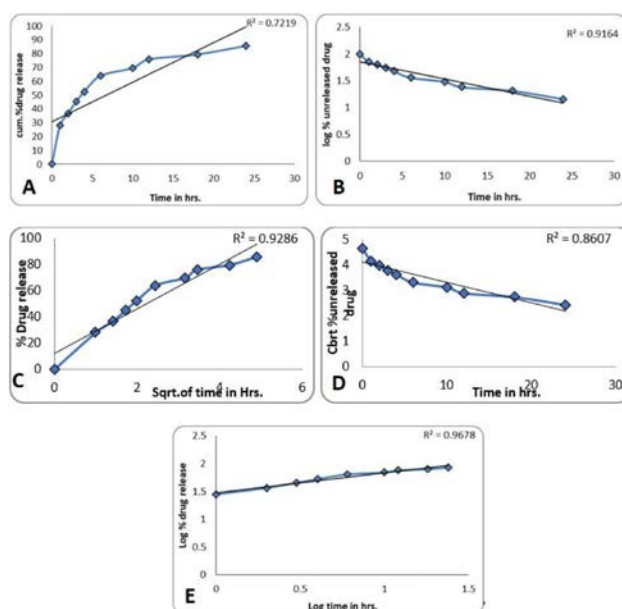


Figure 5: Release kinetics of SLM 8; (A) Zero order plot; (B) First order plot; (C) Higuchi plot; (D) Hixson-Crowell plot; (E) Korsmeyer-Peppas plot of Formulation 8.

shape, entrapment efficiency, and sustained drug release, and were therefore considered for further research. Formulation SLM 8 was chosen as the best of the four batches, having the most stable drug release and therapeutic optimum.

Release Kinetic Study

Based on the characterizations above, lipid microparticles from batch SLM 8 were successful in terms of particle size, shape, entrapment efficiency, and controlled drug release, and were thus determined to be the best formulation with the best sustainability. SLM 8's release profile was fitted to several release kinetic mechanisms, as illustrated in Figure 5. From the

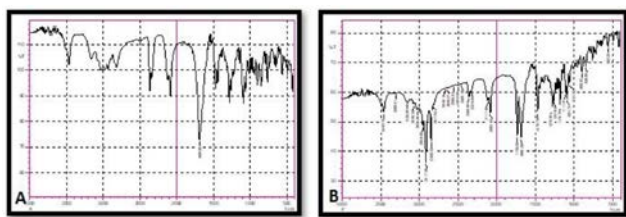


Figure 6: (A) FTIR spectrum of zidovudine (pure drug); (B) FTIR spectrum of formulation blend.

regression coefficient (R^2) values, it could be observed that the best fit was obtained for Higuchi model while the analysis of diffusion component (n) value (0.36) in Korsmeyer Peppas conforms that formulation follows Fickian diffusion mechanism.

Drug-Excipient Compatibility Study

Fourier Transform Infrared Spectroscopy (FT-IR)

FTIR and DSC analyses were used to look into the selected formulation for any potential interactions. The findings revealed that there were no possible interactions between the medicine and the polymers, and that no modifications to the polymer's nature were formed during the formulation. Due to the azido ($-N_3$) group, the drug's main peaks may be seen at wave number 1688.69 cm^{-1} . In the IR spectra of the SLM formulations, the drug's distinctive peaks were seen without any substantial modification from the peak found in the pure drug. As a result, the medicine remained unchanged in the formulation, and no potential interactions with the excipients were discovered. Figure 6 depicts the FT-IR spectra of the pure medication, lipid excipients, and chosen SLM formulations.

Differential Scanning Calorimetry (DSC)

Zidovudine thermograms indicated its typical peak temperatures of 211.4°C and 250.4°C . In the DSC thermograms of SLM formulations, the drug's distinctive peak was not readily visible. This might be because the medicine is present in the form of molecular dispersion and in little amounts. As a result, the formulations were thought to have kept the drug's characteristics while avoiding major incompatibilities (Figure 7).

Stability Study

According to ICH requirements, the best formulation (SLM 8) was stored at accelerated circumstances to ensure its stability. The synthesised formulation was shown to be stable under stress conditions, according to the findings.

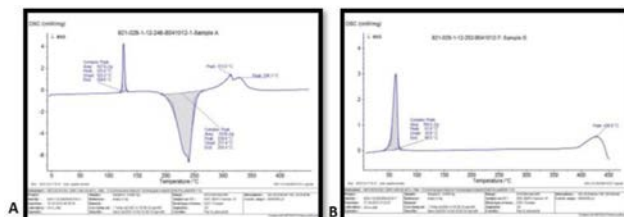


Figure 7: (A) DSC thermogram of Zidovudine; (B) DSC thermogram of SLM 8.

CONCLUSION

The goal of this project was to create solid lipid microparticles of zidovudine for long-term medication administration. For the creation of solid lipid microparticles, two triglycerides, tripalmitin and trimyristin, were used with various quantities of glyceryl monostearate. The emulsifying agent soya lecithin was chosen to study its influence on the production and characteristics of solid lipid microparticles. Based on the findings, it was determined that a combination of triglyceride (tripalmitin and trimyristin) and glyceryl monostearate was successful in delivering zidovudine, a hydrophilic medication, for a long time. PVA used in the formulation acts as a stabilizer by reducing the saturation solubility of the drug in the aqueous phase. The advantages of biocompatibility and timed release, as well as greater bioavailability and fewer adverse effects might be combined in this approach. However, further research is needed in animal models to improve pharmacokinetic and pharmacodynamic effectiveness.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

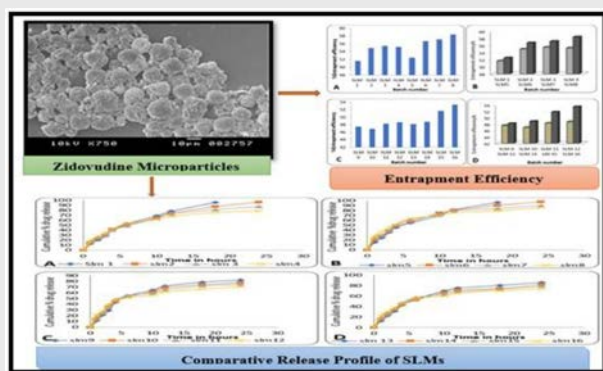
SLM: Solid Lipid Microparticles; **AZT:** Azidothymidine; **HIV:** Human Immunodeficiency Virus; **AIDS:** Acquired Immunodeficiency Syndrome; **BCS:** Biopharmaceutical Classification System; **HPMC:** Hydroxy Propyl Methyl Cellulose; **TPM:** Tripalmitin, **TMS:** Trimyristin; **GMS:** Glyceryl Monostearate; **SEM:** Scanning Electron Microscopy; **nm:** nanometer; **hr:** hour; **KBr:** Potassium

bromide; **min**: minutes; **°C**: degree Celsius; **t**: time; **mg**: milligrams; **ml**: milliliters

REFERENCES

- Scalia S, Young PM, Traini D. Solid lipid microparticles as an approach to drug delivery. *Expert Opin Drug Deliv*. 2015;12(4):583-99. doi: 10.1517/17425247.2015.980812, PMID 25391992.
- Kenechukwu C, et al. Solid Lipid Microparticles (SLMS): An Effective Lipid Based Technology for Controlled Drug Delivery. *Chukwuebuka. Am J PharmTech Res*. 2012; 2(6):01-18.
- López-Iglesias C, Quilez C, Barros J, Velasco D, Alvarez-Lorenzo C, Jorcano JL, et al. García-González CA. Lidocaine-loaded solid lipid microparticles (SLMPs) produced from gas-saturated solutions for Wound applications. *Pharmaceutics*. 2020;12(9):870. doi: 10.3390/pharmaceutics12090870.
- Bertoni S, Tedesco D, Bartolini M, Prata C, Passerini N, Albertini B. Solid lipid microparticles for oral delivery of catalase: Focus on the protein structural integrity and gastric protection. *Mol Pharm*. 2020;17(9):3609-21. doi: 10.1021/acs.molpharmaceut.0c00666, PMID 32786955.
- Ebadi M. Desk reference of Clinical Pharmacology. 2nd ed. CRC Press, Taylor and Francis Group; 2007.
- Rao PS, Vijayabhaskar K. Formulation and evaluation of zidovudine alginate microspheres. *J Drug Delivery Ther*. 2019;9(5-s):57-64. doi: 10.22270/jddt.v9i5-s.3607.
- Panda S, Pattnaik S, Maharana L, Babu Botta G, Mohapatra P. Formulation and evaluation of zidovudine loaded olibanum resin microcapsules: Exploring the use of natural resins as biodegradable polymeric materials for controlled release. *Asian J Pharm Clin Res*. 2013;6(3):191-6.
- Kuksal A, Tiwary AK, Jain NK, Jain S. Formulation and *in vitro*, *in vivo* Evaluation of extended-release Matrix Tablet of zidovudine: Influence of Combination of hydrophilic and Hydrophobic Matrix Formers. *AAPS Pharm Sci Tech*. 2006;7(1):E1. doi: 10.1208/pt070101, PMID 16584139.
- Singh S, Purvin S, Vuddanda PR, Singh SK, Jain A. Pharmacokinetic and tissue distribution study of solid lipid nanoparticles of zidovudine in rats. *J Nanotechnol*. 2014:1-7.
- Ranga Priya M, Natarajan R, Rajendran NN. Formulation and evaluation of zidovudine loaded niosomes. Formulation and evaluation of zidovudine loaded niosomes. 2013;1(1):12-8.
- Deepika B, Begum S, Tahseen F, et al. Formulation and *in vitro* evaluation of zidovudine matrix tablets. *World J Pharm Res*. 2017;6(5):803-10.
- Ruckmani K, Sankar V. Formulation and optimization of zidovudine niosomes. *AAPS PharmSciTech*. 2010;11(3):1119-27. doi: 10.1208/s12249-010-9480-2, PMID 20635228.
- Michel Balaiah Ch, Narendra K, Reddy K. Formulation and evaluation of sustained release tablets of zidovudine by using hibiscus as a natural polymer. *Indian J Res Pharm Biotechnol*. 2016;4(3):99-102.
- Ravi PR, Kotreka UK, Saha RN. Controlled release matrix tablets of zidovudine: Effect of formulation variables on the *in vitro* drug release kinetics. *AAPS PharmSciTech*. 2008;9(1):302-13. doi: 10.1208/s12249-007-9030-8, PMID 18446496.
- Santos JV, Pina ME, Marques MP, De Carvalho LA. New sustained release of zidovudine matrix tablets - cytotoxicity toward Caco-2 cells. *Drug Dev Ind Pharm*. 2013;39(8):1154-66. doi: 10.3109/03639045.2012.669129, PMID 22439754.
- Patil JS, Kadam DV, Kamalapur MV, Marapur SC, Shiralashetti SS. Formulation and Evaluation of Extended-Release Matrix Tablet of Zidovudine Using Hydrophilic and Hydrophobic Matrix Formers. *Indian J Pharm Educ Res*. 2014;48(supplementary):73-82. doi: 10.5530/ijper.48.4s.10.
- Amitava G, Abhradeep S, Sujit D, Tanmoy G. Formulation and *in-vitro* evaluation of zidovudine loaded ethyl cellulose microcapsules. *Int J Pharm Sci Res*. 2011;2(2):289-97.
- Phalguna Y, Venkateshwarlu BS, Ganesh Kumar G, Subal D. HPMC microspheres of zidovudine for sustained release. *Int J Pharm Pharm Sci*. 2010;2(4):41-3.
- Asha K, Vikash D. Formulation and evaluation of zidovudine loaded chitosan Microspheres for controlled release. *Int J Drug Deliv Res*. 2012;4(1):96-105.
- Chetan P, Sunil B, Sunil P, Bhushan R, Nayan G. Preparation and evaluation of hollow microsphere drug delivery system of zidovudine. *Int J Pharm Sci Res*. 2011;2(10):2669-74.
- Uronnachi EM, Ogbonna JDN, Kenechukwu FC, Chime SA, Attama AA, Okore VC. Formulation and release characteristics of zidovudine-loaded solidified lipid microparticles. *Trop J Pharm Res*. 2014;13(2):199-204. doi: 10.4314/tjpr.v13i2.5.
- Chawla V, Saraf SA. *Ars Pharm*. 2016;12:2-7.
- Singh S, Dohal AK, Jain A, Pandit JK, Chakraborty S. Formulation and evaluation of solid lipid nanoparticles of a water-soluble drug: zidovudine. *Chem Pharm Bull (Tokyo)*. 2010;58(5):650-5. doi: 10.1248/cpb.58.650, PMID 20460791.
- Asha K, Vikash D. Formulation and evaluation of zidovudine loaded chitosan microspheres for controlled release. *Int J Drug Dev Res*. 2012;4(1):96-105.
- Peepliwal A, Vyawahare SD, Bonde CG. A quantitative analysis of zidovudine containing formulation by FT-IR and UV spectroscopy. *Anal Methods*. 2010;2(11):1756-63. doi: 10.1039/c0ay00341g.
- Araújo AAS, Storpirtis S, Mercuri LP, Carvalho FM, Dos Santos Filho M, Matos JR. Thermal analysis of the antiretroviral zidovudine (AZT) and evaluation of the compatibility with excipients used in solid dosage forms. *Int J Pharm*. 2003;260(2):303-14. doi: 10.1016/s0378-5173(03)00288-6, PMID 12842349.
- Rao KR, Senapati P, Das MK. Formulation and *in vitro* evaluation of ethyl cellulose microspheres containing zidovudine. *J Microencapsul*. 2005;22(8):863-76. doi: 10.1080/02652040500273498, PMID 16423758.
- Cortesi R, Esposito E, Luca G, Nastruzzi C. Production of lipospheres as carriers for bioactive compounds. *Biomaterials*. 2002;23(11):2283-94. doi: 10.1016/s0142-9612(01)00362-3, PMID 12013175.
- Lopes R, Eleutério CV, Gonçalves LMD, Cruz MEM, Almeida AJ. Lipid nanoparticles containing oryzalin for the treatment of leishmaniasis. *Eur J Pharm Sci*. 2012;45(4):442-50. doi: 10.1016/j.ejps.2011.09.017, PMID 21983568.
- Lim SJ, Kim CK. Formulation parameters determining the physicochemical characteristics of solid lipid nanoparticles loaded with all-trans retinoic acid. *Int J Pharm*. 2002;243(1-2):135-46. doi: 10.1016/s0378-5173(02)00269-7, PMID 12176302.
- Tiyaboonchai W, Tungpradit W, Plianbangchang P. Formulation and characterization of curcuminoids loaded solid lipid nanoparticles. *Int J Pharm*. 2007;337(1-2):299-306. doi: 10.1016/j.ijpharm.2006.12.043, PMID 17287099.
- Pilaniya U. Biodegradable solid lipid microparticles loaded with diltiazem hydrochloride for oral delivery: Preparation and *in-vitro/in-vivo* evaluation. *J Drug Delivery Ther*. 2011;1(1):48-59. doi: 10.22270/jddt.v1i1.10.

PICTORIAL ABSTRACT



SUMMARY

Zidovudine is widely used in the treatment of AIDS and similar illnesses, yet its therapeutic efficacy and usage is limited due to its pharmacokinetics properties. Hence the use of lipid based delivery systems of AZT was assessed in this study as they would make a less bio toxic and efficient in providing spatial placement and temporal release. Optimization of the Solid lipid microparticles of zidovudine was carried out using different lipids and were evaluated for their efficiency. Based on the characterizations above, lipid microparticles from batch SLM 8 were successful in terms of particle size, shape, entrapment efficiency, and controlled drug release, and were thus determined to be the best formulation with the best sustainability. it was determined that a combination of triglyceride (tripalmitin and trimyristin) and glyceryl monostearate was successful in delivering zidovudine, a hydrophilic medication, for a long time.

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