https://doi.org/ 10.33472/AFJBS.6.Si2.2024.1876-1882

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Research Article

Formulation and Evaluation of Proniosomes Loaded with Captopril Maltodextrin

Vivekanand Ankush Kashid[1], Prasad Gorakshanath Ghugarkar[2], M. Jesupillai[3], Julliyan Dilleban A.[4], Vijay Dhondiram Wagh[5], Prasad Laxman Gorde[6], Sachin Tyagi[7], Sandip Barku Ahire[8*]

[1]Principal, Pharmaceutical Education and Research, Babhulgaon, Nashik, Maharashtra, 423401, India

[2]Assistant Professor, Dr. N. J. Paulbudhe College of Pharmacy, Ahmednagar, Maharashtra, 414003, India

[3]Principal, Immanuel Arasar College of Pharmacy, Kanyakumari, Tamil Nadu, 629165, India

[4]Assistant Professor, Department of Pharmacy Practice, Arulmigu kalasalingam College of Pharmacy, Virudhunagar Tamil Nadu, 626126, India

[5]Professor and Principal, NGSPMs College of Pharmacy, Nashik, Maharashtra, 422 213, India

[6]Associate Professor, Matoshri Miratai Aher College of Pharmacy, Karjule Harya, Ahmednagar, Maharashtra, 414304, India

[7]Professor & Director, School of Pharmacy, Bharat Institute of technology, Meerut 250103, India

***Corresponding author: Sandip Barku Ahire,** Assistant Professor, KBHSS Trust's Institute of Pharmacy, Malegaon, Nashik, Maharashtra, 423105, India

ARTICLE INFO:

Volume 6,Issue Si2, 2024

Received:28 Mar 2024

Accepted : 29 Apr 2024

doi: 10.33472/AFJBS.6.Si2.2024.1876-1882

ABSTRACT:

The slurry technique was employed to produce proniosomes based on maltodextrin, loaded with captopril, using different ratios of surfactant to carrier. The proniosome formulation was evaluated for FT-IR analysis and scanning electron microscopy. The stability, kinetic data analysis, in vitro release testing, and trapping efficacy of the niosomal dispersion were further evaluated. The smooth surface of the proniosome is the result of the scanning electron microscopy (SEM) research. Among the three formulations, formulation F3 demonstrated superior performance with an entrapment efficiency of 95.69% and an in vitro cumulative drug release of 103.16% after 12 hours. The phenomenon of first-order kinetics offered the most comprehensive explanation for the process of release. The medication is released following Fickian release, as determined by kinetic studies. The proteosome formulation exhibited sufficient stability for a duration of 45 days by being stored under different conditions. Captopril is an effective treatment for both congestive heart failure and hypertension. However, in order to meet clinical requirements, it is necessary to take the 50 mg daily dose three times a day. Developing a captopril dosage form with an extended duration of action offers several benefits. Developing sustained-release or controlled-release oral captopril formulations has been a longstanding challenge.

KEYWORDS: Proniosomes, Captopril, Maltodextrin, formulation

INTRODUCTION

Because promiosomes are dry, they can help solve many of the issues that come up with niosome dispersions in water and can also help with problems related to physical stability (Gupta, *et al.,* 2007). Prosiosomes can also be moistened right before they are used. When you add the dried carrier formulations that are coated with surfactant to hot water, you can quickly and accurately measure how much water they need (Aneesha, 2013). These carrier particles can be soaked to make a suspension of niosomes before they are used in rapid stirring in a hot water-based solution. The particles are coated with surfactants and dissolve in water (Akhilesh, *et al.,* 2012). The slurry method and spraying of surfactant over water-soluble carrier particles are two ways that have been described to make proniosomes (Sabareesh, *et al.,* 2020). This item is a dry granule that moves easily. When mixed with water, it dissolves or spreads out to make a suspension with many layers and a bad smell. It can be given in different ways or taken by mouth (Suryawanshi, *et al.,* 2021).

Angiotensin converting enzymes, like captopril, are often used to treat high blood pressure and acute heart failure (Kumar and Maurya, 2018). The drug is thought to be the best treatment for high blood pressure because it is very safe and works very well (Sharma, *et al.,* 2018). Most of the time, people who need long-term therapeutic drugs are those who need them because they have a chronic illness (Ahire, *et al.,* 2020). The recommended dose is between 37.5 mg and 75 mg, spread out three times a day. The medicine is taken by mouth, and its effects on high blood pressure show up 6 to 8 hours after a single oral dose (Sharma, *et al.,* 2016). It takes 1.7 hours for the drug to completely break down in water. We are focusing on making captopril by using a proniosome formulation that is based on maltodextrin in this project (Sahoo, *et al.,* 2014).

MATERIALS AND METHODS

A number of different chemicals, including cholesterol, Brij 72 Span 40, Span 60, Captopril, and maltodextrin, were purchased from Sigma Aldrich Chemicals.

Formulation of Proniosomes:

The Slurry Method was used to make the proteosomes. Different recipe ratios were made and then mixed with a solution that was made of 2:1 chloroform to methanol. After that, it was put into a 100 ml round-bottom jar that already had a carrier in it. When the amount of surfactant was smaller, more chloroform:methanol solution was added to make a slurry. It had a rotating flask evaporator attached to it, which let the solvent evaporate at a rate of 60 to 70 turns per minute, at a temperature of 45±2°C, and under 600 mmHg of pressure. This process kept going until the mass inside the jar turned into a dry substance that was easy to pour. After that, the products were dried out in a vacuum desiccator overnight at room temperature. For experiments and more research into the qualities of powders, prosniosome, a dried formulation, was used. Before being looked at more closely, the proniosomes were kept in a jar that was carefully sealed and kept in the fridge (Ramkanth, *et al.,* 2018, Behera, *et al.,* 2010, Surana and Mahajan, 2022 and Reddy and Gandla, 2022).

Table 1: Formulation of Proniosomes containing Captopril

Formulation Code	Captopril (gm)	Maltodextrin (gm)	Brij 72(gm)	Span 40 (gm)	Span 60(gm)	Cholesterol (gm)
F1	0.05	0.04	0.100	0.100	0.100	0.100
F2	0.05	0.04	0.150	0.150	0.150	0.100
F3	0.05	0.04	0.200	0.200	0.200	0.100

Analysis of Drug Content:

Proniosomal configuration A dose of 50 mg of Captopril was introduced into a standard

volumetric flask. In addition, 50 ml of propanol was utilised to rupture the vesicles, and subsequently, 1 ml of the resulting liquid was diluted with 7.4 ml of phosphate buffer. The medication concentration was determined by spectroscopically measuring the absorbance at a wavelength of 212 nm (Yeola, *et al.,* 2023 and Pawar, *et al.,* 2023).

Entrapment Efficiency

The proniosomal preparation was reconstituted with phosphate buffer at a pH of 7.4, heated to 80°C, and mixed using a vortex mixer for two minutes to convert it into niosomes. Subsequently, the medication that was not captured was separated from the niosomes containing captopril using centrifugation at a speed of 14000 revolutions per minute for a duration of 30 minutes at a temperature of 4 degrees Celsius. Following the extraction of the supernatant, it was diluted using a phosphate buffer with a pH of 7.4. The ultimate resolution was determined by employing a solitary UV spectrophotometer at a wavelength of 212 nm (Deepika, *et al.,* 2020 and Ahmad, *et al.,* 2017).

Particle Size Analysis

The particle size and polydispersity index of captopril proniosomes were determined using dynamic light scattering, also known as photon correlation spectroscopy, with a Malvern Zetasizer 3000 Nano S at a temperature of 25ºC. In order to obtain a suitable level of scattering intensity, the substance was diluted with ultra-purified water before conducting the tests. The sizing cuvette of the instrument was filled with the diluted niosomal dispersion. The cuvette holder was used to analyse the dispersion. Air bubbles were removed from the capillary before measuring (Gandra, 2020 and Kakar, *et al.,* 2010).

Scanning Electron Microscopy (SEM)

The size distribution and surface appearance of proniosomes were analysed using scanning electron microscopy. A minute portion of the sample was coated with a thin layer of gold to enhance its electrical conductivity, and it was affixed to a copper stub using double-sided adhesive tape. Scanning electron microscope (SEM) images were obtained using an accelerating voltage of 5 kilovolts (kV) (Sonawane, *et al.,* 2023, Govindarajan, *et al.,* 2022 and Aher, *et al.,* 2023).

***In Vitro* Drug Release Studies**

Using USP type I basket equipment, proniosomal powders and pure medicine were investigated for their in vitro solubility in continuous medium (pH 7.4). The medium was kept at 37°C±0.5°C and 50 rpm for the duration of the experiment. Every time a fresh dissolving media was added, 5 ml of samples were obtained at predetermined intervals for up to 12 hours in order to maintain a constant volume. The samples were measured with a UV spectrophotometer at 212 nm (Surana, *et al.,* 2022 and Keservani, *et al.,* 2010).

RESULTS AND DISCUSSION

Captopril proneosomes were prepared utilising a slurry method. The procedure of this medication is combining cholesterol and non-ionic surfactant in an organic solvent prior to introducing them into the maltodextrin carrier. The utilisation of maltodextrin as a carrier in proniosome preparation allows for greater flexibility in adjusting the quantities of surfactants and other components. This increased flexibility significantly enhances the potential usability of proniosomes in a larger manufacturing environment.

We examined the drug composition and the ability of each of the nine formulations displayed in Tables 2 and 3 to trap the drug effectively. Formulation F3 (95.69%) exhibited the highest entrapment efficiency, suggesting that this formulation may possess the optimal maltodextrin to surfactant ratio for achieving a high level of captopril entrapment.

Table 2: Drug content of Proniosomes of Captopril

Formulation code	Drug content
F1	84.78%

F2	90.53%
F3	94.81%

Table 3: Entrapment efficiency of Proniosomes of Captopril

Formulation code	Entrapment efficiency
F1	81.65%
F2	84.61%
F3	95.69%

Table 4: *In vitro* drug release for all formulations of Proniosomes of Captopril

Time (hr)	Cumulative percentage drug release (%)			
	Control	F1	F2	F3
1	49.83	34.81	33.71	32.55
2	93.91	49.28	50.91	48.56
3	102.01	69.21	62.82	51.91
4	-	78.51	68.44	65.91
5	-	85.96	74.61	76.87
6	-	101.79	81.13	75.63
7	-	-	89.64	84.15
8	-	-	96.52	89.50
9	-	-	102.90	93.86
10	-	-	-	95.61
11	-	-	-	96.91
12	-	-	-	103.16

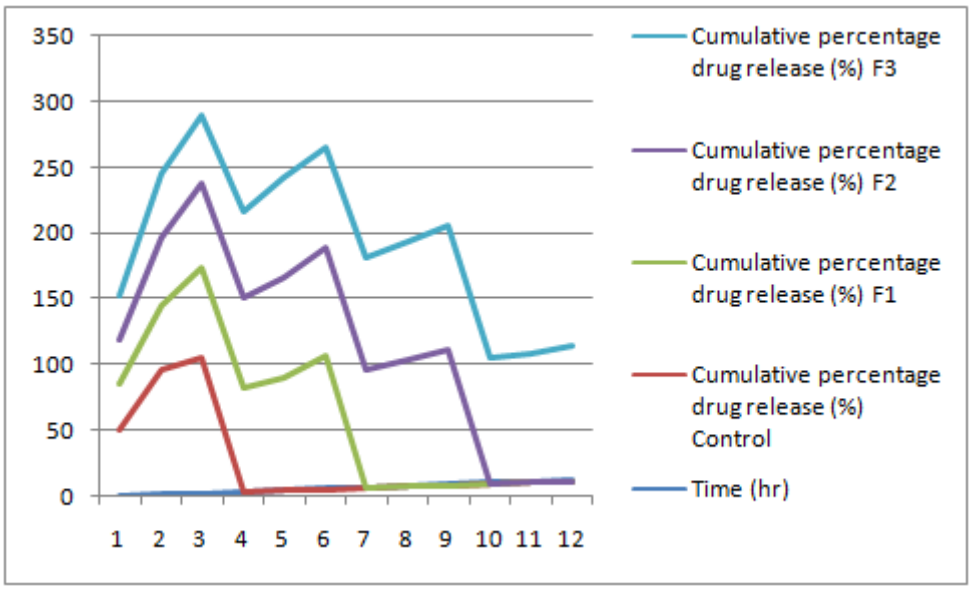

Figure 1: *In vitro* drug release study of Proniosomes of captopril

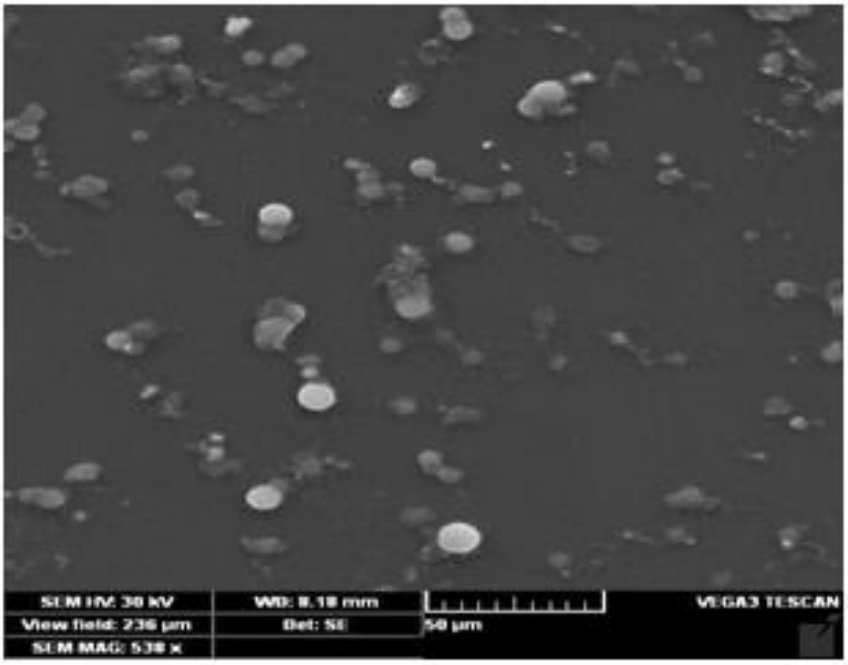

Figure 2: SEM image of optimized formulation F3

Table 5: R^2 value of proniosomes of Captopril in various kinetic models

Formulation	Zero order	First order	Higuchi	Hixon Crowell's	Korsmeyer and peppas
F3	0.8901	0.9903	0.9799	0.9901	0.9904

All three formulations, depicted in figures 1 and 2, were subjected to a release study. Most of the formulations showed a linear release pattern, resulting in an approximately 103.16% release over a 12-hour period. The formulation containing the best F3 was found to have a longer duration of drug release compared to the other formulations. F3 was selected as the optimal formulation due to its consistent release profile of captopril and highest entrapment efficiency. When the logarithmic transformation plot of log time versus log drug release was applied to the in vitro kinetic data, the resulting values indicated that n>0.3, suggesting that the drug release follows Fickian diffusion. The surface characteristics and morphology of proniosomes were examined using scanning electron microscopy. The surface morphology analysis indicated the flat surface of the improved proniosomal formulation.

CONCLUSION

Proniosomes, an innovative drug delivery technique, provide a significant advancement over liposomes or noisomes by addressing concerns related to physical stability, such as vesicle fusion or aggregation, as well as drug leakage during extended storage periods. Regarding storage, transportation, and dosage, niosomes produced from prometheases are more advantageous compared to niosomes produced using conventional methods. The results of this study provide evidence that captopril was successfully trapped within the lipid bilayer of the vesicles. Additionally, the proniosomes made from cholesterol, Span 40, and Span 60 using maltodextrin as a carrier proved to be a practical approach for prolonging the release of the drug.

DECLARATIONS:

Ethics approval and consent to participate:

Not applicable.

Consent for publication:

All the authors approved the manuscript for publication.

Availability of data and material:

All required data is available.

Competing interests:

All authors declare no competing interests.

Funding:

Not applicable.

REFERENCES:

1. Gupta, A., Prajapati, S. K., Singh, M., & Balamurugan, M. (2007). Proniosomal powder of captopril: formulation and evaluation. *Molecular Pharmaceutics*, *4*(4), 596-599.
2. Aneesha, P. (2013). *Formulation and Evaluation of Non-Steroidal Anti-Inflammatory Drug (KETOPROFEN) Loaded Maltodextrin Based Proniosomes* (Doctoral dissertation, Rajiv Gandhi University of Health Sciences (India)).
3. Akhilesh, D., Faishal, G., & Kamath, J. V. (2012). Comparative study of carriers used in proniosomes. *Int J Pharm Chem Sci*, *3*, 6-12.
4. Sabareesh, M., Yanadaiah, J. P., & Sekhar, K. C. (2020). A novel vesicular approach for transdermal administration of enalapril maleate loaded nanoproniosomal gel: Formulation, ex vivo evaluation and in vivo antihypertensive study. *International Journal of Applied Pharmaceutics*, *12*(5), 190-202.
5. Suryawanshi, S. S., Patil, P. P., Gaikwad, R. G., Mali, S. S., & Pol, S. L. (2021). Proniosomes: Modern drug delivery system. *Pharmaceutical resonance*, 41-56.
6. Kumar, S., & Maurya, H. (2018). An Overview on Advance Vesicles Formulation as a Drug Carrier for NDDS. *European Journal of Biomedical*, *5*(2), 292-303.
7. Sharma, A. K., Keservani, R. K., & Kesharwani, R. K. (Eds.). (2018). *Nanobiomaterials: applications in drug delivery*. CRC Press.
8. Ahire, E. D., Sonawane, V. N., Surana, K. R., Jadhav, K. R., Sonawane, D. D., & Shah, A. A. (2020). Convalescent plasma therapy: A promising approach in the treatment of Covid-19. *Int J Pharm Sci Res*, *11*, 4078-4086.
9. Sharma, V. K., Koka, A., Yadav, J., Sharma, A. K., & Keservani, R. K. (2016). Self-micro emulsifying drug delivery systems: A strategy to improve oral bioavailability.
10. Sahoo, R. K., Biswas, N., Guha, A., Sahoo, N., & Kuotsu, K. (2014). Development and in vitro/in vivo evaluation of controlled release provesicles of a nateglinide–maltodextrin complex. *Acta pharmaceutica sinica B*, *4*(5), 408-416.
11. Ramkanth, S., Chetty, C. M., Sudhakar, Y., Thiruvengadarajan, V. S., Anitha, P., & Gopinath, C. (2018). Development, characterization & invivo evaluation of proniosomal based transdermal delivery system of Atenolol. *Future Journal of Pharmaceutical Sciences*, *4*(1), 80-87.
12. Behera, J., Keservani, R. K., Yadav, A., Tripathi, M., & Chadoker, A. (2010). Methoxsalen loaded chitosan coated microemulsion for effective treatment of psoriasis. *International Journal of Drug Delivery*, *2*(2).
13. Surana, K. R., & Mahajan, S. K. (2022). In silico Study of Chromane Ring Compound Rubranonoside from Plumeria rubra as Anticancer Potential. *Trends in Sciences*, *19*(24), 3305-3305.
14. Reddy, K. T. K., & Gandla, K. (2022). Novel Vesicular Drug Delivery Systems Proniosomes. *Pharm Res*, *6*(3), 000272.
15. Yeola, C. A., Sonawane, V. N., Sonawane, V. N., Surana, K. R., Patil, D. M., &

Sonawane, D. D. (2023). Development and Validation of Simple UV-Spectrophotometric Method for Estimation of Diclofenac Sodium. *Asian Journal of Pharmaceutical Analysis*, *13*(3), 183-189.

16. Pawar, S. D., Deore, S. D., Bairagi, N. P., Deshmukh, V. B., Lokhande, T. N., & Surana, K. R. (2023). Vitamins as Nutraceuticals for Anemia. *Vitamins as Nutraceuticals: Recent Advances and Applications*, 253-279.
17. Deepika, S., Rizwana, K., & Sharma, B. (2020). A review on proniosomes drug delivery: An innovative approach. *World J Pharm Res*, *9*, 1322-33.
18. Ahmad, M. Z., Mohammed, A. A., & Mokhtar Ibrahim, M. (2017). Technology overview and drug delivery application of proniosome. *Pharmaceutical development and technology*, *22*(3), 302-311.
19. Gandra, S. M. I. T. H. A. (2020). Enhanced intestinal absorption and bioavailability via proniosomes for Bazedoxifene acetate drug. *Int J Pharm Pharm Sci*, *12*(12), 31-42.
20. Kakar, R., Rao, R., Goswami, A., Nanda, S., & Saroha, K. (2010). Proniosomes: An emerging vesicular system in drug delivery and cosmetics. *Der Pharmacia Lettre*, *2*(4), 227-239.
21. Sonawane, V. N., Yeola, C. A., Sonawane, V. N., Surana, K. R., Patil, D. M., & Sonawane, D. D. (2023). Estimation of Paracetamol in various brands of Paracetamol Tablets and their Comparative Study. *Asian Journal of Pharmaceutical Analysis*, *13*(3), 155-161.
22. Govindarajan, S., Swamivelmanickam, M., Nair, S. P., & Sivagnanam, S. (2022). A Comprehensive Study on Provesicular Drug Delivery System: Proniosomal Gel. *Indian Journal of Pharmaceutical Sciences*, *84*(1).
23. Aher, P., Surana, K., Ahire, E., Patil, D., Sonawane, D., & Mahajan, S. (2023). Development and Validation of RP-HPLC Method for Quantitative Determination of 4-Amino Benzene Sulphonamide in Sulphonamide Hydrochloride. *Trends in Sciences*, *20*(6), 5209-5209.
24. Surana, K. R., Parkhe, A. G., Ahire, E. D., Pawar, A. R., Khairnar, S., Mahajan, S. K., & Kshirsagar, S. J. (2022). Current therapeutic targets for neuropathic pain. *Asian Journal of Pharmaceutical Research*, *12*(1), 96-104.
25. Keservani, R. K., Sharma, A. K., & Ramteke, S. (2010). Novel vesicular approach for topical delivery of baclofen via niosomes. *Lat Am J Pharm*, *29*(8), 1364-1370.