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Research

Design And Development Of Curcumin Loaded Nanorobots For Targeting Colon Cancer

Ubaidulla Uthumansha[1*], Mohamed Asrarullah M.H[1], Mohammad Samiyullah. S[1]

[1]*Department of Pharmaceutics, Crescent School of Pharmacy, B.S. Abdur Rahman Crescent Institute of Science and Technology, GST Road, Vandalur, Chennai, Tamil Nadu, India.*

*Author for Correspondence: Dr. U. Ubaidulla, M.Pharm., Ph.D.
Email: ubaidulla@crescent.education

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Abstract

Colorectal cancer is one of the most widespread tumors worldwide, and it is considered to be the second leading cause of death among cancer groups. Natural compounds, such as curcumin, have shown significant anti-colorectal cancer characteristics among medications that can be used to treat colorectal cancer. Targeted drug delivery systems are essential for improving the effectiveness of cancer treatment while minimizing side effects. The development of smart curcumin nanorobots for targeting colon cancer cells is a significant advancement in this field. By utilizing green synthesis of magnetite, coating curcumin nanoparticles, and incorporating them into smart nanolegs, a motile and targeted drug delivery system has been successfully created.

Keywords: Robotic drug delivery, Colorectal cancer, curcumin, chitosan, sodium alginate

INTRODUCTION

Cancer is one of the leading causes of death in the human populations, moreover colonorectal cancer is the most common gastrointestinal track cancer worldwide with over 1.2 million new diagnoses every year.[1,2] The current study's objective is to pinpoint the anti-cancer drug's site of action and boost its effectiveness. We are concerned with a formulation known as "smart curcumin legs." This formulation is motile, meaning it can pass through the stomach intestinal system and release the medication into the colon. Our formulation's combination of sodium alginate and chitosan succinate has been proven to be advantageous over other traditional formulations because it can target the colon, where medication delivery is needed, and it can overcome the killing of normal healthy cells.[3,4,5] Nanorobotics have the potential to dramatically alter the way we treat cancer by targeting cancer cells more accurately, reducing side effects, and improving treatment outcomes. It is a biodegradable delivery method because our formulation comprises green synthesised magnetite.[6,7] Because the smart curcumin legs can be regulated by an external magnetic field, the onset of action can be significantly faster. Curcumin is a medicine that has been nano reduced and infused with Smart curcumin legs. Curcumin is a naturally occurring medicine with potent anti-cancer potential.[8,9,10] Using curcumin will also help us avoid the negative side effects of this composition. These innovative curcumin nanolegs were put to the capsule shell and delivered orally.

METHODS

The present study aims to develop curcumin loaded nanolegs for targeting using biodegradable polymers. Ferrous oxide NP synthesized by using fenugreek seeds to alleviate the toxicity associated with chemically synthesized iron NP. In this study SCL was prepared using combination of chitosan succinate polymer in addition to alginate. CSSC polymer has an advantage compared to chitosan such as Chitosan soluble in acidic p^H to avoid curcumin release in stomach CSSC was used. Curcumin is insoluble in water and it has poor bioavailability. To improve the bioavailability of curcumin we have prepared curcumin NPs using biodegradable polymers. CSSC is insoluble in acidic p^H and soluble in colon p^H. This property is useful to carry the drug and target the colon cancer.

As our study is concerned with the production of a biodegradable drug formulation, we chose a natural source for the green synthesis of magnetite. The leaves and seeds of Fenugreek (*Trigonella foenum*) have various applications. We select Fenugreek seeds as a precursor for our extraction process.

A known amount (5g) of Fenugreek seeds was weighed and taken. The seeds were washed with distilled water multiple times to remove any possible particulates associated with the seeds. Then the seeds were dried using a hot air oven and then powdered. The extraction is done by using water as a solvent. A Soxhlet apparatus was used for the process. 5g of fenugreek seeds was immersed in an amount of water that was ten times that of the number of seeds taken. The extraction is carried out for an hour at a controlled temperature (65–70 °C). Filter the extract after the solution reaches room temperature. The 50 ml of fenugreek extract was mixed with 100 ml of a solution containing equal amounts of 1M $FeCl_2$ and 2M $FeCl_3$. 10 ml of a 25% NH_3 solution was added dropwise, and then the solution was stirred for 2 hours at room temperature.

RESULTS AND DISCUSSION

In vitro drug release behavior of SCL was determined by employing a USP dissolution equipment type-II at 50 rpm, 37 ˚C ± 0.5 temperature. Dissolution mediums, pH 1.2, 6.8, and 7.4, were used successively for 2, 12 and up to 24 hours, respectively, in a sequential pH change approach. A precisely weighed quantity of samples equivalent to 200 mg of curcumin in SCL was transferred to a dialysis membrane (12-14KDa). It had earlier been soaked in release media for almost 12 hrs. Two clamps were used to secure the dialysis membrane's open ends and immersed in 900 ml of simulated gastric medium pH 1.2 for 2 hrs. After that, the simulated gastric medium pH 1.2 was changed with Phosphate buffer 6.8 for 12 hrs., and finally, it was changed with Phosphate buffer 7.4 for a further 24 hrs. The 5ml of dissolution medium was pulled out at prior set time intervals of 0, 1, 2, 4, 6, 8, 10, 12, 16, 20 and 24 hrs, followed by the addition of an equal volume of a fresh dissolution medium to uphold the required sink conditions throughout the analysis. Filter the pulled-out medium and take the three-time absorbance of the filtrate by employing a UV-Spectrophotometer at λ max 418 nm. With the aid of a regression mathematical equation, the concentration of SCL was computed employing a calibration curve. The percentage of cumulative drug release was calculated as 100.329 for F1, 99.543 for F2, 100.067 for F3, 100.853 for F4 and release profile was observed.

CONCLUSION

The characterization results demonstrate the structural and morphological properties, magnetic properties, and drug release behavior of the smart curcumin nanolegs. Curcumin loading efficiency calculated in nanolegs, and it was found in the range of 60 to 100%. From the FTIR report the curcumin peaks was observed without any changes when compared to pure curcumin that indicates the encapsulated curcumin is stable in the smart curcumin legs. The in vitro release studies show that the smart nanolegs can release the drug in a controlled manner in the colon pH, providing targeted delivery to colon cancer cells. Overall, the development of smart curcumin nanolegs for targeting colon cancer is a promising approach that can potentially improve the treatment of this deadly disease.

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