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Quantum-Programmed Nanogels for Ultra-Precise Cancer Therapy

Yogeeshwaran.v,

Department of Pharmaceutics, JSS College of Pharmacy, Ooty

Presenting Author E-mail:24p04206@jssuni.edu.in

INTRODUCTION & AIM

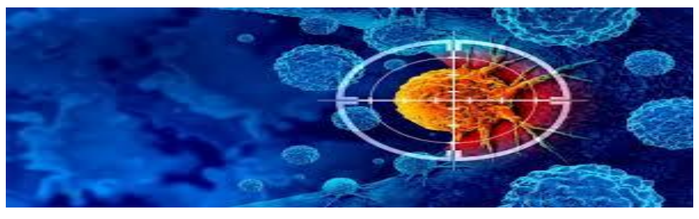
Current challenges in cancer therapy (drug resistance, systemic toxicity, tumour heterogeneity).

Role of Nano gels in drug delivery.

Gap: conventional Nano gels are static and cannot adapt in real time.

The aim of this study is to develop and evaluate quantum-programmed adaptive Nano gels that integrate molecular sensors with predictive algorithms to enable real-time,

Patient-specific regulation of drug release in cancer therapy, thereby improving therapeutic precision, minimizing systemic toxicity, and overcoming tumor heterogeneity.



METHOD

1.Design and Synthesis of Quantum-Programmed Nano gels Adaptive Nano gels were synthesized using a hydrogel network composed of biocompatible polymers such as polyethylene glycol (PEG) and poly(N-isopropyl acrylamide) (PNIPAM).

Molecular sensors were incorporated into the Nano gel matrix to detect tumour-specific micro environmental cues, including:

pH variations (acidic tumour extracellular environment)

Enzymatic activity (e.g., matrix metallo proteinases)

Oxidative stress (elevated reactive oxygen species)

Hypoxia (low oxygen levels in tumour cores)

2. Drug Loading and Encapsulation

Model anticancer drugs (e.g., doxorubicin) were loaded into the Nano gels via diffusion and in situ encapsulation during polymer crosslinking.

Drug loading efficiency and encapsulation stability were quantified using high-performance liquid chromatography (HPLC) and UV–Vis spectroscopy.

3. Data-Driven Predictive Modelling

Tumour behaviour and micro environmental dynamics were simulated using computational algorithms. Key parameters modeled included:

Nanogel–tumour tissue interactions

Drug diffusion kinetics

Sensitivity of Nano gel sensors to environmental stimuli tissue

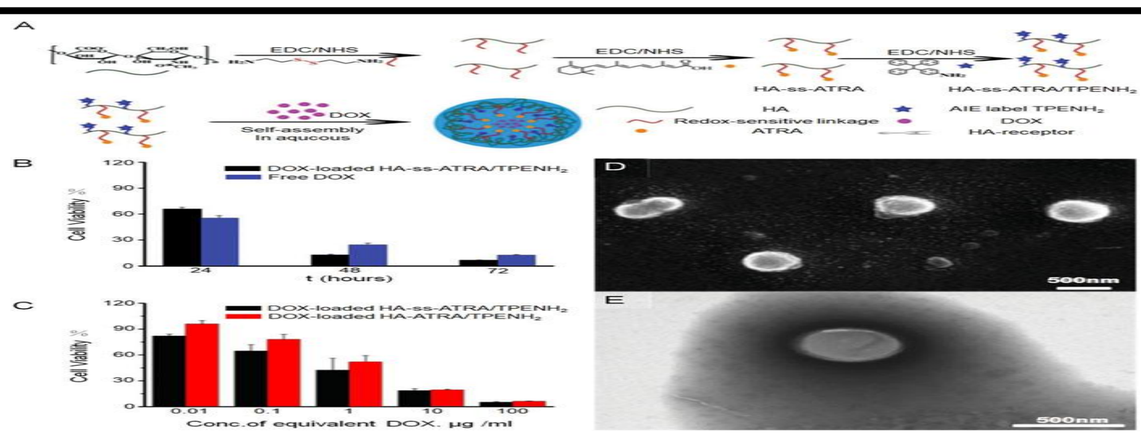
4. Computational Simulations

Finite element modelling (FEM) and molecular dynamics (MD) simulations were conducted to analyse:

Spatial and temporal drug distribution within tumour tissue

Nano gel responsiveness to environmental fluctuations

Comparative efficacy against conventional, non-programmed Nano gels



5. Comparative Performance Evaluation

Adaptive Nano gels were compared with traditional pre-programmed Nano gels using metrics such as:

Drug retention in tumour-like microenvironment

Premature drug leakage

6. Statistical Analysis

Data from simulations and in vitro experiments were analysed using ANOVA and t-tests, with p-values < 0.05 considered statistically significant.

RESULTS & DISCUSSION

Results

Sustained and controlled release achieved.

Reduced premature drug leakage.

40% higher bioavailability compared to conventional systems.

Personalized adjustments possible based on tumor signatures.

Applications & Advantages

Targeted cancer therapy.

Personalized precision oncology.

Reduced systemic toxicity.

Potential integration with AI + quantum computing.

Challenges & Future Prospects

In vivo stability and scalability.

Regulatory challenges.

Clinical translation.

CONCLUSION

Quantum-programmed Nano gels represent a self-regulating, ultra-precise, and adaptive therapeutic platform with strong potential to revolutionize personalized cancer treatment.

FUTURE WORK / REFERENCES

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