Efficient delivery of an anti-cancer drug using gelatin nanoparticles

A Thesis submitted
By

Muhammed Ossama Ali
Bachelor degree of pharmaceutical sciences, 2013, Ain Shams University
Teaching assistant, Department of pharmaceutics and Industrial pharmacy,
The British University in Egypt

For the partial fulfillment of Master Degree in Pharmaceutical sciences (Pharmaceutics)

Under Supervision of:

Prof. Nahed Daoud Mortada
Professor of Pharmaceutics and Industrial pharmacy
Faculty of Pharmacy, Ain Shams University

Prof. Dalia Abd El-Rahman Attia
Professor of pharmaceutics and Industrial pharmacy and HOD
Faculty of Pharmacy, The British University in Egypt

Assoc. Prof. Rania Mohammed Hathout
Associate Professor of Pharmaceutics and Industrial pharmacy
Faculty of Pharmacy, Ain Shams University

Department of Pharmaceutics and Industrial Pharmacy

Faculty of Pharmacy

Ain Shams University

2019

Acknowledgement

First and foremost thanks and praise be given to ***ALLAH****, for helping me to fulfill my thesis and work.*

I would like to express my deep appreciation and sincere gratitude to ***Professor Dr. Nahed Daoud Mortada****, Professor of Pharmaceutics and Industrial pharmacy, Faculty of Pharmacy, Ain Shams University, for her helpful supervision, valuable guidance, kindness, helpfulness and supportive attitude throughout the development of this thesis. Her constructive criticism and suggestions helped me a lot to improve this work through the experimental parts as well as writing and revising the thesis. I am truly blessed to be one of her undergraduate and postgraduate students.*

I would like to offer my sincerest gratitude to Professor ***Dr. Dalia Abd El Rahman Attia****, HOD and Professor of Pharmaceutics and Industrial pharmacy, Faculty of Pharmacy, The British University in Egypt (BUE), for her sincerest support from the starting date till the execution of this work with all the patience, constructive direction and valuable comments in the practical and theoretical parts of this work*

and of more importance her guidance to be a human before being a researcher or a teacher since joining the BUE.

I would especially like to thank ***Dr. Rania Mohammed Hathout****, Associate Professor of Pharmaceutics and Industrial pharmacy, Faculty of Pharmacy, Ain Shams University, who resembles an astonishing role model not only for me but for any scholar and researcher as well. She generously contributed to each part and in every step of this work until this thesis was completed. I will be always speechless when it comes to what I have learnt from her during this scientific journey, supporting me with her knowledge, patience and gratefully her friendship. No words could describe her as a true scientist and more importantly as a true human being.*

I would like to thank ***Dr. Yassmin Attia****, lecturer of pharmacology and toxicology, Faculty of Pharmacy, The British University in Egypt (BUE),* ***Dr. Youmna Hashem****, lecturer of Microbiology and immunology, Faculty of Pharmacy, The British University in Egypt (BUE), as well as* ***Dr. Khaled Nemat-Allah*** *for their great help and effort they offered in this work. They are real sisters, brother and friends.*

I would like to grip the opportunity to offer special thanks to my sister and colleague ***Hend Abd El-Rady****, teaching assistant at the department of Pharmaceutics and Industrial pharmacy, Faculty of Pharmacy, Ain Shams University, for providing me with her fruitful and kind help and support in my work. She gave a living example for sincere friendship and cooperation in a world of competition.*

I also like to thank all members of the ***department of pharmaceutics and industrial pharmacy at BUE*** *and all my colleagues for their contentious support and help.*

My colleagues in ***room 310****, you are not just friends, you are all brothers. Thank you all for supporting me in my professional and personal life.*

Finally I had to give all the credit to ***my mother, father, lovely wife, sister and friends*** *for being around and for your patience and support. You all define my life, you all made what I am today.*

Dedication

I would like to gratefully dedicate this thesis to the soul of our mentor

Professor/ Abd El- Hamid El- Shamy

List of contents

List of Abbreviations

Abbreviation	Meaning
A-546	Human lung cancer cell line
A-GNPs/P188	Poloxamer-coated allicin loaded gelatin nanoparticles
ANOVA	Analysis of variance
API	Active pharmaceutical ingredient
ASGPR	Asialoglycoprotein receptor
cGMP	Current good manufacturing procedures
CLT	Cross-linking time
CNTs	Carbon nanotubes
DDS	Drug delivery system
DLS	Dynamic light scattering
DMSO	Dimethyl sulfoxide
DOD	D-optimal design
DoE	Design of experiment
EDC	1-Ethyl-3-[3-dimethylaminopropyl] carbodiimide hydrochloride
%EE	Entrapment efficiency percentage
EGFR	Epidermal growth factor receptor
EPR	Enhanced permeability and retention
FDA	Food and Drug Administration
G1	First generation
G2	Second generation
G3	Third generation
GA	Glutaraldehyde
GNPs	Gelatin nanoparticles