Production of Bio-Mimetic Nanoparticles for the Detection of Ascorbic Acid

MS Thesis

By

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Master of Science
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by

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It is certified that Nazar Ali, CIIT/SP24-RPH-018/LHR, has carried out all the work related to this thesis under my supervision at the Department of Physics, COMSATS University Islamabad, Lahore campus, and the work fulfils the requirements for the award of the degree of Master of Science in Physics.

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Dedication

TO:

This thesis is devoted to my beloved parents. Their prayers, love and sacrifices have been with me in my studies all the time. I am highly thankful to my supervisors and teachers who have been very helpful and helpful. I also appreciate the colleagues who worked in a team and their useful discussions. My friends gave me a lot of motivation and supported me in some bad days and a special thanks to them. The work is an easy thank you to all the people who assisted, both directly and indirectly, to finalize this work.

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Abstract

Production of Bio-Mimetic Nanoparticles for the Detection of Ascorbic Acid

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An economical, sensitive and new approach based on colorimetric and UV- visible of ascorbic acid (AA) is developed. The mechanism of this method is the oxidation of 3,3',5,5'-Tetramethylbenzidine TMB with the material of the synthesis to create the oxidized TMB of a blue shade (ox-TMB). The ox-TMB is then reduced by the ascorbic acid leading to a decrease in the color intensity which can be both visually and quantitatively determined with the help of a UV Vis scanner. The main experimental parameters of the concentration of materials, TMB concentration, pH and concentration of the analyte were adjusted to improve sensing result. The most favorable conditions were found to be material concentration of 5μM, 0.5μM TMB and an acidic medium with a pH of 3-4. The response had a high reliance on pH indicating a change in color in an acidic conditions and no response at neutral and alkaline conditions (pH 7-11). The UV-vis absorbance at 652 nm under such optimized parameters reduced proportional to the change in AA concentration. High sensitivity was observed in the linear response in the concentration range of 2-5 nM where it had the lowest limit of 1.18 nM detection limit (LOD) and the highest limit of 3.59 nM was the quantification limit (LOQ). The technique proved to be very selective to the AA with minimum signal interference with the normal substances such as dopamine, glucose, cholesterol, urea, uric acid, amino acids, and the metal ions. The feasibility of the sensor was shown by using samples of diluted lemon and orange juice that were able to recover diluted samples of 97.98%-101.11%. To conclude, this has created sensing platform is easy, fast, accurate, and cheap, and therefore can be utilized in ascorbic acid detection in food samples and the future portable sensing platform is achievable.

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List of Abbreviations

Abbreviations	Full Form
TMB	3,3',5,5'-tetramethylbenzidine
AA	Ascorbic Acid
DA	Dopamine
KCl	Potassium Chloride
$Ca(OH)_2$	Calcium Hydroxide
DI	Deionized (water)
Cu- Kα	Copper K-alpha Radiation
FE-SEM	Field Emission Scanning Electron Microscopy
H_2O_2	Hydrogen Peroxide
NaOH	Sodium Hydroxide
$C_6H_{13}MnO_8$	Manganese (III) acetate dihydrate
LOD	Limit of Detection
LOQ	Limit of Quantization
nM	Nanomolar
µM	Micromolar