

TABLE OF CONTENTS

UNDERGRADUATE THESIS	i
RATIFICATION PAGE	ii
STATEMENT PAGE	iii
DEDICATION PAGE	iv
PREFACE	v
TABLE OF CONTENTS	vi
LIST OF FIGURES	viii
LIST OF APPENDICES	ix
ABSTRACT	x
INTISARI	xi
CHAPTER I	1
INTRODUCTION	1
I.1. Background	1
I.2. Research Purposes	4
I.3. Research Benefits	4
CHAPTER II	5
LITERATURE REVIEW AND HYPOTHESIS FORMULATION	5
II.1 Literature Review	5
II.1.1 EPR effect and photoluminescent properties on nanoparticles	5
II.1.2 Cajeput tree twig waste as a biomass waste precursor	6
II.1.3 Carbon dots and its application to cancer cell treatments	7
II.1.4 Chlorophyll and chlorophyll derivatives as photosensitizer	9
II.1.5 Photodynamic therapy	10
II.2 Hypothesis Formulation and Research Design	11
II.2.1 Formulation of hypothesis I	11
II.2.2 Formulation of hypothesis II	12
II.3 Research Design	12
CHAPTER III	14
METHOD	14
III.1 Materials	14
III.2 Equipments	14
III.3.1 Synthesis of carbon dots nanocomposites with chlorophyll before and after hydrolysis	16
III.3.2 Measurement of quantum yield	17
III.3.3 ROS generation activity measurement of carbon dots nanocomposites with chlorophyll before and after hydrolysis	17
CHAPTER IV	19
RESULTS AND DISCUSSION	19

IV.1	Synthesis Temperature Optimization and Stability Assessment of Carbon Dot Nanoparticles	19
IV.1.1	Synthesis temperature optimization of carbon dots	19
IV.1.2	Stability assessment of folic acid-modified carbon dots	20
IV.2	Characterization of Carbon Dots Nanoparticles and Nanocomposites with Chlorophyll and Chlorophyll Derivatives	21
IV.2.1	Photophysical properties of carbon dots	21
IV.2.2	FTIR characterization analysis	25
IV.2.3	Raman spectroscopy characterization analysis	28
IV.2.4	XRD characterization analysis	29
IV.2.5	TEM characterization analysis	30
IV.3	ROS generation activity of carbon dots nanocomposites with chlorophyll before and after hydrolysis	34
CHAPTER V		36
CONCLUSIONS AND SUGGESTIONS		36
V.1.	Conclusions	36
V.2.	Suggestions	36
REFERENCES		37
APPENDICES		43

LIST OF FIGURES

Figure II.1 EPR effect on normal cell and cancer cell (Alasvand <i>et al.</i> , 2017)	5
Figure II.2 Lignin, cellulose and hemicellulose structure (Sankaran <i>et al.</i> , 2021)	7
Figure II.3 Carbon dots classification (Xia <i>et al.</i> , 2019)	8
Figure II.4 Endocytosis mechanism of folic acid-modified carbon dots (Fahmi <i>et al.</i> , 2021)	8
Figure II.5 Chlorophyll and chlorophyllide structure (Petrović <i>et al.</i> , 2014)	10
Figure II.6 Photosensitizer mechanism (Escudero <i>et al.</i> , 2021)	11
Figure IV.1 Fluorescence spectra of (a) CD and (b) FACD variations	20
Figure IV.2 (a) Fluorescence spectra of FACD-100 and (b) fluorescence intensity of FACD-100 at 458 nm	21
Figure IV.3 UV-Vis spectra of carbon dots nanoparticles and nanocomposites	22
Figure IV.4 3D fluorescence spectra of (a) CD-100, (b) FACD-100, (c) FACD-Chl and (d) FACD-Chlide	24
Figure IV.5 3D fluorescence spectra of (a) FACD-Chl, (b) FACD-Chlide, (c) Chl and (d) Chlide	24
Figure IV.6 FTIR spectra of CD-100, FACD-100, FACD-Chl, FACD-Chlide, Cajeput Tree Twig Waste, Folic Acid, Chlorophyll, dan Chlorophyll Derivatives	26
Figure IV.7 FTIR spectra of CD-100, FACD-100, FACD-Chl and FACD-Chlide	27
Figure IV.8 Raman spectra of carbon dots nanoparticles and nanocomposites	28
Figure IV.9 Diffractogram of carbon dots nanoparticles and nanocomposites	29
Figure IV.10 (a) HRTEM of CD-100, (b) EDX spectra of CD-100, (c) HRTEM of FACD-100 and (d) EDX spectra of FACD-100	31
Figure IV.11 (a) Hexagonal carbon lattice, (b) in-plane lattice constant, (c) basal plane lattice and (d) FFT image of hexagonal crystal structure from FACD-100	32
Figure IV.12 TEM of (a) FACD-Chl and (b) FACD-Chlide	33
Figure IV.13. Reaction between DPBF and singlet oxygen (Ercin <i>et al.</i> , 2021)	34
Figure IV.14 ROS generation activity of blank solution, CD-100, FACD-100, FACD-Chl and FACD-Chlide	35

LIST OF APPENDICES

Appendix 1.	FTIR Spectra	43
Appendix 2.	XRD Diffractogram	51
Appendix 3.	HRTEM Images	71
Appendix 4.	Raman Spectra	78
Appendix 5.	QY Calculation	82
Appendix 6.	Particle Size Calculation	83
Appendix 7.	ROS Rate Constant Calculation	85