UTILIZATION OF BIXIN AND IRON(III)-BIXIN COMPLEXES AS SENSITIZER FOR DYE-SENSITIZED SOLAR CELL
(DSSC)
FAUZIN NAIMAH, Dr. Indriana Kartini, M.Si.
Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

TABLE OF CONTENTS

TITLE ..... **i**
APPROVAL PAGE ..... **ii**
STATEMENT ..... **iii**
DEDICATION PAGE ..... **iv**
ACKNOWLEDGEMENT ..... **v**
TABLE OF CONTENTS ..... **vi**
LIST OF FIGURES ..... **viii**
LIST OF TABLES ..... **ix**
LIST OF APPENDICES ..... **x**
ABSTRACT ..... **xi**
INTISARI ..... **xii**
CHAPTER I INTRODUCTION **1**
I.1 Background 1
I.2 Objectives 3
I.3 Advantages 3
CHAPTER II LITERATURE REVIEW AND HYPOTHESIS **4**
II.1 Literature Review 4
II.1.1 Dye sensitized solar cell (DSSC) 4
II.1.2 Natural dye as sensitizer for DSSC 5
II.1.3 Iron complex based sensitizer 8
II.2 Hypothesis Formulation 9
II.3 Experimental Design 10
CHAPTER III EXPERIMENTAL METHOD **11**
III.1 Materials 11
III.2 Tools 11
III.3 Procedures 11
III.3.1 Isolation of bixin from achiote seeds 11
III.3.2 Synthesis of Fe(III)-bixin complexes 12
III.3.3 Photostability Test 13
III.3.4 Dyes sensitization on TiO_2 13
III.3.5 Characterization method 14
a. UV-Visible Spectrophotometry 14
b. Fourier Transform Infrared Spectroscopy 14
c. Atomic Absorption Spectrocopy (AAS) 14
d. I-V meter 15
CHAPTER IV RESULT AND DISCUSSION **16**
IV.1 Bixin Isolation 16
IV.2 The Formation of Iron(III)-bixin Complexes 20
IV.2.1 Observation of the complexes formation per treatment by UV-Visible spectrophotometry wavelength scanning 21
IV.2.2 Determination of the complexes structure 23
IV.3 Photostability Study of Iron(III)-bixin 28

UNIVERSITAS
GADJAH MADA
UTILIZATION OF BIXIN AND IRON(III)-BIXIN COMPLEXES AS SENSITIZER FOR DYE-SENSITIZED SOLAR CELL (DSSC)
FAUZIN NAIMAH, Dr. Indriana Kartini, M.Si.
Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

IV.4 Sensitization and Cell Performance of Iron(III)-bixin 30
CHAPTER V CONCLUSION AND OUTLOOK 37
V.1 Conclusion 37
V.2 Outlook 37
REFERENCES 38
APPENDICES 41

UTILIZATION OF BIXIN AND IRON(III)-BIXIN COMPLEXES AS SENSITIZER FOR DYE-SENSITIZED SOLAR CELL
(DSSC)
FAUZIN NAIMAH, Dr. Indriana Kartini, M.Si.
Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

LIST OF FIGURES

Figure II.1 A schematic overview of DSSC (a) and the simple energy level diagram for DSSC (b) (Hagfeldt, 2010; Nkurunziza, 2014) 4
Figure II.2 Structure of norbixin (Gomez *et al*., 2010)..... 7
Figure II.3 Structure of Bixin (Gomez *et al*., 2010) 7
Figure IV.1 The TLC results for eluate no. 28 and no. 48 in ethyl acetate:acetone 1:1 eluent 18
Figure IV.2 UV-Visible spectra of achiote crude extract (a) and purified extract using column chromatography (b) in ethanol 18
Figure IV.3 FTIR spectra of purified achiote extract from column chromatography (a) and crude achiote extract (b) 20
Figure IV.4 UV–Visible scanning spectra of the complexes per treatment at mole ratio 1:1 (a); 1:2 (a); and 1:3 (c) Fe(III):bixin..... 22
Figure IV.5 UV-Vis spectra of Fe(III)-bixin complexes after filtration and washing treatment 23
Figure IV.6 FTIR spectra results for 1:1 (a); 1:2 (b); 1:3 (c) Fe(III):bixin 26
Figure IV.7 Proposed structure for 1:1 iron(III):bixin ([Fe(bixin)(H2O)3(NO3)2](NO3)•nH_2O..... 27
Figure IV.8 Absorbance of Fe(III)-bixin complexes at mole ratio 1:1 (a), 1:2 (b), 1:3 (c), and bixin (d) under exposure of visible light for 3 h..... 28
Figure IV.9 UV-Vis spectra of time stability observation of the complexes 1:1 (a); 1:2 (b); 1:3 (c) Fe(III):bixin..... 29
Figure IV.10 UV-Visible spectra of the dye solution in sensitization with TiO_2 1:1 (a); 1:2 (b); 1:3 (c); bixin (d); N719 (e). The inset shows a photo of TiO_2-dyes sistem after adsorption 31
Figure IV.11 FTIR spectra of TiO_2-1:1 Fe(III):bixin (a), TiO_2-1:1 Fe(III):bixin (b), TiO_2-1:1 Fe(III):bixin (c), bixin (d), N719 (e), and TiO_2 (f)..... 32
Figure IV.12 Specular reflectance UV-Visible Spectra of TiO_2 (a); 1:1 Fe(III)-bixin-TiO_2 (b); 1:2 Fe(III)-bixin-TiO_2; (c) 1:3 Fe(III)-bixin-TiO_2; (d) bixin-TiO_2; N719-TiO_2..... 33
Figure IV.13 I-V curve of N179 (a); bixin (b); 1:1 (c); 1:2 (d), 1:3 Fe(III):bixin (e) cell 34
Figure IV.14 I-V curve of the Fe(III):bixin complexes at mole ratio 1:1, 1:2, 1:3 34

UNIVERSITAS
GADJAH MADA
UTILIZATION OF BIXIN AND IRON(III)-BIXIN COMPLEXES AS SENSITIZER FOR DYE-SENSITIZED SOLAR CELL (DSSC)
FAUZIN NAIMAH, Dr. Indriana Kartini, M.Si.
Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

LIST OF TABLES

Table III.1 Preparation of Fe(III)-bixin at various mole ratio 12
Table IV.1 Result of the major fraction obtained from column chromatography by TLC analysis 17
Table IV.2 Electronic properties of Fe(III)-bixin complexes..... 23
Table IV.3 Molar conductivity of the standard solution (1 x 10^{-3} M) and Fe(III)-bixin complexes 24
Table IV.4 The proposed iron(III)-bixin formula..... 25
Table IV.5 Photovoltaic characteristic of the dyes from I-V Keithley analysis. 35
Table IV.6 Efficiency and molar extinction coefficient of solar cell 35

UNIVERSITAS
GADJAH MADA
UTILIZATION OF BIXIN AND IRON(III)-BIXIN COMPLEXES AS SENSITIZER FOR DYE-SENSITIZED SOLAR CELL (DSSC)
FAUZIN NAIMAH, Dr. Indriana Kartini, M.Si.
Universitas Gadjah Mada, 2016 | Diunduh dari http://etd.repository.ugm.ac.id/

LIST OF APPENDICES

Appendix 1 Column chromatography eluates and TLC analysis results 41
Appendix 2 Determination of counter ion 42
Appendix 3 FFe Content - Theoretical and Experimental Calculation 43
Appendix 4 Calculation molar extinction coefficient and the complexes 46
Appendix 5 FTIR spectra 48
Appendix 6 SR-UV raw data..... 60
Appendix 7 I-V curve raw data 65