

**APPLICATION OF MIXED IRON OXIDES NANOPARTICLE-
ENHANCED COLORIMETRIC ASSAY FOR THE
DETECTION OF SOME ORGANOPHOSPHATE
PESTICIDES**

ALOIS MATHEW NGONYANI

**MASTER OF SCIENCE
IN ENVIRONMENTAL SCIENCE**

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright© by Chiang Mai University
All rights reserved

**GRADUATE SCHOOL
CHIANG MAI UNIVERSITY
DECEMBER 2016**

**APPLICATION OF MIXED IRON OXIDES NANOPARTICLE-
ENHANCED COLORIMETRIC ASSAY FOR THE
DETECTION OF SOME ORGANOPHOSPHATE
PESTICIDES**

ALOIS MATHEW NGONYANI

**A THESIS SUBMITTED TO CHIANG MAI UNIVERSITY IN PARTIAL
FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE
IN ENVIRONMENTAL SCIENCE**

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright© by Chiang Mai University
All rights reserved

**GRADUATE SCHOOL, CHIANG MAI UNIVERSITY
DECEMBER 2016**

**APPLICATION OF MIXED IRON OXIDES NANOPARTICLE-
ENHANCED COLORIMETRIC ASSAY FOR THE
DETECTION OF SOME ORGANOPHOSPHATE
PESTICIDES**

ALOIS MATHEW NGONYANI

THIS THESIS HAS BEEN APPROVED TO BE A PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE
IN ENVIRONMENTAL SCIENCE

Examination Committee:

Prasak Chairman
(Assoc. Prof. Dr. Prasak Thavornytikarn)

Pitchaya Member
(Asst. Prof. Dr. Pitchaya Mungkornasawakul)

S. Wangkarn Member
(Asst. Prof. Dr. Sunanta Wangkarn)

Chumni Member
(Asst. Prof. Dr. Chumni Sangphagdee)

Advisory Committee:

Pitchaya Advisor
(Asst. Prof. Dr. Pitchaya Mungkornasawakul)

S. Wangkarn Co-advisor
(Asst. Prof. Dr. Sunanta Wangkarn)

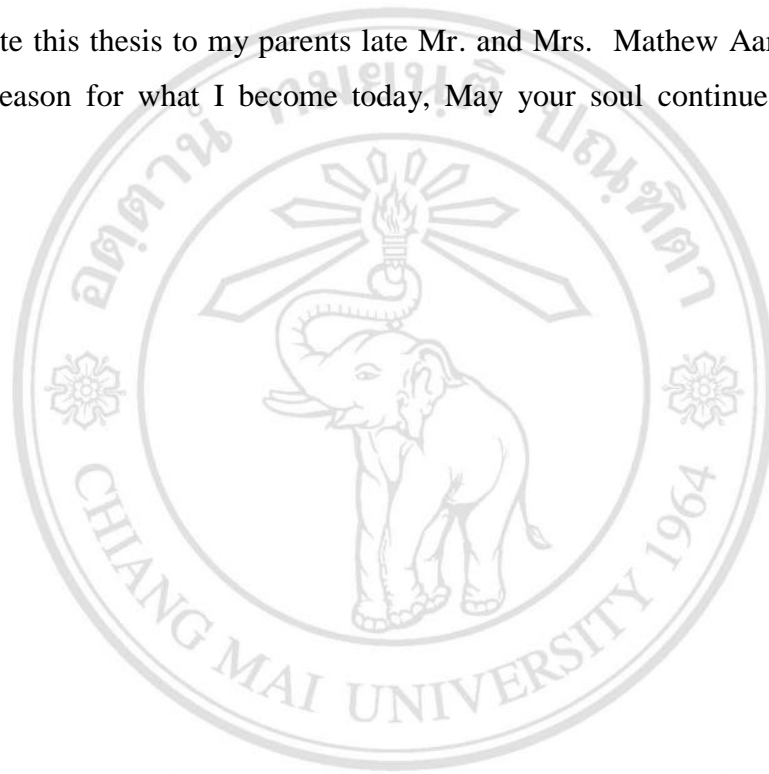
Kontad Co-advisor
(Asst. Prof. Dr. Kontad Uunnunkad)

23 December 2016

Copyright © by Chiang Mai University

DEDICATION

I dedicate this thesis to my parents late Mr. and Mrs. Mathew Aaron Ngonyani, you are the reason for what I become today, May your soul continue resting in an eternal peace.



ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright© by Chiang Mai University
All rights reserved

ACKNOWLEDGEMENTS

I would like to express my special thanks and gratitude to my supervisor, Asst. Prof. Dr. Pitchaya Mungkornasawakul, her dedication, desire and commitment of seeing her student successful had been of great contribution towards completion of this thesis. Her sensible and intellectual advice, expert guidance, exhaustive scrutiny, moral and material support has been instrumental towards completion of this research. Without her guidance, encouragement and tireless support this research would not have been possible.

A debt of gratitude is also owed to my Co-advisors Asst. Prof. Dr. Kontad Ounnunkad and Asst. Prof. Dr. Sunanta Wangkarn, their valuable and timely suggestions, guidance, encouragement and constructive ideas has been vital towards completion of this thesis.

I genuinely thank Asst. Prof. Dr. Somporn Chantara, Chairman of the Environmental Science Program, for her precious guidance, encouragement, moral and material support at various stages of my studies.

I would like to extend my thanks to the Royal Thailand Government through Thailand International Cooperation Agency (TICA) for their financial support and the Government of the United Republic of Tanzania for allowing me to take part into this course.

I also acknowledge with many thanks kind help, support and cooperation I have received from my fellow laboratory members (Pang, Lin, Mali, Nut and Tip), throughout my research period.

I would like to thank my family, friends and relatives for their love and support which had helped me surviving all the pressure during my studies.

Alois Ngonyani