

**ENZYMES IN STARCH DEGRADING SYSTEM  
AND LACTIC ACID PRODUCTION**

**BY *Lactobacillus* sp. S21**

**APINUN KANPIENGJAI**

**DOCTOR OF PHILOSOPHY**

**IN BIOTECHNOLOGY**

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**GRADUATE SCHOOL  
CHIANG MAI UNIVERSITY**

**NOVEMBER 2013**

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The seal of Chiang Mai University is a circular emblem. It features an elephant in the center, facing left, with a traditional Thai umbrella (parasol) above its head. The text "มหาวิทยาลัยเชียงใหม่" (Mahavithayalai Chiang Mai) is written in Thai script around the top inner edge, and "CHIANG MAI UNIVERSITY 1964" is written in English around the bottom inner edge. There are decorative floral motifs on the sides.

**APINUN KANPIENGJAI**

**A THESIS SUBMITTED TO CHIANG MAI UNIVERSITY IN  
PARTIAL FULFILLMENT OF THE REQUIREMENTS  
FOR THE DEGREE OF  
DOCTOR OF PHILOSOPHY  
IN BIOTECHNOLOGY**

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NOVEMBER 2013**

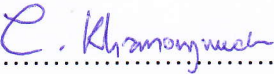
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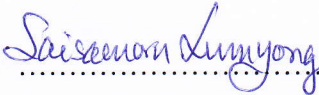
APINUN KANPIENGJAI


THIS THESIS HAS BEEN APPROVED TO BE A PARTIAL FULFILLMENT OF  
THE REQUIREMENTS FOR THE DEGREE OF  
DOCTOR OF PHILOSOPHY  
IN BIOTECHNOLOGY


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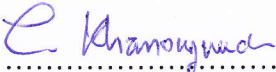
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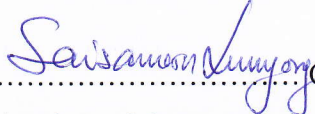
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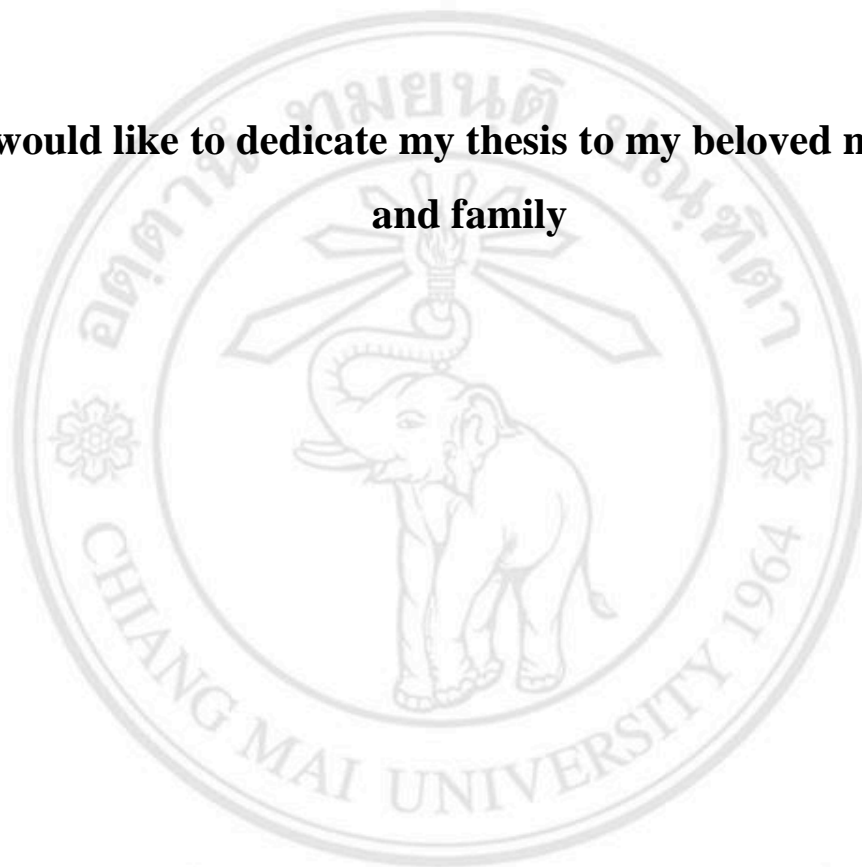
 ..... Co-advisor  
(Prof. Dr. Saisamorn Lumyong)

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(Dr. Wasu Pathom-aree)

27 November 2013

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**I would like to dedicate my thesis to my beloved mother  
and family**



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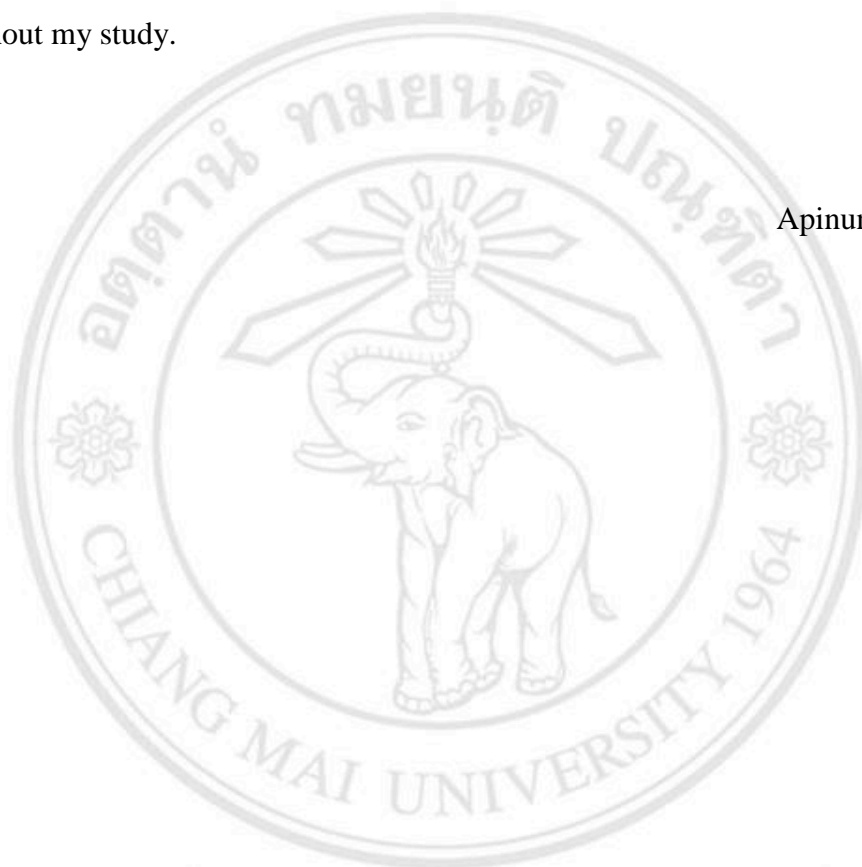
My thanks are also given to Petra Wuehrer for her kind help during gene cloning, expression and enzyme purification. I would like to extend my thanks to technicians and my laboratory members at Food Biotechnology laboratory, Instituted of Food Technology, University of Natural Resource and Life Science, Austria for their helps offering me and particularly for their best friendships.

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