



**UNIVERSITI PUTRA MALAYSIA**

***IMPROVING THE NUTRITIVE VALUE OF RICE BRAN BY FUNGAL  
AND EXTRUSION TREATMENTS***

**LIM YI CHIN**

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EXTRUSION TREATMENTS**



LIM YI CHIN

DEPARTMENT OF BIOCHEMISTRY

FACULTY OF BIOTECHNOLOGY AND BIOMOLECULAR SCIENCES

UNIVERSITI PUTRA MALAYSIA

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**IMPROVING THE NUTRITIVE VALUE OF RICE BRAN BY FUNGAL AND  
EXTRUSION TREATMENTS**

By

LIM YI CHIN

161401

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Faculty of Biotechnology and Biomolecular Sciences,

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## PENGESAHAN

Dengan ini adalah disahkan bahawa thesis yang bertajuk '**Improving the Nutritive Value of Rice Bran by Fungal and Extrusion Treatments**' telah siap serta dikemukakan kepada Jabatan Biokimia oleh **Lim Yi Chin (161401)** sebagai memenuhi syarat kursus BCH 4999 Project.

Disahkan oleh

.....  
(Prof. Dr. Norhani Abdullah)

Penyelia Project,

Jabatan Biokimia,

Fakulti Bioteknologi dan Sains Biomolekul

Universiti Putra Malaysia.

Tarikh: .....

.....  
(Prof. Dato' Dr. Abu Bakar Salleh)

Ketua Penyelia,

Jabatan Biokimia

Fakulti Bioteknologi dan Sains Biomolekul,

Universiti Putra Malaysia.

Tarikh: .....

## ABSTRACT

One of the limitations of the growth of poultry industry in Malaysia is the high cost of feed. Rice bran, a by-product from the rice milling process, could be used as a raw feed ingredient of poultry at a higher inclusion rate. Although rice bran is a cheaper feed material, it requires treatments to improve the nutritive value as to fulfill the nutritional requirement of poultry. Poultry demands for relative higher level of soluble protein and reducing sugar. While the dietary fibre of feed for poultry should be kept at low level due to the lack of fibre digestive enzymes in poultry. This study was performed to improve the nutritive value of rice bran by fungal and extrusion treatments. Solid state fermentation (SSF) was conducted by using *Rhizopus oligosporus*, while the extrusion was performed by utilization of twin screw extruder. The fermentation conditions were optimized by Response Surface Methodology (RSM) with central composite design (CCD) method. Manipulated fermentation conditions were the moisture (A), incubation duration (B), incubation temperature (C) and inoculum density (D). The optimal SSF conditions obtained were 100 ml for A, 2.5 days for B, 35 °C for C and  $1 \times 10^6$  spores/ml for D. The responses measured for fermented rice bran and extruded rice bran were 4.26 mg/g and 2.31 mg/g for soluble protein (SP), 11.29 mg/g and 3.97 mg/g for reducing sugar (RS), 10.9 % and 6.7 % for crude fibre (CF), 31.5 % and 21.1 % for neutral detergent fibre (NDF) respectively. The SP, RS, CF and NDF values for untreated rice bran were 2.24 mg/g, 6.35 mg/g, 7.3 % and 27.9 % respectively. Study showed that fermentation and extrusion were the approaches to improve the nutritive value of rice bran.

## ABSTRAK

Salah satu batasan dalam pertumbuhan industri penternakan ayam di Malaysia adalah kos yang tinggi bagi makanan ayam. Bran beras, produk sampingan daripada proses pengilangan beras, berpotensi untuk digunakan sebagai bahan mentah sebatian pemakanan ayam. Walaupun bran beras adalah bahan makanan yang murah, ia memerlukan rawatan untuk meningkatkan nilai pemakanan bagi menyesuaikan keperluan pemakanan ayam. Keperluan ayam untuk protein dan gula adalah lebih tinggi, manakala serat makanan perlu dikurangkan kepada tahap yang lebih rendah kerana ayam tidak mempunyai enzim untuk mencernakan serat. Kajian ini telah dijalankan untuk meningkatkan nilai pemakanan bran beras melalui rawatan kulat dan penyemperitan. Fermentasi keadaan pepejal (SSF) telah dijalankan dengan menggunakan *Rhizopus oligosporus*, manakala penyemperitan dilakukan oleh penggunaan penyemperit skru berkembar. Keadaan fermentasi telah dioptimumkan dengan kaedah permukaan respon (RSM) dengan kaedah reka bentuk komposit pusat (CCD). Keadaan fermentasi yang dimanipulasi ialah kelembapan (A), tempoh inkubasi (B), suhu inkubasi (C) dan densiti inokulum (D). Keadaan SSF optimum diperolehi ialah 100 ml bagi A, 2.5 hari untuk B, 35 °C untuk C, dan  $1 \times 10^6$  spora/ml untuk D. Respon diukur untuk bran beras yang telah difermentasi dan bran beras tersemerit masing-masing adalah 4.26 mg/g dan 2.31 mg/g untuk protein (SP), 11.29 mg/g dan 3.97 mg/g untuk gula (RS), 10.9 % dan 6.7 % untuk serat mentah (CF), 31.5 % dan 21.1 % bagi serat detergen neutral (NDF). Nilai SP, RS, CF dan NDF masing-masing bagi bran beras tanpa rawatan ialah 2.24 mg/g, 6.35mg/g, 7.3 % dan 27.9 %. Kajian menunjukkan bahawa fermentasi dan penyemperitan adalah pendekatan untuk meningkatkan nilai pemakanan bran beras.

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## LIST OF ABBREVIATIONS

CCD	Central Composite Design
CF	Crude fibre
CP	Crude protein
DM	Dry matter
DNS	3,5-dinitrosalicylic acid
EDTA	Ethylenediaminetetraacetate
g	Gram
H <sub>2</sub> SO <sub>4</sub>	Sulphuric acid
kg	kilogram
KH <sub>2</sub> PO <sub>4</sub>	Monopotassium phosphate
ml	millilitre
μl	microlitre
mg	milligram
M	Molar
MgSO <sub>4</sub> .7H <sub>2</sub> O	Magnesium sulfate heptahydrate
NaOH	Sodium hydroxide
NDF	Neutral detergent fibre
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	Ammonium sulfate
PDA	Potato dextrose agar
PKC	Palm kernel cake
rpm	revolutions per minute
RB	Rice bran
RS	Reducing sugar
RSM	Response Surface Methodology
SD	Standard deviation
SDS	Sodium dodecyl sulphate
SmF	Submerged fermentation
SP	Soluble protein
SSF	Solid state fermentation
°C	Degree celcius

# CHAPTERS I

## INTRODUCTION

In Malaysia, the growing of human population demands for higher quantity of protein sources in diet, including poultry, beef, lamb and soybean-derived products. The poultry industry is the most important livestock sector due to preference of the population (Jayaraman *et al.*, 2013). The production of poultry meat and its products has increased in terms of the quantity. To become more cost-effective, the scientists and farmers have developed and implemented various methods to improve the quantity and quality of poultry by adopting good practices in feed formulation and farming conditions.

The limiting factor to the expansion of poultry industry is the cost of the feed ingredients (Ng, 2004). At present, poultry production relies heavily on imported feeds such as soybean and corn. The cost of feeds will influence the production costs, which affects the market price and consumers (Rittgers and Wahab, 2014). Utilisation of locally available feed ingredients are necessary to maintain poultry production. As such, agricultural by products like rice bran, palm kernel cake and sago waste should be considered.

The criteria for the development of alternative poultry feed ingredients are the price, nutritional value and availability of raw material. Rice bran is a by-product of rice milling industry in Malaysia and it is a potential substitute of poultry feed. Rice bran has been used in ruminant feed as the price is cheaper and its high nutritional values. Besides, the availability of the rice bran is constant in Malaysia, a paddy planting country.

However, rice bran consists of high level of neutral detergent fibre (20 to 30 %, Sauvant *et al.*, 2004), which is not suitable for poultry as it does not have digestive system to break down fibre. Besides, rancidity of rice bran is often encountered as the

presence of high moisture and fat content. Thus, additional treatments to rice bran are essential to improve the nutritive values before being use as poultry feed.

Fungal fermentation treatment is one of the biological methods to alter the chemical compositions of rice bran. Besides, physical treatment such as extrusion cooking could be implemented to improve the nutritive values of rice bran.

### **1.1 Problem Statements**

The high level of fibre in rice bran limits the utilization of rice bran in poultry diet. Hence appropriate biological and physical treatments of rice bran should be investigated to improve the nutritive value of rice bran. The optimal conditions for fungal fermentation of rice bran have not been well studied and require further investigations. Furthermore, the effects of both extrusion and fungal treatments of rice bran have not been evaluated.

### **1.2 Hypothesis**

By fungal fermentation and extrusion treatments, the nutritive value of rice bran could be improved.

### **1.3 Objectives of Study**

The main objective of the study was to improve the nutritive value of rice bran by fungal fermentation and extrusion. The specific objectives were:

1. To optimize the fermentation conditions of the rice bran by Response Surface Methodology (RSM).
2. To evaluate the effects of extrusion and fungal treatments on the nutritive value of rice bran.

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