



**UNIVERSITI PUTRA MALAYSIA**

***EFFECTS OF GROUND CANDLENUT (*Aleurites moluccana* (L.) Willd.)  
KERNEL ON GROWTH PERFORMANCE AND FATTY ACID  
COMPOSITION IN BROILER CHICKENS***

**ROHAIDA BINTI ABDUL RASID @ ABDUL RASHID**

**FP 2014 30**



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**ROHAIDA BINTI ABDUL RASID @ ABDUL  
RASHID**

**MASTER OF SCIENCE  
UNIVERSITI PUTRA MALAYSIA**

**2014**



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**By**

**ROHAIDA BINTI ABDUL RASID @ ABDUL RASHID**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,  
in Fulfilment of the Requirements for the Master of Science**

**January 2014**

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## DEDICATION

I dedicate this thesis to my beloved mum, without you none of my success would be possible.



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the Master of Science

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COMPOSITION IN BROILER CHICKENS**

By

**ROHAIDA BINTI ABDUL RASID @ ABDUL RASHID**

**January 2014**

**Chairman: Prof. Abd. Razak bin Alimon, PhD**

**Faculty: Agriculture**

Candlenut (*Aleurites moluccana*) is a spice commonly used in cooking especially in Indian and Asian recipes. The kernel contain more than 40% oil which is used for industrial purposes especially in paints or as drying oils. The candlenut kernel oil contains high amounts of alpha linolenic fatty acid and linoleic acid, unfortunately, it also contain anti-nutritional factors such as phorbol and saponin. Therefore, it application in animal nutrition especially poultry is limited. The objective of this study was to examine if candlenut kernel can be a source of polyunsaturated fatty acids for poultry and to identify methods of heating to reduce the anti-nutritional factors in the kernel.

Three experiments were conducted to determine the effects of ground candlenut (*Aleurites moluccana*) kernel supplementation on growth performance and fatty acid composition in broiler chickens. In the first experiment, the candlenut kernels were ground to 2 - 3 mm particles and the proximate composition of the kernels was determined. The dry matter, ash, crude fibre, crude protein, ether extract and nitrogen free extract were 94.39%, 1.02%, 4.71%, 23.56%, 65.88% and 4.83%, respectively, whilst gross energy was 32.05 MJ/kg. The oil fraction contained 41.6% linoleic acid, 29.5% linolenic acid, 21.6% oleic acid, 4.86% palmitic acid and 2.42% stearic acid. Only 7.74% (fresh weight basis) saponin was detected as anti-nutritional component whilst hydrogen cyanide and phorbol esters were not detected. The total contents of phenol and antioxidants were 127.6 mg/100g and 212.9 mg/100g, respectively. The results indicated that candlenut kernels may be a source of omega-3 fatty acids for broiler chickens and that dietary supplementation may enrich the fatty acids contents

in the meat of chickens. Hence, the second experiment was conducted to examine the effect of ground candlenut kernel as a dietary source of omega-3 fatty acids on the growth performance and fatty acid contents in the meat of broiler chickens.

A total of 280 male broiler 21-day old chicks (Cobb 500) were used in an experiment to determine the effects of varying levels of ground candlenut kernel supplementation (0, 0.5, 1.0 and 2.0%) in broiler diet on growth performance and carcass characteristics of broiler chickens at grower-finisher stage. In this experiment, supplemented 2% of ground candlenut kernel in broiler diet had significantly ( $p < 0.05$ ) higher final body weight and body weight gain than in control and other levels. Higher mortality rate (8%) in the treatment group (2.0% ground candlenut kernel) could be due to the presence of anti-nutritional factor (saponin). Hence, supplementation of 2% ground candlenut kernel may be producing a better performance if the toxicity could be eliminated or reduced.

The last experiment was conducted to determine the effects of heat treated ground candlenut kernel supplementation in broiler diet on growth performance, carcass yield, nutrient digestibility, and fatty acid profiles in meat at grower-finisher stage. A total of 270 male broiler chicks 21 days old (Cobb 500) were divided into six groups and fed diet containing 2% ground candlenut kernel which been heat treated by (a) dry heating, (b) roasting (c) boiling and (d) autoclaving. The group on control diet were given feed without ground candlenut kernel, while the negative control is the diet supplemented with untreated ground candlenut kernel. Although growth performance, carcass yield, nutrient digestibility and fatty acid profiles in meat were significantly ( $p < 0.05$ ) influenced by heat treatment the differences were small. Based on the results, heat treatment by autoclaving showed the best performance amongst the treatments.

In conclusion, supplementation of ground candlenut kernel heat-treated by autoclaving in broiler diet showed improved broiler performance and increased fatty acid composition especially omega-3 fatty acids in the meat.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia  
sebagai memenuhi keperluan untuk Ijazah Sarjana Sains

**KESAN MIL ISIRUNG BUAH KERAS (*Aleurites moluccana* (L.) Willd.)  
KEATAS PRESTASI PERTUMBUHAN DAN KOMPOSISI ASID LEMAK  
DALAM AYAM PEDAGING**

Oleh

**ROHAIDA BINTI ABDUL RASID @ ABDUL RASHID**

**Januari 2014**

**Pengerusi: Prof. Abd. Razak bin Alimon, PhD**

**Fakulti: Pertanian**

Buah keras (*Aleurites moluccana*) adalah sejenis rempah yang sering digunakan dalam resipi masakan India dan Asia. Isirung buah keras ini mengandungi lebih dari 40% minyak yang digunakan untuk tujuan industri seperti dalam cat dan minyak pengering. Minyak isirung buah keras mengandungi kadar alfa-linolenik dan linolik asid yang tinggi, tetapi ia juga mengandungi faktor anti-pemakanan seperti phorbol dan saponin. Oleh itu kegunaannya dalam pemakanan ayam amat terhad. Tujuan kajian ini adalah untuk menentukan samada isirung buah keras boleh menjadi sumber asid lemak tak tepu untuk ayam dan juga untuk mengenalpasti kaedah pemanasan yang sesuai untuk mengurangkan faktor anti-pemakanan.

Tiga eksperimen telah dijalankan untuk menentukan kesan tambahan mil isirung buah keras keatas prestasi pertumbuhan dan kandungan asid lemak dalam ayam pedaging. Dalam ujian pertama mil buah keras dikisar 2 – 3 sm saiz dan komposisi proksimat ditentukan. Kandungan bahan kering, abu, serabut kasar, protein kasar, ekstrak eter dan ekstrak bebas nitrogen adalah masing-masing 94.39%, 1.02%, 4.71%, 23.56%, 65.88% dan 4.83%, manakala tenaga kasar adalah 32.05 MJ/kg. Bahagian minyak mengandungi 41.6% asid linolik, 29.5% asid linolenik, 21.6% asid oleik, 4.86% asid palmitik, dan 2.42% asid stearik. Hanya 7.74% (berat basah) saponin dapat dikesan sebagai komponen anti-pemakanan, manakala hidrogen sianida dan phorbol tidak dapat dikesan. Jumlah kandungan phenol dan anti-oksidaan adalah masing-masing 127.6 mg/100g dan 212.9 mg/100g. Keputusan ini menunjukkan yang isirung buah keras boleh menjadi sumber asid lemak omega-3 untuk ayam pedaging dan

suplementasi dalam makanan boleh meningkatkan kandungan asid lemak ini dalam daging ayam. Oleh itu, eksperimen kedua telah dijalankan untuk menentukan kesan mil isirung buah keras sebagai sumber asid lemak omega-3 keatas prestasi pertumbuhan dan kandungan asid lemak dalam daging ayam.

Sejumlah 280 ekor anak ayam pedaging berumur 21 hari (Cobb 500) telah digunakan dalam satu eksperimen untuk menentukan kesan beberapa tahap mil buah keras (0, 0.5, 1.0 dan 2.0%) dalam diet ayam pedaging keatas prestasi pertumbuhan dan ciri-ciri karkas ayam pedaging pada peringkat pembesaran-penamat. Dalam eksperimen ini suplementasi mil isirung buah keras pada aras 2% menunjukkan berat badan dan peningkatan berat badan lebih tinggi dibandingkan dengan 'control' dan aras lain. Aras kematian yang agak tinggi (8%) dalam kumpulan ini (2%) mungkin disebabkan kandungan anti-pemakanan (saponin) yang tinggi. Oleh itu suplementasi pada aras 2% mil buah keras mungkin memberi prestasi yang baik jika ketoksikan dapat dikurangkan.

Eksperimen yang terakhir telah dijalankan untuk menentukan kesan suplementasi isirung buah keras yang dirawat keatas prestasi pertumbuhan, hasil karkas, kebolehcernaan nutrien, profil asid lemak haba dalam daging ayam pedaging. Sejumlah 270 ekor ayam pedaging jantan berumur 21 hari (Cobb 500) telah dibahagikan kepada enam kumpulan dan diberi makan diet mengandungi 2% mil isirung buah keras yang telah dirawat haba dengan (a) pemanasan kering, (b) pemanas ketuhar, (c) didih dalam air dan (d) otoklaving. Kumpulan 'control' telah diberi diet tanpa mil buah keras, manakala 'control negative' adalah diet yang mengandungi mil buah keras tanpa dirawat. Walaupun prestasi pertumbuhan, hasil karkas, kebolehcernaan nutrien dan profil asid lemak dipengaruhi ( $p < 0.05$ ) oleh rawatan haba perbezaan yang didapati adalah kecil. Berasaskan keputusan, rawatan haba dengan otoklav menunjukkan prestasi yang lebih baik dari rawatan yang lain.

Adalah dirumuskan, suplementasi dengan mil buah keras dirawat haba secara otoklav dalam diet ayam pedaging menunjukkan peningkatan prestasi ayam pedaging dan juga peningkatan asid lemak, lebih-lebih lagi asid lemak omega-3.

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Finally, big thanks to my beloved family for their moral support, encouragement, love and understanding.

I certify that a Thesis Examination Committee has met on 20 January 2014 to conduct the final examination of Rohaida binti Abdul Rasid @ Abdul Rashid on her thesis entitled “Effects of Ground Candlenut (*Aleurites moluccana* (L.) Willd.) Kernel on Growth Performance and Fatty Acid Composition in Broiler Chickens” in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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Signature: _____	Signature: _____
Name of Chairman of Supervisory Committee: _____	Name of Member of Supervisory Committee: _____



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## LIST OF ABBREVIATIONS

ADL	Adrenoleukodystrophy
AFP	Abdominal fat pad
AICPR	All India Coordinated Research project on utilization of Agricultural by-products
ALA	Alpha linoleic acid
ANF	Anti-nutritional factor
ANOVA	Analysis of Variance
AOAC	Association of Official Analytical Chemists
BD	Brand of Falcon tube
BHA	Butylated hydroxyanisole
BHT	Butylated hydroxytoluene
CDGS	Corn distillers dried grains with soluble
CLA	Conjugated Linoleic Acid
CP	Crude Protein
CRD	Completely Randomized Design
DHA	Docosahexaenoic acid
DM	Dry matter
DMB	Dry matter basis
dmb	dry matter basis
DMRT	Duncan's Multiple Range Test
DNA	Deoxyribonucleic acid
DPPH	2,2-diphenyl-1-picrylhydrazyl
EER	Energy efficiency ratio
EFA	Essential fatty acid

EPA	Eicosapentaenoic acid
EOLSS	Encyclopedia of Life Support Systems
FAME	Fatty acid methyl esters
FA	Fatty acids
FCR	Feed Conversion Ratio
FDA	Food and Drug Administration
FID	Flame Ionization Detector
FLKS	Fatty Liver Kidney Syndrome
FLS	Fatty Liver Syndrome
FO	Fish oil
FS	Flaxseed
GAE	Gallid Acid Equivalent
GB	Great Britain
GC	Gas Chromatography
GE	Gross energy
GIT	Gastrointestinal tract
GLM	General linear model
GRAS	Generally Recognized as Safe
HCN	Hydrogen cyanide
HIV	Human immunodeficiency virus
HPLC	High Performance Liquid Chromatography
IKA	Brand of instrument
<i>J.</i>	<i>Jatropha</i>
<i>L.</i>	<i>Linn</i>
LA	Linoleic acid

LCFA	Long chain fatty acid
LCPUFA	Long chain polyunsaturated fatty acid
LDL	Low-density lipoprotein
LNA	Linolenic acid
MCFA	Medium chain fatty acids
ME	Metabolizable energy
MRT	Mean retention time
MUFA	Monounsaturated fatty acid
<i>n</i> -3	Omega-3
<i>n</i> -6	Omega-6
NDNS	National Diet and Nutrition Survey
NFE	Nitrogen Free Extract
NRC	National Research Council
PC	Personal computer
PER	Protein efficiency ratio
PKC	Protein kinase C
PNG	Papua New Guinea
PUFA	Polyunsaturated fatty acid
RNA	Ribonucleic acid
SAS	Statistical Analysis System
SCFA	Short chain fatty acid
SE	Standard error
SFA	Saturated fatty acid
SFE	Supercritical Fluid Extraction
Sp.	Species



USFA	Unsaturated fatty acid
VLCFA	Very long chain fatty acid
Wt	Weight
W/V	Weight / volume
Y.	Yucca



# CHAPTER 1

## INTRODUCTION

Omega-3 (*n*-3) and omega-6 (*n*-6) fatty acids are essential fatty acids (EFA) required in animal and human nutrition because of its beneficial effects on health (Von Schacky, 2000; Harris and Isley, 2001; Surai and Sparks, 2001; Woods and Fearon, 2009). Warren (2006) noted that omega-3 and omega-6 exhibit greatest biological activity in both animal and human bodies. Animal and human are not able to synthesize the EFAs, whereby they must be provided through the diet (Cunnane *et al.*, 1995).

Modification of poultry diets by supplementing fatty acids in the form of fish oil, fish meal and plants such as linseed, canola oil, camelina, and chiaseed had been proven to enrich the fatty acid profile in meat and eggs (Beynen, 2004; Wongsuthavas *et al.*, 2007; Carrillo *et al.*, 2008). Inclusion of these fatty acid enriched at different dietary levels had been shown to increase growth performance and nutrient digestibility, reduce the amount of abdominal fat in broilers, and improve fertility and immune system (Villaverde *et al.*, 2005; Azcona *et al.*, 2007; Woods and Fearon, 2009; Mridula *et al.*, 2011).

*Aleurites moluccana* species which produce the candlenut is an another oilseed crop of the Euphorbiaceae family. This nut is known to contain high proportions of unsaturated fatty acids such as omega-3 (alpha linolenic acid), omega-6 (linoleic acid) and omega-9 (oleic acid) (Duke, 1983; Morton, 1992; Ako *et al.*, 2005; Martin *et al.*, 2010). Contain high levels of *n*-3 fatty acid, and may be considered as an alternative for *n*-3 fatty acid source in poultry nutrition.

Unfortunately, the use of candlenut seed in animal diet had been reported by Duke (1983) to be toxic to the animals. This could be due to the presence of the main anti-nutritional factors such as phorbol and saponin in candlenut (Duke, 1983). It was also noted that pytoxin and saponin are principal poisons in candlenut (Covacevich *et al.*, 1987). However, some varieties, such as the one found in Vanuatu (Maewo), have no apparent toxic effect (Walter and Sam, 2002). There have been reports that heat treatments can eliminate or reduce this toxicity (Makkar *et al.*, 1998; Osman, 2007; Nwosu *et al.*, 2010).

The use of candlenut is mainly focused in skin care products and cooking. Not much information is available on its usage in poultry, especially regarding these fatty acids in broiler diet. Therefore it is hypothesized that modification of animal diet by including of candlenut containing high omega-3 fatty acids in the diet would improve the performance of broiler chicken and enhanced the fatty acid profile of meat. Thus, the specific objectives of this study were as follows:

- i. to determine the nutrient and anti-nutrient profiles of raw grounds in the candlenut
- ii. to determine the effects of varying levels of candlenut supplementation in the diet on growth performance and carcass yield in broiler chickens
- iii. to determine the effects of various types of heat treatments on the chemical composition of candlenut, and their effects on growth performance, carcass yield, nutrient digestibility and fatty acid composition in meat of broiler chickens



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