



**UNIVERSITI PUTRA MALAYSIA**

**STUDIES ON THE IMPROVEMENT OF THE NUTRITIVE VALUE AND  
UTILIZATION OF PALM KERNEL CAKE AS A FEED  
RESOURCE FOR RUMINANTS**

**CHARURAT CHINAJARIYAWONG**

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By

**CHARURAT CHINAJARIYAWONG**

**Thesis Submitted in Fulfillment of the Requirements for the Degree of  
Doctor of Philosophy in the Institute of Bioscience  
Universiti Putra Malaysia**

**March 2000**



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in fulfilment of the requirements for the Degree of Doctor of Philosophy

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**Faculty : Institute of Bioscience**

Utilization of palm kernel cake (PKC) as the principal feed for ruminants was investigated in four studies. The study on the nutritive value showed that PKC-solvent extracted (PKC-S) and PKC-expeller pressed (PKC-E) contained similar amounts of OM, CP, CF and ADL. PKC-E had higher DM, EE and GE but lower NFE, NDF, ADF and shell contents. Amounts of Ca, P, Cu and Zn were similar in both types of PKC, but Na was higher and Mg was lower in PKC-S. Ruminal pH, NH<sub>3</sub>-N concentration, molar proportions of VFA and passage rates of liquid and small digesta particles in cattle fed either PKC-S or PKC-E were similar. Total VFA concentration was higher in cattle fed PKC-S. Effective DM and OM degradabilities were lower in animals fed PKC-S, but degradation

rates were similar. PKC-E contained more soluble fractions than PKC-S. CP of PKC-S was more soluble, but its effective degradability and degradation rate were similar to that of PKC-E.

The study on the effects of formaldehyde treatments on CP degradability of both types of PKC showed that CP degradability decreased with increasing levels of formaldehyde. Acid-pepsin digestibility showed no difference in CP digestibility among untreated and formaldehyde-treated PKC up to 2.5g/100g CP.

The study on the effects of PKC and formaldehyde treatment on the performance and nutrient utilization of cattle showed that feed intake was lower in cattle fed PKC-E, but growth rates and feed per gain ratios did not differ from those fed PKC-S. Formaldehyde-treated (2g/100g CP) PKC gave poorer growth rates and feed conversion ratios when compared to untreated PKC. Types of PKC and formaldehyde treatment did not affect the nutrient digestibility, but PKC-E gave lower N retention. Formaldehyde had no effect on N retention.

In the final study, lambs fed PKC + 15% grass showed improvement in intakes and growth rates. Urea at either 0.5 or 1.0%, had no effect on feed intakes and feed conversion ratios. However, growth rates of lambs fed PKC + 0.5% urea were higher compared to other groups. Lambs fed PKC plus 15% grass and 0.5% urea had the highest intake and growth rate. Carcass traits were not affected by urea but grass supplementation reduced dressing percent and kidney fat of lambs.

Abastrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

**KAJIAN KE ATAS PENINGKATAN PEMAKANAN DAN PENGGUNAAN  
MEAL ISIRONG KELAPA SAWIT SEBAGAI SUMBER MAKANAN UNTUK  
RUMINAN**

Oleh

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**MAC 2000**

**Pengerusi: Profesor Tan Sri Dato' Syed Jalaludin Syed Salim, PhD**

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Kajian penggunaan meal isirong kelapa sawit (PKC) sebagai komponen utama ruminan telah dijalankan. Dari kajian nilai pemakanan menunjukkan nilai pemakanan 'PKC-solvent extracted' (PKC-S) dan 'PKC-expeller extracted' (PKC-E) mengandungi kandungan OM, CP, CF and ADL yang sama. PKC-E mengandungi jumlah DM, EE dan GE yang tinggi tetapi NFE, NDF, ADF dan kandungan tempurung yang rendah. Jumlah Ca, P, Cu dan Zn pada kedua-dua jenis PKC adalah sama tetapi amau Na lebih tinggi dan Mg lebih rendah pada PKC-S. Nilai pH rumen, kepekatan NH<sub>3</sub>-N, peratus molar VFA, kadar pengaliran bendalir dan partikel halus pada lembu yang diberi makan PKC-S dan PKC-E adalah sama. Jumlah kepekatan VFA lebih tinggi pada lembu yang diberi PKC-S. Degradasi efektif DM dan OM lebih rendah pada haiwan yang diberi PKC-S tetapi kadar degradasi sama. PKC-E mempunyai nilai fraksi larut yang lebih tinggi dari PKC-S. CP PKC-S adalah lebih larut daripada PKC-E tetapi degradasi efektif dan kadar degradasi kedua-dua PKC adalah sama.

Kajian kesan formaldehid ke atas kadar degradasi CP bagi PKC-S dan PKC-E menunjukkan degradasi CP menurun dengan peningkatan tahap formaldehid. Penghadaman asid-pepsin menunjukkan tiada perbezaan pada penghadaman CP di antara PKC yang tidak dirawat dan PKC yang dirawat dengan formaldehid hingga 2.5g/100g CP.

Dalam kajian kesan PKC dan rawatan formaldehid ke atas prestasi dan pengambilan makanan pada lembu menunjukkan kadar pengambilan makanan yang rendah pada lembu yang diberi PKC-E tetapi kadar pertumbuhan dan nisbah makanan pertumbuhan tidak berbeza daripada lembu yang diberi PKC-S. Lembu yang diberi makan PKC yang dirawat formaldehid pada tahap 2g/100g CP menunjukkan kadar pertumbuhan dan nisbah penukaran makanan yang merosot dibandingkan dengan lembu yang diberi PKC tanpa rawatan. Jenis PKC dan rawatan formaldehid tidak memberi kesan ke atas penghadaman nutrien tetapi lembu yang diberi PKC-E menunjukkan retensi nitrogen yang rendah. Rawatan formaldehid tidak memberi kesan terhadap retensi nitrogen.

Kajian terakhir menunjukkan peningkatan pengambilan makanan dan kadar pertumbuhan anak bebiri yang diberi PKC dan 15% rumput. Urea pada tahap 0.5 atau 1.0% tidak memberi kesan terhadap pengambilan makanan dan nisbah pertukaran makanan. Walaubagaimana pun, kadar pertumbuhan anak bebiri yang diberi PKC dan 0.5% urea lebih tinggi dibandingkan dengan dengan kumpulan yang lain. Anak bebiri yang diberi makan PKC serta 15% rumput dan 0.5% urea menunjukkan pengambilan makanan dan pertumbuhan yang tinggi. Ciri karkas tidak terjejas dengan penambahan urea tetapi penambahan rumput mengurangkan peratusan berat bersih dan lemak ginjal anak bebiri.

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## TABLE OF CONTENTS

	<b>Page</b>	
<b>ABSTRACT .....</b>	ii	
<b>ABSTRAK .....</b>	iv	
<b>ACKNOWLEDGEMENTS.....</b>	vi	
<b>APPROVAL SHEETS.....</b>	viii	
<b>DECLARATION FORM.....</b>	x	
<b>TABLE OF CONTENTS.....</b>	xi	
<b>LIST OF TABLES.....</b>	xv	
<b>LIST OF FIGURES.....</b>	xx	
<b>LIST OF ABBREVIATIONS.....</b>	xxii	
 <b>CHAPTER</b>		
I	INTRODUCTION .....	1
II	LITERATURE REVIEW .....	4
	Palm Oil Industry in Malaysia .....	4
	Process of Palm Oil Extraction .....	4
	Palm Oil By-Products as Animal Feed	
	Materials .....	7
	Nutritive Value of Palm Kernel Cake .....	8
	Performance of Ruminants Fed PKC or PKC-Based	
	Diets .....	19
	Diary Cattle .....	19
	Beef Cattle .....	20
	Buffaloes .....	23
	Goats and Sheep .....	24
	Dietary Protein Degradation .....	25
	Strategies for Feeding Ruminants .....	26

	Page	
	<b>Fermentable Nitrogen Supplementation and Utilization .....</b>	<b>27</b>
	<b>Methods of Dietary Protein Protection .....</b>	<b>28</b>
	Heat Treatment .....	29
	Formaldehyde Treatment .....	30
	<b>Animals Response to Protected Proteins .....</b>	<b>32</b>
	Intake and Nutrient Utilization .....	32
	Growth .....	33
	Milk Production and Quality .....	35
III	<b>NUTRITIVE VALUE OF PALM KERNEL CAKE</b>	<b>37</b>
	<b>Introduction .....</b>	<b>37</b>
	<b>Materials and Methods .....</b>	<b>38</b>
	Chemical Compositions, Gross Energy and Shell Content .....	38
	Rumen Fluid Characteristics .....	42
	Passage Rates of Liquid and Small Particles from the Rumen .....	44
	<i>In Situ</i> Degradation of PKC .....	51
	<b>Results .....</b>	<b>54</b>
	Chemical Compositions, Gross Energy and Shell Content .....	54
	Rumen Fluid Characteristics .....	56
	Passage Rates of Liquid and Small Particles from the Rumen .....	68
	<i>In Situ</i> Degradation of PKC .....	72
	<b>Discussion .....</b>	<b>78</b>
IV	<b>EFFECTS OF FORMALDEHYDE TREATMENT ON PROTEIN DEGRADABILITY OF PALM KERNEL CAKE .....</b>	<b>94</b>
	<b>Introduction .....</b>	<b>94</b>
	<b>Materials and Methods .....</b>	<b>96</b>
	Experiment 1 -The Effect of Formaldehyde Treatment Times on CP Degradation of PKC ...	96
	Experiment 2 -The Effect of Formaldehyde Concentrations on CP Degradability of PKC ...	99
	<b>Results .....</b>	<b>103</b>
	Effects of Formaldehyde Treatment Times on CP Degradation of PKC .....	103

	Page
V	Effects of Formaldehyde Concentrations on CP Degradability of PKC ..... 107
	Discussion ..... 120
VI	<b>PERFORMANCE OF BEEF CATTLE FED FORMALDEHYDE TREATED PALM KERNEL CAKE</b> ..... 124
	Introduction ..... 124
	Materials and Methods ..... 125
	Experiment 1 -Feeding Trial ..... 126
	Experiment 2 -Digestibility Trial ..... 128
	Results ..... 131
	Effects of Types of PKC and Formaldehyde Treatment on Dry Matter Intake, Growth Rate and Feed Conversion Ratio in Cattle ..... 131
	Effects of Types of PKC and Formaldehyde Treatment on Efficiency of Feed Utilization ..... 138
	Discussion ..... 146
	<b>EFFECTS OF SUPPLEMENTING PKC-BASED DIETS WITH GRASS AND UREA ON THE PERFORMANCE AND CARCASS CHARACTERISTICS OF LAMBS</b> ..... 155
	Introduction ..... 155
	Materials and Methods ..... 157
	Animals and their Management ..... 157
	Experimental Design ..... 158
	Diets and Feeding Methods ..... 159
	Measurement and Sampling Methods ..... 159
	Slaughter and Cutting Procedures ..... 161
	Analytical Methods ..... 162
	Statistical Analyses ..... 163
	Results ..... 163
	Chemical Composition of Dietary Components
	Feed Intake, Growth Rate and Feed Conversion
	Ratio of Lambs Fed PKC Supplemented with
	Grass and Urea ..... 164
	Effects of Grass and Urea Supplementation on
	Efficiency of Dietary Utilization ..... 171
	Carcass Characteristics ..... 188
	Discussion ..... 193

	Page
VII                   GENERAL DISCUSSION AND CONCLUSIONS..	205
BIBLIOGRAPHY .....	215
APPENDIX .....	243
BIOGRAPHICAL VITA .....	245

## LIST OF TABLES

Table No.		Page
1	Nutrient Compositions of Palm Kernel Cake (Based on Dry Matter) .....	9
2	Amino Acid Compositions of Palm Kernel Cake (g amino acid/16 g N) .....	11
3	Apparent Digestibility Coefficients, Digestible Energy and Metabolizable Energy of Palm Kernel Cake in the Ruminants..	13
4	Mineral Compositions of Palm Kernel Cake (Based on Dry Matter).....	17
5	Comparisons of Chemical Compositions, Gross Energy, Shell Content and Mineral Contents between PKC-Solvent Extract (PKC-S) and Expeller Pressed (PKC-E) .....	55
6	The Mean Values of Ruminal pH, Ammonia-N and Volatile Fatty Acids for Cattle Fed PKC-S and PKC-E .....	58
7	Water Intake, Fluid Rate Constant, Rumen Fluid Volume, Fluid Outflow Rate and Mean Retention Time (MRT) in Cattle Fed PKC-S or PKC-E .....	70
8	Dry Matter Intake (DMI), Water Intake (WI), Passage Rate Constants, Total Retention Time, Rumen Retention Time, Lower Tract Retention Time, and Transit Time of Small Particles from Rectal Sampling in Cattle Fed PKC .....	72
9	Degradation Parameters of Dry Matter (DM), Organic Matter (OM) and Crude Protein (CP) of PKC-S and PKC-E .....	77
10	Percentage of Protein Degradation of PKC-S and PKC-E Untreated and Treated with Formaldehyde at Various Treatment Times after 24 h Incubation in the Rumen of Cattle.	104

	Page
11 Percentage Protein Degradation of PKC-S and PKC-E Treated with Formaldehyde after 24 h Incubation in the Rumen of Cattle Fed PKC .....	105
12 Apparent Protective Effect of Formaldehyde on Protein in PKC-S and PKC-E (Percent Protection after Being Incubated in Rumen of Cattle for 24 h) .....	107
13 Percentage of CP Remaining in PKC-S and PKC-E after 36 h <i>In Situ</i> Incubation at Different Formaldehyde Levels .....	111
14 Degradation Rate and Effective Protein Degradability Estimates of Formaldehyde-Treated and Untreated PKC-S ....	113
15 Degradation Rate and Effective Protein Degradability Estimates of Formaldehyde-Treated and Untreated PKC-E ....	114
16 Relationship of Formaldehyde Treatment at Various Concentrations and By-pass Protein in PKC-S and PKC-E ....	116
17 Apparent Protective Effect of Formaldehyde on Protein in PKC-S and PKC-E .....	119
18 Effects of Formaldehyde Treatment on Protein Digestibility of PKC-S and PKC-E Estimated from <i>In Vitro</i> Pepsin Digestion (%) .....	120
19 Compositions of Diets .....	127
20 Effects of Dietary Treatment on Dry Matter Intake (DMI), Growth Rate and Feed Conversion Ratio of Cattle .....	134
21 Effects of PKC-S and PKC-E on Dry Matter Intake (DMI), Growth Rate and Feed Conversion Ratio of Cattle .....	136
22 Effects of Formaldehyde Treatment on Dry Matter Intake (DMI). Growth Rate and Feed Conversion Ratio of Cattle ....	137

	Page
23 Comparative Voluntary Feed Intake (VFI) and Apparent Digestibility Coefficient of Nutrients of Cattle Fed PKC-S and PKC-E Untreated and Treated with Formaldehyde	139
24 Comparative Voluntary Feed Intake (VFI) and Apparent Digestibility Coefficient of Nutrients of Cattle Fed PKC-S and PKC-E	140
25 Effects of Formaldehyde Treatment on Voluntary Feed Intake (VFI) and Apparent Digestibility Coefficient of Nutrient of Cattle	141
26 Mean Values of Gross Energy (GE), Apparent Digestibility of Gross Energy (DGE) and Total Digestible Nutrient (TDN) of Cattle Fed PKC-S and PKC-E Untreated and Treated with Formaldehyde	143
27 Mean Values of Nitrogen Retention and Nitrogen Balance of Cattle Fed PKC-S and PKC-E Untreated and Treated with Formaldehyde	145
28 Amino Acid Compositions of Rumen Microbial Protein (Bacterial and Protozoal Protein) and PKC Protein (g amino acid/16 g N)	152
29 Compositions of the Dietary Treatments	160
30 Effects of Grass Supplementation on Feed Intake, Growth Rate and Feed Conversion Ratio of Lambs Fed PKC-Based Diets	167
31 Effects of Urea Supplementation on Feed Intake, Growth Rate and Feed Conversion Ratio of Lambs Fed PKC-Based Diets	168
32 Mean Values for Initial Liveweight, Final Liveweight, Feed Intake, Growth Rate and Feed Conversion Ratio of Lambs Fed PKC Supplemented with Grass and Urea	170

	Page
33 Effects of Grass Supplementation on Intakes of Dry Matter (DM), Organic Matter (OM), Ether Extract (EE), Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) and their Digestibilities in Lambs Fed PKC-Based Diets	172
34 Effects of Urea Supplementation on Intakes of Dry Matter (DM), Organic Matter (OM), Ether Extract (EE), Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) and their Digestibilities in Lambs Fed PKC-Based Diets	173
35 Mean Values of Intakes of Dry Matter (DM), Organic Matter(OM), Ether Extract (EE), Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) and their Digestibilities in Lambs Fed PKC Supplemented with Grass and Urea	174
36 Mean Values of Gross Energy (GE) Intake, Apparent Digestibility of GE (DGE) and Digestible Energy (DE) in Lambs Fed PKC Supplemented with Grass and Urea	177
37 Main Effects of Grass Supplementation on Nitrogen Intake (NI) and Utilization in Lambs Fed PKC-Based Diets	179
38 Main Effects of Urea Supplementation on Nitrogen Intake (NI) and Utilization in Lambs Fed PKC-Based Diets	181
39 Mean Values of Nitrogen Intake (NI) and Utilization in Lambs Fed PKC Supplemented with Grass and Urea	183
40 Effects of Grass Supplementation on Rumen pH, Concentrations and Molar Proportions of Volatile Fatty Acids (VFA) in Lambs Fed PKC-Based Diets	185
41 Effects of Urea Supplementation on Rumen pH, Concentrations and Molar Proportions of Volatile Fatty Acids (VFA) in Lambs Fed PKC-Based Diets	186

	Page
42      Mean Values for Concentrations and Molar Proportions of Volatile Fatty Acids (VFA) in Lambs Fed PKC Supplemented with Grass and Urea .....	187
43      Effects of Slaughter Weight, Grass Supplementation and Urea Supplementation on Dressing Percent, Ribeye Area and Backfat Thickness in Lambs Fed PKC-Based Diets .....	189
44      Mean Values for Dressing Percent Ribeye Area and Backfat Thickness of Lambs .....	191
45      Effects of Slaughter Weight, Grass Supplementation and Urea Supplementation on Wholesale Cuts of Lambs Fed PKC-Based Diets .....	192
46      Mean Values for Wholesale Cuts of Lambs .....	194

## LIST OF FIGURES

Figure No.		Page
1	A Breakdown of Output Percent from Palm Oil Production ...	6
2	Ruminal pH in Cattle Fed PKC-S and PKC-E .....	57
3	Ruminal NH <sub>3</sub> -N in Cattle Fed PKC-S and PKC-E .....	60
4	Total Rumen VFA Concentration of Cattle Fed PKC-S and PKC-E .....	61
5	Molar Percent of Acetate in the Rumen of Cattle Fed PKC-S and PKC-E .....	63
6	Molar Percent of Propionate in the Rumen of Cattle Fed PKC-S and PKC-E .....	64
7	Molar Percent of Butyrate in the Rumen of Cattle Fed PKC-S and PKC-E .....	65
8	Molar Percent of Other VFAs (Isobutyrate + Isovalerate + Valerate) in the Rumen of Cattle Fed PKC-S and PKC-E ...	67
9	Dilution Curve for Co in Rumen Fluid of Cattle Fed PKC-S and PKC-E .....	69
10	Build-up Curve for Cr from Rectal Samples of Cattle Fed PKC-S and PKC-E .....	71
11	Dry Matter Disappearance from PKC-S and PKC-E at Various Incubation Times in the Rumen of Cattle Fed PKC ...	73
12	Organic Matter Disappearance from PKC-S and PKC-E at Various Incubation Times in the Rumen of Cattle Fed PKC ...	74
13	Crude Protein Disappearance from PKC-S and PKC-E at Various Incubation Times in the Rumen of Cattle Fed PKC ...	75

	Page	
14	Effect of Formaldehyde Levels on Protein Disappearance from PKC-S at Various Incubation Times in the Rumen of Cattle .....	108
15	Effect of Formaldehyde Levels on Protein Disappearance from PKC-E at Various Incubation Times in the Rumen of Cattle .....	109
16	By-pass Protein in PKC and Formaldehyde Levels .....	117
17	Dry Matter Intake of Cattle Fed PKC-S and PKC-E Untreated and Treated with Formaldehyde at Various Times of the Experimental Period .....	132
18	Liveweight of Cattle Fed PKC-S and PKC-E Untreated and Treated with Formaldehyde at Various Times of the Experimental Period .....	133
19	Dry Matter Intake of Lambs Fed PKC Supplemented with Grass and Urea at Various Times of the Experimental Period	165
20	Mean Liveweight of Lambs Fed PKC Supplemented with Grass and Urea at Various Times of the Experimental Period	166
21	Break Down of Lamb Carcass .....	243
22	Bone Structure of Lamb Carcass .....	244

## **LIST OF ABBREVIATIONS**

ADF	- Acid detergent fibre
ADL	- Acid detergent lignin
AOAC	- Association Official Agricultural Chemists
ARC	- Agricultural Research Council
CF	- Crude fibre
CP	- Crude protein
DE	- Digestible energy
DGE	- Apparent digestibility of gross energy
DM	- Dry matter
DMI	- Dry matter intake
DMRT	- Duncan's multiple range test
DNI	- Digestible nitrogen intake
DOMI	- Digestible organic matter intake
EDTA	- Ethylenediamine tetraacetic acid
EE	- Ether extract
G	- Grass supplementation
GE	- Gross energy
HCHO	- Formaldehyde
ME	- Metabolisable energy

MRT	- Mean retention time
NDF	- Neutral detergent fibre
NFE	- Nitrogen free extract
NI	- Nitrogen intake
NRC	- National Research Council
OM	- Organic matter
PKC	- Palm kernel cake
PKC-E	- Palm kernel cake-expeller press
PKC-S	- Palm kernel cake-solvent extraction
POME	- Palm oil mill effluent
PPF	- Palm press fibre
SAS	- Statistical Analysis System
TCA	- Trichloroacetic acid
TDN	- Total digestible nutrient
TMRT	- Total mean retention time
TPKC-E	- Formaldehyde treated palm kernel cake-expeller press
TPKC-S	- Formaldehyde treated palm kernel cake-solvent extraction
TT	- Transit time
U	- Urea supplementation