



UNIVERSITI PUTRA MALAYSIA

**EFFECTS OF ENZYME-TREATED PALM KERNEL EXPELLER ON
ITS NUTRITIVE VALUE, AND GROWTH PERFORMANCE
AND CARCASS QUALITY OF BROILER CHICKENS**

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NUTRITIVE VALUE, AND GROWTH PERFORMANCE AND CARCASS
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By

PORNPAN SAENPHOOM

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfillment of the Requirements for the Degree of Doctor of Philosophy**

May 2012

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May 2012

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Palm kernel expeller (PKE) contains high fiber which is mainly in the form of highly non-digestible mannan-hemicellulose. Pre-treating PKE with exogenous enzymes to hydrolyze the insoluble oligosaccharides is an option to enhance the efficiency of the utilization of this agro-industrial byproduct by monogastric animals such as the poultry. The primary objectives of this thesis were to examine the effect of enzyme treatment on the nutritive value of PKE and the effect of feeding the enzyme treated PKE on growth performance and carcass quality in broiler chickens. Three experiments were conducted to achieve the above objectives. The effect of enzyme treatment on chemical composition and production of reducing sugars in PKE was evaluated. Results showed that enzyme treatment decreased ($P<0.05$) hemicelluloses and cellulose contents by 35.70 and 22.14%, respectively, and increased ($P<0.05$) the content of reducing sugars by about 36 folds. Extract of enzyme treated PKE had significantly higher ($P<0.05$) mannanase and cellulase enzymes than those in the raw PKE.

Effects of the enzyme treatment on apparent (AME) and true (TME) metabolizable energy of PKE in broiler chickens were estimated in experiment 2. Chickens were assigned to three experimental diets: raw PKE, enzyme treated PKE and corn (as control). The results showed that although enzyme treatment increased AME and nitrogen corrected AME (AME_n) by 4.0 and 4.4%, respectively, compared to the raw PKE, the values were not statistically different. However, enzyme treatment increased ($P < 0.05$) TME (7.55 MJ/kg) and its nitrogen corrected value (TME_n; 6.54 MJ/kg) values by 37.6 and 33.0%, respectively, compared to the raw PKE (4.71 and 4.38 MJ/kg, respectively).

In experiment 3, the effects of inclusion of enzyme treated PKE on growth performance [during grower (21 days) and finisher (41 days) stages], intestinal villus height, digesta viscosity and carcass quality in broiler chickens were investigated. Commercial broiler chickens (Cobb 500) were fed with a commercial starter diet followed by combinations of three experimental grower diets (0% raw PKE, 5% raw PKE and 5% enzyme treated PKE) and five finisher diets (0% raw PKE, 20% raw PKE, 20% enzyme treated PKE, 30% raw PKE and 30% enzyme treated PKE). Average daily gain (ADG), feed intake and feed conversion ratio (FCR) of chickens fed on different dietary treatments in the grower period were not significantly different. Although there was no difference in feed intake ($P > 0.05$) among treatment groups in the finisher period, ADG of chickens in the control (PKE-free diet) was significantly higher ($P < 0.05$) than in all treatment groups fed either 20 or 30% PKE and irrespective of with or without enzyme treatment. However, ADG of birds fed with 20% PKE was higher than those fed with 30% PKE. The FCR of chickens in the control was the lowest (2.20) but not significantly different

from those fed 20% PKE diets while birds in the 30% PKE diets recorded higher ($P>0.05$) FCR. The above results suggested that inclusion of up to 5% PKE (enzyme treated or untreated) in the grower diet did not affect the growth performance of broiler chickens and to avoid any negative effect on the overall, the maximum inclusion rate of PKE is 20% in finisher broiler diet.

Dressing percentage and weight of cuts of commercial value (wing, breast meat and thigh-drumstick) as percentage of carcass weight were not significantly different among treatments ($P>0.05$). Among the internal organs, weight of gizzard in chicken fed PKE diets, particularly in the 30% inclusion level was higher ($P<0.05$) than the PKE-free control diet. The shear force value, indicating the degree of tenderness of meat for the control was higher ($P<0.05$) than the corresponding values fed diets supplemented with PKE. In general, color of meat, measured using lightness (L^*) and redness (a^*) values did not differ between the control and treatment groups ($P>0.05$) except the yellowness (b^*) value of meat in birds fed 30% PKE inclusion rate treatment was higher than those in the control and 20% PKE diets.

The intestinal villus height and crypt depth (duodenum, jejunum and ileum) were not different ($P>0.05$) among treatments except for duodenum crypt depth. However, the villus height and crypt depth of birds in enzyme treated PKE diets were higher ($P<0.05$) than those in the raw PKE groups. Viscosity of the intestinal digesta was not different ($P>0.05$) among treatments. Apparent digestibility of dry matter (DM), organic matter (OM) and energy of chickens in the PKE-free control diet were significantly higher

($P < 0.05$) than all treatment groups with PKE, irrespective of inclusion level and enzyme treatment except for apparent digestibility of crude protein and crude fiber.

Results of this thesis suggest that exogenous enzyme (consisted mainly cellulase and mannanase) is effective in hydrolyzing the fiber (hemicellulose and cellulose) component and improved the ME values of PKE. However, the positive effects were not reflected in the growth performance in broiler chickens fed the enzyme treated PKE compared to those raw PKE. The results suggest that PKE can be included up to 5% in the grower diet and 20% in the finisher diet without any significant negative effect on FCR in broiler chickens.

Abstract tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**KESAN RAWATAN ENZIM TERHADAP NILAI NUTRISI ISIRONG KELAPA
SAWIT, DAN PRESTASI PERTUMBUHAN DAN KUALITI KARKAS BAGI
AYAM DAGING**

Oleh

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Isirong kelapa sawit (PKE) mengandungi kandungan serat yang tinggi, terutamanya dalam bentuk mannan-hemisellulosa yang tidak dapat dihadam. Pra-rawatan PKE dengan enzim luaran untuk mengdegradasi oligosakarida tidak larut, merupakan salah satu cara untuk meningkatkan kecekapan penggunaan hasil sampingan industri pertanian ini dalam haiwan monogastrik seperti unggas. Objektif utama tesis ini adalah untuk mengkaji kesan rawatan enzim pada nilai nutrisi PKE, dan kesan pemberian PKE yang dirawat dengan enzim pada prestasi pertumbuhan dan kualiti karkas ayam daging. Tiga percubaan telah dilaksanakan untuk mencapai objektif ini. Kesan rawatan enzim pada komposisi kimia dan kandungan gula dalam PKE telah dinilai. Hasil kajian menunjukkan bahawa rawatan enzim dapat mengurangkan ($P < 0.05$) kandungan hemisellulosa dan selulosa sebanyak 34.70 dan 22.14% masing-

masing. Ia juga meningkatkan ($P < 0.05$) kandungan lebih kurang 36 kali ganda. Ekstrak PKE yang dirawat enzim mempunyai jauh lebih tinggi ($P < 0.05$) enzim mannanase dan sellulase daripada PKE mentah.

Kesan rawatan enzim terhadap tenaga AME dan TME isirong kelapa sawit dalam ayam daging juga telah dianggarkan dalam eksperimen 2. Ayam dibahagikan kepada tiga kumpulan diet eksperimen: PKE mentah, PKE yang dirawat oleh enzim, dan jagung (sebagai kawalan). Hasil kajian menunjukkan bahawa walaupun rawatan menggunakan enzim meningkatkan AME dan AME_n sebanyak 4.0 dan 4.4%, masing-masing, berbanding dengan PKE mentah, nilai ini tidak berbeza dari segi statistik. Walau bagaimanapun, rawatan oleh enzim meningkatkan ($P < 0.05$) TME (7.55 MJ/kg) dan TME_n (6.54 MJ/kg) sebanyak 37.6 dan 33.0%, masing-masing, berbanding dengan PKE mentah (4.71 dan 4.38 MJ/kg, masing-masing).

Dalam eksperimen 3, kesan penambahan PKE yang dirawat oleh enzim ke atas prestasi pertumbuhan semasa peringkat pertumbuhan (21 hari) dan penamatan (41 hari), ketinggian vilus, kelikatan digesta dan kualiti karkas ayam daging telah dikaji. Ayam daging komersial (Cobb 500) telah diberi makan dengan diet pemulaan komersil diikuti oleh tiga eksperimen makanan seimbang (0% PKE mentah, 5% PKE mentah dan 5% PKE yang telah dirawat oleh enzim) dan lima makanan seimbang penamatan (0% PKE mentah, 20% PKE mentah, 20% PKE yang dirawat oleh enzim, 30% PKE mentah dan 30% PKE yang dirawat enzim). ADG, pengambilan makanan dan FCR ayam yang diberi rawatan makanan seimbang yang berlainan dalam tempoh penamatan tidak berbeza secara ketara. Walaupun tidak terdapat perbezaan

dalam pengambilan makanan ($P>0.05$) antara kumpulan rawatan dalam tempoh pengahiran, ADG ayam dalam kumpulan kawalan (makanan seimbang tanpa PKE) adalah lebih tinggi ($P<0.05$) daripada semua kumpulan diet sama ada 20 atau 30% PKE, dengan atau tanpa rawatan enzim. Walau bagaimanapun, ADG burung dalam kumpulan makanan seimbang 20% PKE adalah lebih tinggi daripada burung dalam kumpulan makanan seimbang 30% PKE. FCR bagi kumpulan kawalan adalah yang paling rendah (2.20) tetapi tidak berbeza ketara berbanding makanan seimbang PKE 20%, manakala burung dalam makanan seimbang 30% PKE mencatatkan FCR yang lebih tinggi ($P>0.05$). Hasil kajian di atas menunjukkan bahawa penambahan sehingga 5% PKE (dirawat atau tidak dirawat oleh enzim) dalam makanan seimbang penamatan tidak menjejaskan prestasi pertumbuhan ayam daging dan untuk mengelakkan sebarang kesan negatif secara keseluruhan, kadar penambahan maksimum PKE adalah 20% PKE dalam makanan seimbang ayam daging.

Peratus karkas dan berat pemotongan nilai komersial (sayap, daging dada dan peha) sebagai peratusan berat karkas tidak menunjukkan perbezaan yang ketara di antara semua rawatan ($P>0.05$). Diantara organ-organ dalaman, berat hempedal ayam kumpulan makanan seimbang PKE, terutamanya di tahap penggunaan 30% PKE adalah lebih tinggi ($P<0.05$) berbanding dengan makanan seimbang kawalan tanpa PKE. Nilai daya ricih, menunjukkan tahap kelembutan daging kumpulan kawalan adalah lebih tinggi ($P<0.05$) berbanding nilai yang sama yang kumpulan makanan seimbang PKE. Pada amnya, warna daging, yang diukur menggunakan kecerahan (L^*) dan kemerahan (a^*) tidak berbeza antara kumpulan kawalan dan kumpulan rawatan ($P>0.05$) kecuali nilai kekuningan (b^*) daging bagi burung dalam kumpulan

yang diberi makan 30% PKE adalah lebih tinggi daripada mereka dalam kumpulan kawalan dan kumpulan diet PKE 20%.

Ketinggian vilus dan *crypt depth* (duodenum, jejunum dan ileum) tidak berbeza ($P > 0.05$) di kalangan kumpulan rawatan kecuali bagi *crypt depth* duodenum. Walau bagaimanapun, ketinggian vilus dan *crypt depth* burung dalam makanan seimbang rawatan enzim adalah lebih tinggi ($P < 0.05$) daripada mereka di dalam kumpulan PKE mentah. Kelikatan digesta usus adalah tidak berbeza ($P > 0.05$) diantara rawatan. Kebolehcernaan ketara bahan kering (DM), bahan organik (OM) dan tenaga ayam dalam makanan seimbang tanpa PKE adalah lebih tinggi ($P < 0.05$) berbanding semua kumpulan rawatan dengan PKE, tanpa mengambil kira tahap kemasukan dan rawatan enzim kecuali untuk penghadaman jelas protein kasar dan serat mentah.

Keputusan tesis ini mencadangkan bahawa enzim luaran (mengandungi terutamanya sellulase dan mannanase) berkesan untuk mengdegradasi komponen serat (hemiselulosa dan selulosa) dan meningkatkan nilai ME bagi PKE. Walau bagaimanapun, kesan positif yang di atas tidak ditunjukkan dalam prestasi pertumbuhan dalam ayam daging yang diberi makanan seimbang PKE dirawat oleh enzim berbanding dengan PKE mentah. Hasil kajian mencadangkan bahawa PKE boleh ditambah sehingga 5% dalam makanan seimbang pemulaan dan 20% dalam makanan seimbang penamat tanpa apa-apa kesan negatif yang ketara terhadap FCR dalam ayam daging.

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I certify that a Thesis Examination Committee has met on **18 May 2012** to conduct the final examination of **Pornpan Saenphoom** on her thesis entitled **“Effects of enzyme treated palm kernel expeller on its nutritive value and growth performance and carcass quality of 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 Doctor of Philosophy.

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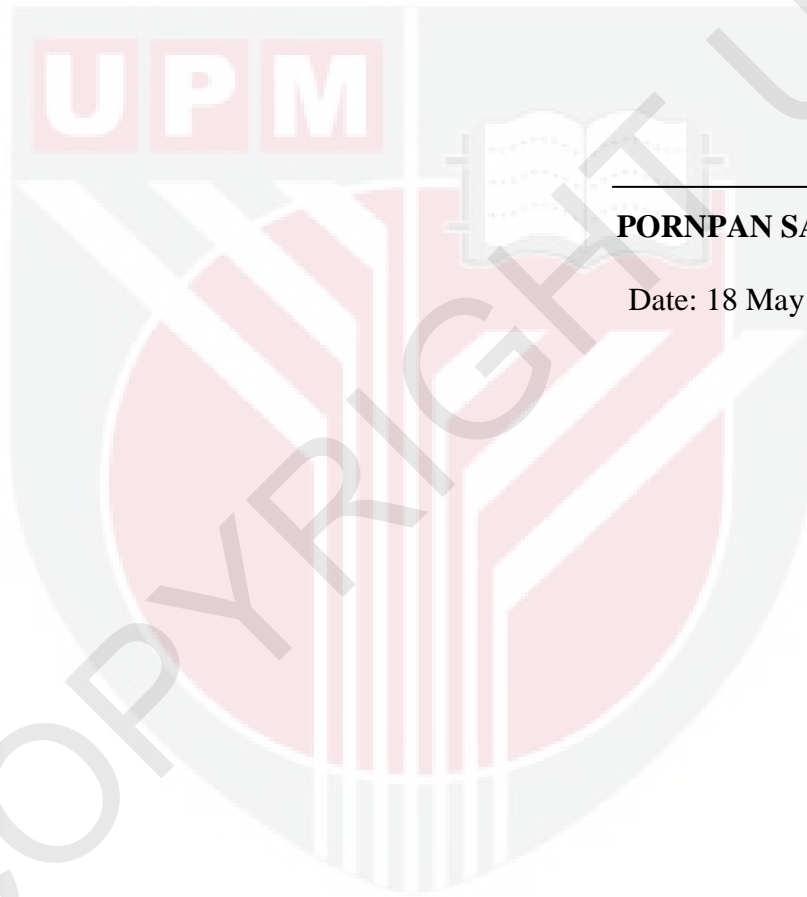
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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously and is not concurrently submitted for any other degree at Universiti Putra Malaysia or other institutions.



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Date: 18 May 2012



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