

UNIVERSITI PUTRA MALAYSIA

EFFECTS OF DIETARY ENZYMATIC EXTRACTS FROM CELLULOSE DIGESTION OF PALM KERNEL CAKE ON GROWTH PERFORMANCE, MEAT QUALITY AND DIGESTIBILITY OF BROILER CHICKEN

HASSAN USMAN ZAMANI

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

June 2015



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DEDICATION

To my late parents Usman Alhaji Dauda and Aisha Garba Mainagge.



Abstract of thesis presented to the senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

EFFECTS OF DIETARY ENZYMATIC EXTRACTS FROM CELLULOSE DIGESTION OF PALM KERNEL CAKE ON GROWTH PERFORMANCE, MEAT QUALITYAND DIGESTIBILITY OF BROILER CHICKEN

By

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Utilisation of palm kernel cake (PKC) is limited in monogastric animal nutrition due to its high fibre content, low lysine and methionine. These factors can be address by supplementation of exogenous enzymes into the diet. Two experiments were conducted for these studies. The first experiment was conducted to produce enzyme and determine their activity. Experiment 2 was carried out to study the effects of different inclusion level of locally produced enzymes on growth performance, meat quality and digestibility of broiler chicken. The experimental design was based on completely randomized design. Three cellulolytic bacteria; Paenibacillus curdlanolyticus DSMZ 10248, Bacillus megaterium ATCC 9885, and Paenibacillus polymyxaATCC 842were used to produce enzyme at different moisture ratio of 1:0.5, 1:1, and 1:1.5. The ratio was later increased to nine ratios; 1:0, 1:0.5, 1:1, 1:1.5, 1:2.0, 1:2.5, 1:3.0, 1:3.5 and 1:4.0. This was done to obtain the optimum moisture ratio needed for the solid state fermentation (SSF). Based on the result obtained, higher enzyme activities were recorded on the fourth day of SSF at moisture of 1:1.5. However, lower enzyme activities were observed at the ratio of 1:0.5. No activity was recorded on the eight day of SSF. PKC and Paenibacillus curdlanolyticus were then chosen as the best raw material and microbe for their higher enzyme activities in order to produce enzymes for the next experiment. A total of 252 male broiler chickens (Cobb 500) were raised in a battery cage system in the research Unit at Department of animal science, Universiti Putra Malaysia, from day-old to 42 days of age. The birds were randomly divided into 7 groups and fed different treatment diets: All diet contain 15% PKC + corn and soybean meal. All the diet contains 15% PKC + corn and soybean meal. The dietary treatment consisted of: (i) PKC without enzyme (ii) PKC + 0.1% commercial enzyme (iii) PKC + 0.2% crude enzyme. (iv) PKC+ 0.4% crude enzyme (v) PKC + 0.6% crude enzyme (vi) PKC+ 0.8% crude enzyme (vii) PKC + 1% crude enzyme. The findings showed that addition of locally produced enzyme to palm kernel cake dietary significantly increased (P<0.05) growth performance of broiler chicken. Higher body weight and feed intake were observed in the groups fed 15 % PKC with 1% crude enzymes, while lower body weight and feed intake were observed in groups fed 15 % PKC without enzymes. Similarly, higher FCR were recorded in the same group. However, the result for meat quality and digestibility showed that birds fed PKC with locally produced enzymes showed an improvement compare to those fed 15% PKC without enzymes. Production of enzymes via solid state fermentation using cellulolytic bacteria in PKC, rice bran and wheat pollard as substrates could be achieved at an incubation time of 4 days at a moisture ratio of 1:1.5. Similarly, application of enzymes into the diet reduces the variation in nutrient quality of ingredients. It also increases the feeding value of raw materials, thereby improving growth performance, meat quality and digestibility of broiler chicken.



Abstrak tesis yang dikemukakan kepada senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

KESAN DIET EKSTRAK ENZIMATIK DARIPADA PENCERNAAN SELULOSA ISIRUNG KELAPA SAWIT TERHADAP PRESTASI PERTUMBUHAN, KUALITI DAGING DAN DAYA CERNA AYAM PEDAGING

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Penggunaan Isirung Kelapa Sawit atau PKC dalam pemakanan haiwan monogastrik adalah terhad disebabkan oleh kandungan serabutnya yang tinggi, serta kandungan lysine dan methionine yang rendah. Faktor-faktor ini boleh diatasi dengan penambahan enzim exogenous dalam diet. Dua eksperimen telah dijalankan untuk kajian ini. Eksperimen pertama telah dijalankan untuk menghasilkan dan menentukan aktiviti enzim. Eksperimen kedua dijalankan bagi mengkaji kesan penambahan enzim hasil tempatan pada tahap yang berbeza terhadap prestasi pertumbuhan, kualiti daging dan daya cerna ayam pedaging. Rekabentuk eksperimen berasaskan Rekabentuk Rawak Lengkap. Tiga bakteria selulotik Paenibacillus curdlanolyticus DSMZ 10248, Bacillus megaterium ATCC 9885 dan Paenibacillus polymyxa ATCC 842 digunakan untuk menghasilkan enzim pada tahap nisbah kelembapan yang berbeza; 1:0.5, 1:1, dan 1:1.5. Nisbah itu kemudiannya ditingkatkan kepada 9; 1:0, 1:0.5, 1:1, 1:1.5, 1:2.0, 1:2.5, 1:3.0, 1:3.5 and 1:4.0. Ia bertujuan untuk mendapatkan nisbah kelembapan paling optimum yang diperlukan bagi fermentasi peringkat pepejal (SSF). Berdasarkan keputusan, didapati aktiviti enzim lebih tinggi pada hari ke-4 SSF, pada nisbah kelembapan, 1:1.5. Walaubagaimanapun, pada nisbah 1:0.5, aktiviti enzim adalah lebih rendah. Tiada aktiviti enzim berlaku pada hari ke-8 SSF. PKC dan P. curdlanolyticus dipilih sebagai bahan mentah dan mikrob terbaik untuk eksperimen seterusnya kerana aktiviti enzimnya yang lebih tinggi bagi menghasilkan enzim. Sebanyak 252 ekor ayam pedaging jantan (Cobb 500) dipelihara dalam sistem sangkar bateri di Unit Penyelidikan Jabatan Sains Haiwan, Universiti Putra Malaysia, daripada umur sehari ke 42 hari. Ayam dibahagikan secara rawak kepada 7 kumpulan dan diberi diet rawatan yang berbeza; (i) PKC tanpa enzim (ii) PKC dengan 0.1% enzim komersial (iii) PKC

dengan 0.2% enzim mentah (iv) PKC dengan 0.4% enzim mentah (v) PKC dengan 0.6% enzim mentah (vi) PKC dengan 0.8% enzim mentah (vii) PKC dengan 1% enzim mentah. Penambahan enzim hasil tempatan dalam makanan isirung kelapa sawit ketara meningkatkan (P<0.05) prestasi pertumbuhan ayam pedaging. Berat badan dan pengambilan makanan yang lebih tinggi direkodkan dengan pemberian makanan 15% dengan 1% enzim mentah, manakala pemberian makanan 15% PKC tanpa enzim mencatatkan berat badan dan pengambilan makanan yang lebih rendah. Kumpulan yang sama juga merekodkan FCR yang lebih tinggi. Walaubagaimanapun, untuk kualiti daging dan daya cerna, ayam yang diberi PKC dengan enzim hasil tempatan menunjukkan peningkatan berbanding dengan pemberian 15% PKC tanpa enzim. Penghasilan enzim melalui fermentasi peringkat pepejal menggunakan bakteria selulotik dalam PKC, sekam padi dan polar gandum sebagai subtrak boleh dicapai dengan 4 hari masa inkubasi pada nisbah kelembapan 1:1.5. Aplikasi enzim dalam diet juga mengurangkan variasi dalam kualiti nutrien bahan, meningkatkan nilai pemberikan makanan bahan mentah, seterusnya menambahbaik prestasi pertumbuhan, kualiti daging dan daya cerna ayam pedaging.

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I certify that a Thesis Examination Committee has met on (16 June2015) to conduct the final examination of (Hassan Usman Zamani) on his thesis entitled "Effects of dietary enzymatic extracts from cellulose digestion of palm kernel cake on growth performance, meat quality and digestibility of broiler chicken" 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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LIST OFABREVIATIONS

- ANF: Anti-nutritional factor
- BW: Body weight
- CF: Crude fiber
- CL: Cooking loss
- CMC: Carboxymethyl cellulose
- CP: Crude protein
- DL: Drip loss
- DM: Dry matter
- EE: Ether extract
- FCR: Feed conversion ratio
- FI: Feed intake
- IB: infectious bronchitis
- LBG: locust bean gum
- ND: New castle disease
- NSP: Non-starch polysaccharide
- OPF: Oil palm fronds
- PKC: Palm kernel cake
- PKM: Palm kernel meal
- POME: Palm oil mill effluent
- RB: Rice bran
- SSF: Solid state fermentation
- TME: True metabolizable energy
- TWG: Total weight gain
- U/g: Unit per gram
- V/w: Volume versus weight
- WP: Wheat pollard

WG: Weight gain

W/w: Weight versus weight



CHAPTER 1

INTRODUCTION

Palm kernel cake is a major by-product in palm oil extraction. The product from the mechanical expeller is referred to as palm kernel cake (PKC), whereas the product from solvent extraction technique is called palm kernel meal (PKM). Palm kernel cake cannot be fully utilised in monogastric diet due to its high percentage of hemicellulose and cellulose content. It is therefore necessary to look for the possible ways on how to decrease the percentage of these hemicellulose and cellulose. One of the methods used is solid state fermentation using microorganism such as bacteria and fungi. It was reported by Alimon, (2005), that palm kernel meal contains crude protein ranges from 14.5- 19.6%, and crude fibre 13.0-20.0%. It was reported that the non-starch polysaccharide in PKC constitute of 12 % cellulose, 3 % glucoronoxylan, and 3 % arabinoxylan, and 78% mannan (Sundu and Dingle, 2002). Another author reveals that the amount of lignin was about (13.6%) in PKC, possibly due to contamination with nut shell, thereby rendering the feedstuff feel gritty and fibrous, which can be improved by addition of enzymes to the feeds (Sekoni, *et al.* 2008).

Conventional feedstuffs are likely to be insufficient for animal production because the ingredients used are mostly based on grain, which is also a staple food for man in most of the developing countries. Therefore, on research for an alternative animals' diet is essential. Many agro by-products have been identified as a feedstuff in animal nutrition such as palm kernel cake, palm kernel meal, wheat meal, and copra meal. Most of these by product contain significant amount of anti-nutritional factors (ANF) and they are also considered as non-starch polysaccharide. PKC can be used as an energy source in the diet, and protein source to some extent, even though it has been reported to have low protein content.

Agro-industrial by-products are those by-products derived after processing of the main products. Examples include palm oil mill effluent (POME), molasses, rice bran, PKC, wheat pollard etc. Some by-products are available in Malaysia like PKC, while others were imported especially corn and soybean meal. The limitation of utilising these by-product to monogastric is that most of them contain high fibre content, NSPs and antinutritional factors (Devendra, 1987). Most of those NSPs were in form of mannan, xylan, and cellulose. However, most of the available commercial enzymes are imported from other countries. Thus, alternative locally produced enzymes need to be explored. Therefore, this study was aimed to supplement locally produced enzyme to broiler chicken fed with palm kernel cake based diet at different inclusion levels.

Problem statement

Most of the raw material ingredients for Malaysian poultry feeds are not produced locally, they are imported from other countries. These ingredients include corn, soybean meal, fish meal, corn gluten meal which are very costly. It was reported that the use of PKC in broiler rations is limited due to its higher fibre content (Zahari and Alimon, 2003). Moreover, there is limited research work on the use of locally produced enzymes in animal nutrition.

Justification

It is necessary to carry out research on how to transform unconventional feed ingredients such as PKC for usage in monogastric animals. Palm kernel cake has been reported to contain β -mannan which has anti-nutritional properties that hinder full utilisation of nutrient in PKC by monogastric animals. To address this problem, studies on the effect of enzyme supplementation in PKC on monogastric animal feeding have been carried out by many researchers. The degradation of β -mannan in PKC by an appropriate enzyme to mannose will release sugar and other digestible sugars that can be absorbed and metabolised by monogastric animals. It was reported that the use of mannan degrading enzyme increased the digestibility of dietary fibre and it supports maximum growth of broilers (Sundu and Dingle, 2002). Applications of enzymes also enhance feed intake, growth rate, productivity, and good feed conversion.

Hypothesis

It is hypothesized that moisture ratio and incubation time in solid state fermentation can affect enzyme production, application of enzymes into broiler diet have effects on growth performance, digestibility and meat quality of broiler chicken.

Objectives of the study

The general objective of this research work was to study the effect of locally produced enzyme by cellulolytic bacteria on broiler performance.

The specific objectives were

- 1. To produce and determine enzyme activity (cellulase xylanase and mannanase) via solid state fermentation using different substrates, moisture ratio, incubation time and different cellulolytic bacteria.
- 2. To study growth performance, meat quality and digestibility of birds fed diet supplemented with different inclusion level of locally produced enzymes.

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