UNIVERSITI PUTRA MALAYSIA

GROWTH PERFORMANCE, NUTRIENT DIGESTIBILITY AND CARCASS CHARACTERISTICS OF GOATS FED DIFFERENT LEVELS OF PALM OIL DECANTER CAKE

ANWAR ABDELGAFAR SHABAN AHMED

ITA 2014 14

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By

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

January 2014

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DEDICATION

With appreciation and respect, I dedicated
this thesis to the people of Egypt, as I owe my country a great debt, to the soul of my father and my mother; brothers and sisters who supported and inspired me with ambitions and confidence and to my lovely wife, who gives me the moral support.

Abstract of thesis submitted to the Senate of Universiti Putra Malaysia, in fulfillment of the requirements for the Degree of Master of Science

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January 2014

Chairman: Prof. Abdul Razak Alimon, Ph.D.

Institute: Tropical Agriculture

Feed shortage in Malaysia is undeniably requires alternative potential local cheap feed sources to reduce the import costs. Introducing palm oil decanter cake (PODC) for ruminant ration to overcome feed shortage could help in this case, since PODC contains of crude protein (CP) 11.4-14%, locally produced in big amounts and cheap. However, researches investigating the chemical composition of PODC and the effects on growth performance and carcass characteristics in goats are limited; therefore the objectives of a series of experiments were to evaluate such effects.

In the first experiment, two samples of PODC were collected from five different palm oil mills and subjected to proximate analysis. The chemical compositions of the PODC were significantly different between all mills ($P < 0.05$) and the mean were for the DM (dry matter), Ash, CP (crude protein), NDF (natural detergent fiber), ADF (acid detergent fiber) and ADL (acid detergent lignin) and EE (ether extract) were: 7.16, 16.47, 12.48, 50.39, 38.03, 38.03 and 12.26 respectively.

In the second experiment 15 male one year Kacang goats with initial mean body weight (BW) of 16.2 ± 1.3 kg, the objective was to evaluate the nutrient digestibility and feed intake when fed with different levels of the PODC. The experiment duration was 30 days, including 9 days of adaptation period, 21 days of a feeding trial and the digestion trials was at the last 7 days of the feeding trial. The goats were fed Napier grass *ad libtum* and also received once daily (1.5% of BW) one of three concentrate diets (treatments; approximately 16% CP on dry matter basis), five goats were randomly assigned to each treatment. The treatments included (1) grass + PKC (T1, control) and PODC replaced partly the PKC at a level of (2) 10% decanter cake + grass, (T2) and (3) 20% decanter cake + grass (T3). The intake of grass was not affected by dietary

treatments. However, the intake of PODC was significantly increased by increasing the level of PODC in the diet. Similarly, total dry matter intake was higher ($P < 0.05$) in goats fed with 10% or 20% respectively comparable to those fed control diet. Additionally, apparent digestibility of DM, OM, CP, EE, ADF and NDF were similar ($P < 0.05$) among dietary treatments T1, T2, T3 and T4.

In the third experiment, twenty four one year male Kacang goats with initial mean body weight (BW) of 16.8 ± 1.14 kg been used. The objectives were to evaluate the effect of supplementation of different levels of PODC on growth performance and carcass characteristic of goats. The four treatments were: control diet consisting of soy bean meal (SBM) and corn grain (T1) or 10% (T2), 20% (T3), 30% (T4) PODC. All goats were fed Napier grass *ad libitum* and also received once daily (1.5% of BW) one of four concentrate diets (treatments; approximately 16% CP on dry matter basis). Total feed intake was similar ($P < 0.05$) in all groups, however, T3 and T4 had significantly higher ($P<0.0001$) PODC intake compare with T1 and T2. BW gain (kg), slaughter weight (kg), empty body weight (kg), hot carcass weight (kg), cold carcass weight (kg) and carcass dressing percentage were not significantly different ($P < 0.05$) among dietary treatments.

It was concluded that PODC has variable chemical compositions and different from one mill to another. PODC could be used to replace grains in the rations of growing goats up to 30% with normal performance.

Abstrak tesis dikemukakan kepada SenatUniversiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PERSTASI TUMBESARAN, PENGHADAMAN NUTRISI DAN KARAKTER CIRI-CIRI KAMBING YANG TELAH DIBERI MAKANAN MENGANDUNGI DEKANTER KEK KELAPA SAWIT YANG BERBEZA

Oleh
ANWAR ABDELGAFAR SHABAN AHMED

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Kekurangan makanan haiwan di Malaysia tidak dapat dinafikan memerlukan alternative dari sumber makanan haiwan tempatan yang lebih murah untuk mengurang kan kos import. Usaha untuk memperkenalkan decanter kek kelapasawit (PODC) kepada kumpulan ruminant mungkin membantu dalam menyelesaikan masalah ini kerana protein mentah (CP) 11.4-14% dihasilkan di Malaysia secara besar-besaran dengan harga yang lebih murah. Walaubagaimanapun, kajian untuk menilai komposisi kimia dalam PODC dan kesannya terhadap prestasi tumbesaran dan ciri-ciri karkas kambing adalah terhad; oleh itu objektif beberapa sirikajian ada lah untuk menganalisa kesan tersebut.

Dalam eksperimen pertama, dua sampel PODC diambil dari 5 buah kilang kelapa sawit yang berbeza dan dianalisis. Kandungan kimia dalam PODC didapati sangat berbeza untuk setiap kilang ($P < 0.05$) dan purata untuk kandungan DM (bahan kering), abu, CP (protein mentah), NDF (fiber detergen natural), ADF (fiber detergen berasid) dan ADL (lignin detergen berasid) dan EE (ekstrak ether) masing-masing adalah masing-masing 7.16, 16.47, 12.48, 50.39, 38.03,38,03 dan 12.26.

Di dalam eksperimen kedua, 15 ekor kambing Kacang jantan berumur 1 tahun dengan min berat badan awal (BW) 16.2 ± 1.3 kg, objektifnya adalah untuk menilai penghadaman nutrisi dan pengambilan makanan mengandungi PODC yang berbeza. Tempoh eksperimen adalah 30 hari, termasuk 9 hari tempoh penyesuaian, 21 hari kajian pemakanan, dan tujuh hari tempoh kajian penghadaman. Kambing-kambing tersebut diberi makan rumput Napier *ad libtum* dan juga menerima sekali sehari (1.5% BW) satu daripada tiga diet tepu (makanan; anggaran 16% CP pada asas bahan kering), dengan lima kambing untuk setiap makanan. Campuran makanan terdiri daripada (1) rumput + PKC (T1, kawalan) dan PODC menggantikan sebahagian PKC pada tahap 10% kek

decanter (T2) dan 20% kek decanter (T3). Keputusan kajiaan menunjukkan kadar pengambilan rumput tidak dipengaruhi oleh diet pemakanan, tetapi kadar pengambilan PODC telah meningkat dengan signifikan dengan peningkatan PODC dalam diet. Pengambilan keseluruhan bahan kering adalah lebih tinggi ($P < 0.05$) dalam kambing-kambing yang diberi makan 10% dan 20% setiap satu, berbanding dengan kambing-kambing yang diberi makan diet kawalan. Kadar penghadaman DM, OM, CP, EE dan NDF adalah hampir sama ($P < 0.05$) di antara diet makanan T1,T2, T3 dan T4.

Dalam eksperimen ketiga, dengan 24 ekor kambing Kacang jantan berumur satu tahun dengan berat badan (BW) 16.8 ± 1.14 kg. Objektif adalah untuk menilai kesan suplementasi pelbagai tahap berbeza PODC ke atas prestasi pembesaran dan ke atas ciri-ciri karkas kambing. Empat jenis makanan adalah: diet kawalan yang terdiri daripada makanan kacang soya (SBM) dan bijiran jagung (T1) atau 10% (T2), 20% (T3), 30% (T4) PODC. Semua kambing telah diberi makan rumput Napier *ad libitum* dan juga menerima sekali sehari (1.5% BW) satu daripada empat diet tepu (makanan; anggaran 16% CP atas asas bahan kering). Jumlah pengambilan makanan keseluruhan adalah hampir sama ($P < 0.05$) dalam semua kumpulan, tetapi T3 dan T4 mempunyai lebih tinggi($P<0.0001$) pengambilan PODC secara signifikan dibandingkan dengan T1 dan T2. Kenaikan berat badan (kg), berat sembelihan (kg), berat badan kosong (kg), berat karkas panas (kg), berat karkas sejuk (kg) dan peratusan kadar peningkatan berat adalah tidak ada perbezaan ($P < 0.05$) di antara diet makanan.

Kesimpulannya, PODC mempunyai pelbagai komposisi kimia dan ada lah berbeza antara setiap kilang kelapa sawit. PODC boleh digunakan sehingga 30% untuk mengganti jagung dalam makanan kambing tanpa menjejaskan ciri-ciri karkas kambing.

ACKNOWLEDGEMENTS

I am deeply indebted to all my supervisors, especially Professor Dr/Abdul Razak Alimon and Dr/Awis Qurni Bin Sazili for their unduly assistance and invaluable guidance who really gives all encouragements efforts and support throughout my study are very much appreciated and the late Professor, Dr/Yaakob Bin Che Man his constant encouragement, assistance and guidance .
I am grateful for the technical assistance provided by Mr. Zakaria bin Mohd Sah in the Animal Nutrition Laboratory. I am also indebted to Mr. Mohd Faizal Yope Baharudin for his invaluable assistance during the feeding trial. I wish to thank all my colleagues in the Department of Animal Science for their understanding, suggestions, ideas and cooperation. Finally, I would like to express my deepest gratitude and appreciation to my wife Aber, brothers Shaban and Hatem, sisters Nagat, Sabah and Iman, and all cousins for their unfailing support, patience and encouragement throughout my study.

I certify that an Examination Committee met onMarch 2014 to conduct the final examination of Anwar AbdelgafarShaban Ahmed on his Master of Science thesis entitled "*GROWTH PERFORMANCE, NUTRIENT DIGESTIBILITY AND CARCASS CHARACTERISTICS OF GOATS FED DIFFERENT LEVELS OF PALM OIL DECANTER CAKE*" in accordance with Universiti Putra Malaysia (Higher Degree) Act 1980 and UniversitiPertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree.

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LIST OF ABBREVIATIONS

AAS	Atomic absorption spectrophotometer
ACC	Administrative committee on coordination
ADF	Acid detergent fiber
ARC	Agricultural research center
BOD	Biochemical oxygen demand
C	Celsius (unit of measurements for temperature)s
COD	Chemical oxygen demand
CF	Crude fiber
CP	Crude protein
CPO	Crude palm oil
DES	Dietary energy supply
DM	Dry matter
DMD	Dry matter digestibility
DMI	Dry matter intake
DOE	Department of environment
DVS	Department of veterinary services
EE	Ether extract
EFB	Empty fruit bunch
EQA	External quality assessment
FAO	Food and agricultural organization
g	Gram
ha	Hectare
h	Hour
M	Methane
MARDI	Malaysian Agricultural Research And Development Institute
MDF	Medium density fiberboard
ME	Metabolizable energy
mg	Milligram
MINT	Malaysian Institute for Nuclear Technology Research
MJ/KG	Mega joules per kilogram
MOA	Ministry of Agriculture
MOSTI	Ministry of Science, Technology and Innovation.
MPOB	Malaysian palm oil board
NDF	Neutral detergent fiber
NFE	Nitrogen free extract
OM	Organic matter
OPF	Oil palm frond
PH	Measure of acidity or alkalinity
PODC	Palm oil decanter cake
PKC	Palm kernel cake

PPF	Palm press fiber
PKO	Palm kernel oil
POME	Palm oil mill effluent
POS	Palm oil sludge
PPF	Palm press fiber
PPM	Part per million
RM	Ringgit Malaysia
SEM	Standard error of the mean
UN	United Nations Organization.

CHAPTER 1

INTRODUCTION

Palm oil industry contributes significantly towards the Malaysian foreign exchange earnings and increases the standard of living, which had been given a reason for the government to emphasize on the palm oil productions and industry to increase the palm oil productions and export (Yusoff & Hansen, 2007).

It is expected that it would be a rise in oil palm plantation from 4 to 6 million by the year 2030, which would be further increase in the oil production to a figure from 28 million to 50 million tons per year, where is an incessant interest pertaining to the usage of the oil palm waste as renewable energy in addition to the production of oil and fats (De Vries, 2008) and (Lam et al., 2009).

On the other hand the agricultural residues are abundant and not widely utilized in Malaysia, especially the by-products from the oil palm industry is important and could contribute significantly to the feeding system for ruminants, for instance, include the forages under the oil palm plantations beside the utilization of energy and protein rich by-products from the palm oil mill, as the report of Singhet al. (2010)there are five principal by-products namely palm press fiber (PPF), palm kernel cake (PKC), oil palm fronds (OPF), palm oil mill effluent (POME) and palm oil decanter cake (PODC), also he had reported that the utilization of wastes produced at the palm oil mills could be a good practice and useful recycling of good plant nutrients and the good management of these wastes could be utilized as animal feed as well.

Over the past decades, Malaysia has become self-sufficient only in non-ruminant products such as poultry, meat and eggs, but the demand for red meat including beef, mutton, and chevon along with dairy products is far greater than the local production. For instance, around 12,500 tons of mutton and 14000 tons of chevon are required whereas only 21.7% and 7.4%, respectively of these two products are available locally (MOA, 2008).

Malaysia trends are to improve its livestock industry mainly in ruminant production by increasing its farm production and that could reduce the importation of beef, chevon and milk. Enhancing ruminant production is also a strategy and security to ensure a major availability of protein food source to the growing population, while Malaysia is getting the highest importer bill of these farm products, and the trend will rise due to a higher consumption of the

growing population, especially meat and milk (Jelan, 2005). Again, De Silva & Anderson (1995) had stressed the supply importance of inputs such as livestock feed to be ensured in order to achieve the production goals by fulfilling the nutrient and energy requirements of the species under cultivation which is still inadequate for ruminant.

Moreover, Goh and Rajion (2007) had concluded that the main strategy to develop animal industries should be to raise the use of available, low cost and the native feed resources to decrease feed cost been imported from abroad, since the cost-effective constraints and the competition between humans and monogastric livestock for grain had its limitation level in ruminant feeds. Also the FAO (2011) had included in their report that already the era of getting cheap food is over as world maize and wheat are getting scarce, currently maize and wheat consumers spending almost half of their meager income for food and cannot afford as much as they could in the past.

Also Al-Kirshiet al. (2011) reported that the palm oil production has tremendous and huge amounts of by-products produced annually. These by-products could be used as an alternative cheap, available animal feeds to enhance local ruminant production in Malaysia's livestock industry which is still far from producing sufficient beef, milk and mutton to meet the domestic demand.

Moreover, palm oil decanter cake (PODC) is one of the solid wastes and products generated in huge quantities in palm oil mills during the extraction process contributing pollution to the environment (Afdalet al., 2012).

1.1.Research problem

Livestock production improvement programs are always hindered by shortage of feed resources in terms of quantity and quality in most tropical areas because most of the lands are utilized for crop production. Therefore, an alternative locally produced, low cost feed resources are needed to overcome the problem of feed shortage. Palm oil by-products such as the decanter cake (PODC) could be used as ruminant feed to replace high cost imported feeds such as corn grain and soybean meal. In Thailand Seephueak et al (2011) had conducted his feed trial on cattle and included PODC in feed rations and suggested that PODC could include for ruminant at 30% level. Since researches are limited to evaluate PODC affects on ruminant's performance.

1.2.Research hypothesis

Making formulation economically viable diets is always a big challenge for nutritionist to provide as closely as possible the nutrient requirement of livestock. An especially feed with high protein is always affect livestock production cost because high protein feeds is the highest costs in feed rations. It is assumed that the PODC can be use in small ruminants feed rations and the subsequent utilization of the economically cheap PODC in the diet could enhance the small ruminant growth performance, and serve as a good source of nutrient requirements to overcome Malaysian feed shortages.

1.3.Objectives

The main objective of the present study was to evaluate the nutritive value of palm oil decanter cake as ruminants feed using goats as a model animal. The specific objectives were to:

(i) Determine and compare the chemical composition of palm oil decanter cake produced in different local mills.
(ii) Determine the effect of feeding different levels of palm oil decanter cake on the nutrient digestibility growth performance in goats.
(iii) Evaluate the carcass characteristics of goats fed with different levels of palm oil decanter cake.

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