



UNIVERSITI PUTRA MALAYSIA

PRESERVATIVE EFFECT OF CINNAMON *Cinnamomun burmannii* (Nees & T. Nees) Blume BARK POWDER ON FRESH PALM OIL DECANter MEAL FOR GOATS

M. AFDAL

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BERILMU BERBAKTI

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By

M. AFDAL

Thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia, in fulfilment of the requirements for the Degree of Doctor of Philosophy

March 2013

DEDICATION

To

*My beloved mother Alawiyah, My lovely wife Indriyani, My joyful children; Rifqi,
Dhila, Avin and Hana*



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

PRESERVATIVE EFFECT OF CINNAMON *Cinnamomun burmannii* (Nees & T.Nees) BLUME BARK POWDER ON FRESH PALM OIL DECANter MEAL FOR GOATS

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March 2013

Chairman: Assoc. Prof. Azhar Kasim, PhD

Faculty: Agriculture

Palm oil decanter meal (PODM) is a by-product from the palm oil industry. It is abundantly available and to a limited extent, utilized as organic fertilizer. This by-product has the potential as animal feed due to its high protein content, which is comparable to that of grass. However, the problem of rancidity remained the main constraint in its application as animal feed. Rancidity deteriorates the PODM quality within few days in open air. Antioxidants have been widely applied to preserve food and processed products. Cinnamon (*Cinnamomum burmannii*) bark (CB) was chosen as a source of antioxidants, as it is cheap and easily available. Hence, the main objective of this study was to preserve PODM quality by inhibiting rancidity using CB. Experiments conducted include determination of the chemical characteristics, rancidity properties and inherent microbial species of PODM; evaluation of different solvents to extract the bioactive compounds present in CB for PODM treatment; palatability test

in goats fed treated PODM with ground CB (GCB); *in sacco* degradability and digestibility of treated PODM with GCB in goats and fermentation kinetics of treated PODM by rumen microbes *in vitro*. The results showed that fresh PODM contained 267±7.6 g/kg (dry matter), 60±3.6 g/kg (ash), 117±2.1 g/kg (crude protein), 28±5.7 g/kg (ether extract), 751±24.8 g/kg (neutral detergent fibre) and 445±56.6 g/kg (acid detergent fibre). The mineral composition consisted of 0.24±0.08 ppm (Cr), 13.10±0.70 ppm (Fe), 0.43±0.03 ppm (Mn), 0.96±0.02 ppm (Ni), and 6.54±2.19 ppm (Cu). The fatty acid (FA) composition included 40.7±0.84 % (palmitic (C16:0)), 5.6±0.49 % (stearic (C18:0)), 41.2±0.43 % (oleic (C18:1)), 11.0±0.27 % (linoleic (C18:2)) and 1.3±0.50 % (α -linolenic (C18:3)). The rancidity status of fresh PODM measured by peroxide value (PV) and thiobarbituric acids (TBA) values (1.92±0.09 meq/kg and 1.75±0.62 mg/kg, respectively) was low. However, PV and TBA values increased to 18.12 meq/kg and 8.13 mg/kg PODM, respectively within 10 days in the open air. Eight bacterial isolates were obtained, but only four could be identified as it was needed other method to do. They were *Kocuria* sp *Bacillus subtilis*, *Bacillus megaterium* and *Paenibacillus nanensis*. Three fungal isolates were obtained, but were not identified yet and kept left at the plant protection laboratory.

The highest total phenolics and flavonoids were observed in the methanol extract with the values of 111.43 and 286.27 mg gallic acid equivalent/g dry weight (DW), respectively, while the lowest amounts detected in hexane were 57.23 and 64.73 mg gallic acid equivalent/g DW, respectively. Methanol extracts also showed significantly ($P<0.05$) higher antioxidant activity measured by the 1.1-diphenyl-2-picrylhydrazyl

(DPPH) radical scavenging method. The highest value of DPPH inhibition was $69.6 \pm 0.24\%$ to scavenge free radical ion. This inhibition was higher than vitamin E ($25.4 \pm 0.25\%$) but lower than butylated hydroxytoluene (BHT) ($91.8 \pm 0.02\%$).

Different levels of CB extract (CBE) and ground CB (GCB) were tested for their effects on PV and TBA of PODM. Both PV and TBA values of PODM were significantly ($P < 0.05$) different among all treatments and over time of sampling. The GCB at 0.1 % (w/w) showed the best reduction in rancidity of PODM with PV and TBA of 10.24 meq/kg and 5.81 mg/kg respectively. Further studies showed that PV and TBA values of PODM were significantly ($P < 0.05$) different among different levels of GCB. The level of 0.2 % of GCB showed the highest reduction in PV and TBA values at 8.96 meq/kg and 4.95 mg/kg respectively. This reduced PV by 42.8 % and TBA by 55.1%.

A palatability study was conducted according to the cafeteria method using 4 Kacang Boer crossed goats. The intake of PODM preserved with 0.2% GCB (GDM), untreated PODM (UDM), Napier grass (NG) and Rice straw (RS) as standards was significantly different ($P < 0.05$) on day one and in periods 1, 2 and 3. In period one, intake of GDM, UDM and NG were higher than that of RS. Intake of UDM (362.74 UDM g/day) was higher than that of GDM (211.16 GDM g/day). However, in periods 2 and 3, intake of GDM was significantly ($P < 0.05$) higher than that of UDM. There was no significant difference on the effect of different levels of GDM in the four experimental diets of goats on the total dry matter intake (DMI), the apparent digestibility of DM, neutral detergent fibre (NDF), and acid detergent fibre (ADF). There was no significant difference in rumen pH of goats among treatments. Rumen pH decreased slightly at 2 h

and after that increased until 6 h. Rumen pH for all treatments was within the range of 6.47 - 7.10. There were no significant effects of experimental diets on the concentration of ammonia nitrogen (13.20 – 16.68 mg/100ml) in rumen of goats. The nitrogen intake was comparable among four dietary treatments. The effect of experimental diet was significantly different ($P < 0.05$) on faecal N as percentage of intake and faecal N per metabolic weight ($\text{mg/kgBW}^{0.75}$). The effects of diets were not significant in urinary N excretion. However, the effects of experimental diets were significantly different ($P < 0.05$) on N absorption (g/d), N retention (g/d), N retention as percentage of intake (% of intake) and N retention as percentage of absorption of goats. In the fermentation kinetics study *in vitro*, there was a significant difference ($P < 0.05$) on the effect of experimental diets on a, b and a+b values except for c value. A significant difference ($P < 0.05$) was also observed in gas production at 24, 48 and 96 h. There was not significantly different ($P > 0.05$) in fermentation kinetics between GDM and UDM.

The present study showed that methanol was the best solvent to extract CB with high DPPH scavenging activity, but its ability to reduce PV and TBA of PODM was lower than GCB. It was observed that GCB at 0.2 % (w/w) could reduce PV and TBA up to 42.8% and 55.1%, respectively. The GDM was more palatable than UDM after 5 days of experiment and the digestibility of GDM in diet was not significantly different in comparison with the control. It could be concluded that PODM treated with 0.2% of GCB could be used as goat feed without any negative effect on the digestibility of feed and the rumen environment.

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

**KESAN PENGAWET DARIPADA TEPUNG KULIT KAYU MANIS
(*Cinnamomum burmannii* Nees & T.Nees) KE ATAS DEKANTER MINYAK
KELAPA SAWIT SEGAR SEBAGAI MAKANAN KEPADA KAMBING**

Oleh

M. AFDAL

Mac 2013

Pengerusi: Prof. Madya Azhar Kasim, PhD

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Mil dekanter minyak kelapa sawit (PODM) adalah hasil sampingan daripada industri minyak sawit. Ia didapati dengan banyak dan digunakan secara terhad sebagai baja organic. Bahan sampingan ini adalah produk yang mempunyai potensi sebagai makanan ternakan kerana kandungan proteinnya yang tinggi setanding dengan rumput. Walau bagaimanapun, masalah bau tengik kekal sebagai kekangan utama dalam pemprosesannya sebagai makanan haiwan. Ketengikan merosakkan kualiti PODM dalam masa beberapa hari di ruang udara terbuka. Antioksidan telah digunakan secara meluas untuk memelihara makanan dan produk yang diproses. Kulit kayu manis (*Cinnamomum burmannii*) (CB) telah dipilih sebagai sumber antioksidan, kerana ia murah dan mudah didapati. Oleh itu, objektif utama kajian ini adalah untuk memelihara kualiti PODM dengan merencatkan ketengikan menggunakan CB. Eksperimen yang telah dijalankan termasuk penentuan ciri-ciri kimia, ciri-ciri ketengikan dan kehadiran

spesies mikroba dalam PODM; penilaian pelarut yang berbeza untuk mengekstrak sebatian bioaktif yang hadir dalam CB untuk rawatan PODM; ujian kesedapan bagi kambing yang memakan PODM yang dirawat dengan CB yang dikisar (GCB); kebolehubaan dan kebolehadaman secara 'in sacco' PODM dirawat dengan GCB oleh kambing dan kinetik penapaian PODM dirawat oleh mikroba rumen secara *in vitro*. Keputusan menunjukkan bahawa PODM segar mengandungi 267 ± 7.6 g/kg (bahan kering), 60 ± 3.6 g/kg (abu), 117 ± 2.1 g/kg (protein mentah), 28 ± 5.7 g/kg (ekstrak eter), 751 ± 24.8 g/kg (fiber detergen neutral) dan 445 ± 56.6 g/kg (fiber detergen asid). Komposisi mineral terdiri daripada 0.24 ± 0.08 ppm (Cr), 13.10 ± 0.07 ppm (Fe), 0.43 ± 0.03 ppm (Mn), 0.96 ± 0.02 ppm (Ni), dan 6.54 ± 2.19 ppm (Cu).

Asid lemak (FA) komposisi termasuk $40.7 \pm 0.84\%$ [palmitic (C16:0)], $5.6 \pm 0.49\%$ [stearic 9C18:0], $41.2 \pm 0.43\%$ [oleic (C18:1)], $11.0 \pm 0.27\%$ [linoleic (C18:2)] dan $1.3 \pm 0.50\%$ [α -linolenik (C18:3)]. Status ketengikan PODM segar diukur oleh nilai peroksida (PV) dan nilai asid tiobarbiturik (TBA) (1.92 ± 0.09 meq/kg dan 1.75 ± 0.62 mg / kg, masing-masing) adalah rendah. Walau bagaimanapun, nilai PV dan TBA masing-masing meningkat kepada 18.12 meq/kg dan 8.13 mg/kg PODM dalam tempoh 10 hari di ruang udara terbuka. Lapan isolat bakteria diperolehi tetapi hanya empat dapat dikenalpasti. Bakteria tersebut adalah *Kocuria* sp., *Bacillus subtilis*, *Bacillus megaterium* dan *Paenibacillus nanensis*. Tiga jenis kulat telah diperolehi tetapi tidak dapat dikenal pasti dan disimpan di makmal Jabatan Perlindungan Tumbuhan. Jumlah tertinggi fenolik dan flavonoid diperhatikan dalam ekstrak methanol dengan nilai masing-masing adalah 111.43 dan 286.27 mg asid gallik setara/g berat kering (DW),

manakala jumlah terendah yang dikesan dalam heksana masing-masing ialah 57.23 dan 64.73 mg asid gallik setara/g berat kering (DW). Ekstrak methanol turut menunjukkan aktiviti antioksidan yang signifikan tinggi diukur dengan 1.1-diphenyl-2-picrylhydrazyl (DPPH) kaedah pengumpulan radikal. Nilai tertinggi perencatan DPPH kepada pengumpulan ion radikal bebas adalah $69.6 \pm 0.24\%$. Perencatan ini adalah lebih tinggi daripada vitamin E ($25.4 \pm 0.25\%$) tetapi lebih rendah daripada BHT ($91.8 \pm 0.02\%$). Perbezaan tahap CB ekstrak (CBE) dan CB kisar (GCB) telah diuji untuk kesan mereka pada PV dan TBA PODM. Kedua-dua nilai PV dan TBA PODM ketara ($P < 0.05$) yang berbeza di antara semua rawatan dan persampelan. GCB pada 0.1% menunjukkan pengurangan terbaik dalam ketengikan PODM s dengan PV dan TBA masing-masing adalah 10.24 meq / kg dan 5.81 mg / kg. Kajian selanjutnya menunjukkan bahawa nilai PV dan TBA PODM ketara ($P < 0.05$) berbeza diantara tahap GCB yang berbeza. Tahap 0.2% GCB menunjukkan penurunan tertinggi dalam nilai PV dan TBA masing-masing pada 8.96 meq / kg dan 4.95 mg / kg. Ini mengurangkan PV sebanyak 42.8% dan TBA sebanyak 55.1%. Kajian kesedapan telah dijalankan mengikut kaedah kafeteria menggunakan 4 kambing Boer kacuk. Pengambilan PODM dipelihara dengan GCB 0.2% (GDM), PODM tidak dirawat (UDM), rumput napier (NG) dan jerami padi (RS) sebagai standard adalah jauh berbeza ($P < 0.05$) pada hari pertama dan dalam tempoh 1, 2 dan 3. Dalam tempoh pertama, pengambilan GDM, UDM dan NG adalah lebih tinggi daripada RS. Pengambilan UDM (362.74 UDMg / hari) adalah lebih tinggi daripada GDM (211.16 GDMg / hari). Walau bagaimanapun, dalam tempoh kedua dan ketiga, pengambilan GDM ketara ($P < 0.05$) lebih tinggi daripada UDM. Tiada perbezaan yang signifikan pada kesan tahap GDM yang berbeza dalam empat diet eksperimen ke atas

jumlah pengambilan bahan kering (DMI), kebolehadaman ketara DM, NDF dan ADF kambing.

Tiada perbezaan yang signifikan dalam pH rumen kambing pada semua rawatan. pH rumen menurun sedikit dalam 2 jam dan selepas itu meningkat sehingga 6 jam. pH rumen untuk semua rawatan adalah dalam julat 6.47 - 7.10. Tiada kesan ketara diet eksperimen pada kepekatan nitrogen ammonia (13.20 - 16.68 mg/100ml) dalam rumen kambing. Pengambilan nitrogen adalah setanding antara empat rawatan pemakanan. Kesan diet eksperimen adalah jauh berbeza ($P < 0.05$) pada N najis sebagai peratus pengambilan dan N najis setiap berat metabolik (mg/kgBW^{0.75}). Kesan diet tidak ketara dalam kencing N perkumuhan. Walau bagaimanapun, kesan diet eksperimen berbeza secara ketara ($P < 0.05$) pada N penyerapan (g / d), pengekalan N (g / d), pengekalan N sebagai peratus pengambilan (% daripada pengambilan) dan pengekalan N sebagai peratus penyerapan bagi kambing. Dalam kajian kinetik penapaian *in vitro*, terdapat perbezaan yang signifikan ($P < 0.05$) pada kesan diet eksperimen ke atas nilai a, b dan a+b kecuali nilai c.

Satu perbezaan yang signifikan ($P < 0.05$) juga telah diperhatikan dalam penghasilan gas pada 24, 48 dan 96 jam. Tiada perbezaan ketara ($P > 0.05$) dalam kinetik penapaian antara GDM dan UDM. Kajian ini menunjukkan metanol adalah pelarut terbaik untuk mengekstrak CB dengan DPPH tinggi pengumpulan aktiviti, tetapi keupayaannya untuk mengurangkan PV dan TBA PODM adalah lebih rendah daripada GCB.

Ia telah diperhatikan bahawa GCB pada 0.2% (w/w) boleh mengurangkan PV dan TBA masing-masing sehingga 42.8% dan 55.1%. GDM adalah lebih sedap daripada UDM selepas 5 hari eksperimen dan kebolehadaman GDM dalam diet tidak jauh berbeza berbanding dengan kawalan.

Ia boleh disimpulkan bahawa PODM dirawat dengan 0.2% (w/w) GCB boleh digunakan sebagai makanan kambing tanpa memberi kesan negatif ke atas kebolehadaman makanan dan persekitaran rumen.

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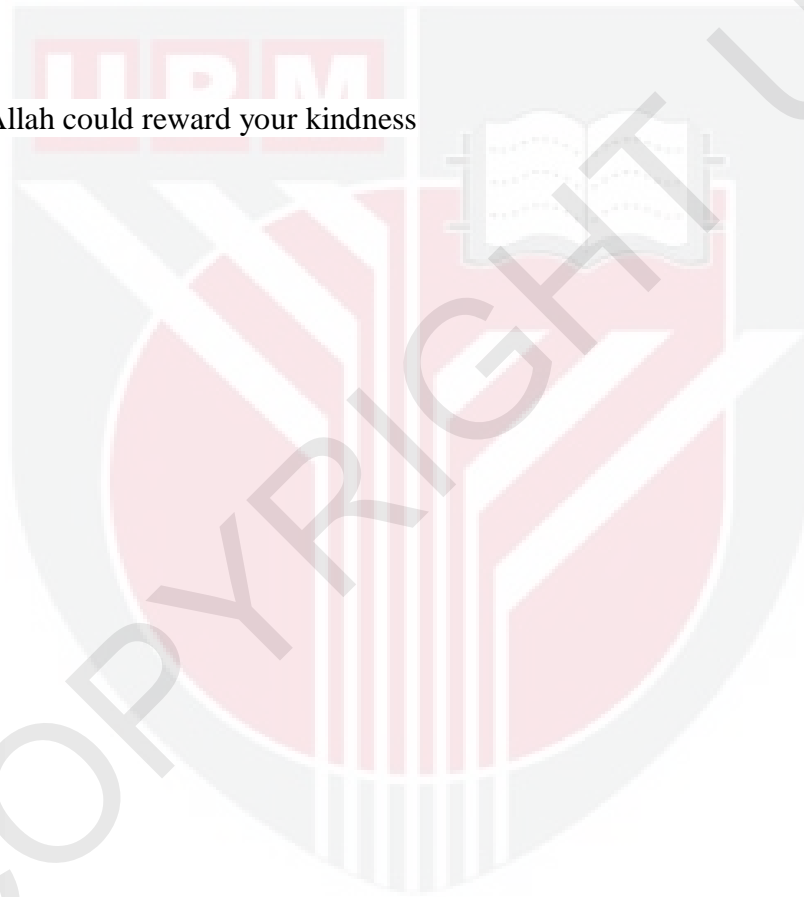
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Only Allah could reward your kindness



I certify that a Thesis Examination Committee met on 8th March 2013 to conduct the final examination of Muhammad Afdal on his Doctor of Philosophy thesis entitled “Preservative effect of cinnamon (*Cinnamomun burmannii*) bark powder in fresh palm oil decanter meal for goats” in accordance with Universiti Putra Malaysia (Higher Degree) Act 1980 and Universiti Putra Malaysia (Higher Degree) Regulation 2007. The Committee recommends that the candidate be awarded the relevant degree.

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DECLARATION

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

M. AFDAL

Date: 8th March 2013

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