UNIVERSITI PUTRA MALAYSIA

EFFECTS OF MULBERRY (*Morus alba*) FOLIAGE SUPPLEMENTATION ON SHEEP FED WITH RICE STRAW

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By

DWI YULISTIANI

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

January 2008

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DEDICATION

To

My devoted husband Markus Anda, my dearest children Dita and Ones and my beloved parents Soedjono and Soekini

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

EFFECTS OF MULBERRY (*Morus alba*) FOLIAGE SUPPLEMENTATION ON SHEEP FED WITH RICE STRAW

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January 2008

Chairman : Professor Zainal Aznam bin Mohd Jelan, PhD

Faculty : Agriculture

Feeding of fibrous agricultural by-product is the most appropriate strategy to reduce the cost of feeding of ruminants. However, these by-products have low nutritive values and the use of tree foliages as supplement could improve the utilisation of these fibrous feeds. A study consisting of three experiments was conducted with the aim of enhancing the utilization of rice straw by supplementation of the diet with mulberry foliage in sheep.

The first experiment evaluated the effect of adding fermentable energy in the mulberry-rice straw basal diet by *in vitro* gas production technique. Molasses supplementation to mulberry-urea treated rice straw based (TRSM) significantly ($P<0.05$) improved fermentation of the diet as indicated by the increase in gas production, microbial biomass yield and proportion of propionic acid. Supplementation of molasses at 5% level was sufficient to improve fermentation of the diet.

The second experiment was carried out based on the result from the first experiment. It was postulated that mulberry supplementation also provide fermentable nitrogen

and energy in the rumen. Therefore in the second experiment was conducted to compare the effect of mulberry foliage or urea-rice bran mixture supplementation on nutrient digestibility, N utilization, rumen fermentation and fibre degradation. Sheep were fed urea treated rice straw basal diet and three different supplements namely; (i) mulberry, (ii) 50% of the mulberry replaced with urea-rice bran mixture and (iii) mulberry was replaced by to rice bran and urea. DMI, nutrient digestibility, nitrogen balance, and efficiency rumen microbial protein synthesis was similar in sheep fed on urea treated rice straw based diet supplemented by mulberry foliage or urea-rice bran mix. Hence, mulberry supplementation at 30% level in urea treated rice straw basal diet provided fermentable energy and protein. The rate of protein degradability of mulberry in the rumen was reduced in sheep fed mixed urea-rice bran supplement. Supplementation of mulberry or urea-rice bran mixed to urea treated rice straw basal diet resulted in similar fibre degradation of rice straw or urea treated rice straw. Hence, mulberry or urea-rice bran mixture offers an alternative source of fermentable nitrogen and energy to improve the utilisation of rice straw by sheep.

The third experiment determined the effect of mulberry and mulberry-leucaena foliage supplementation on feed utilization, rumen fermentation and growth of lambs fed urea-treated rice straw basal diet. In an *in vitro* gas production study, mulberry was mixed with either one of the two leucaena varieties (*Leucaena leucocephala* hybrid and *Leucaena leucocephala* local) at 2 levels (25 and 50%). Supplementation of leucaena to mulberry decreased *in vitro* true organic matter digestibility (IVOMD), the rate of gas production and protein digestibility in the rumen buffered medium. Protein digestibility in acid pepsin which is an estimate of protein availability in intestine was increased. Tannin derived from leucaena hybrid

supplementation to mulberry at ratio 1:1 was most effective level to decrease protein digestion in the rumen, but increased the protein digestibility in acid pepsin incubation. In a feeding trial, supplementation level at 30% of mulberry-leucaena mixture at the ratio of 1:1 to urea treated rice straw basal diet showed similar effect to mulberry or rice bran supplementation on nutrient digestibility, N balance, microbial protein synthesis and body weight gain. Hence, supplementation of either mulberry-*Leucaena* mixture or mulberry or urea-rice bran mixture provided the critically deficient nutrient required by rumen microbes to stimulate rumen fermentation digestion and thus the efficiency forage utilization.

It is concluded that mulberry utilization improved when molasses was also supplemented to the rice straw basal diet. In addition, mulberry supplementation also provided the fermentable energy and nitrogen. However, due to the rapid microbial fermentation of mulberry protein in the rumen, mixing of *Leucaena* that has high tannin content with mulberry could reduce protein degradability in the rumen (*in vitro*). Feeding of *Leucaena*-mulberry mixture had similar effect to mulberry supplementation on growth of lambs.

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

STRATEJI SUPLEMENTASI MULBERI *(Morus alba)* FOLIAJ UNTUK BIRI-BIRI YANG DIBERI MAKANAN JERAMI PADI

Oleh

DWI YULISTIANI

January 2008

Pengerusi : Profesor Zainal Aznam bin Mohd Jelan, PhD

Fakulti : Pertanian

Pemberian makanan daripada hasil sampingan pertanian yang berserat adalah strategi yang wajar untuk mengurangkan kos pemberian makanan ruminan. Walau bagaimanapun, hasil sampingan ini mempunyai nilai pemakanan yang rendah dan penggunaan foliaj pokok sebagai suplemen boleh meningkatkan penggunaan bahan makanan berserat ini. Satu kajian yang mengandungi tiga eksperimen telah dilakukan dengan tujuan untuk meningkatkan penggunaan jerami padi dengan suplementasi diet ini dengan foliaj mulberi pada biri-biri.

Eksperimen pertama telah menilai kesan penambahan tenaga terfermentasi dalam diet berasas mulberi-jerami padi melalui teknik produksi gas *in vitro*. Suplementasi molas pada mulberi-jerami padi terawat urea pada kadar 5% (TRSM) adalah bererti ($P<0.05$) untuk meningkatkan fermentasi diet seperti ditunjukkan oleh peningkatan pengeluaran gas, hasil biomas mikrob dan perkadaran asid propionik. Suplementasi molas pada paras 5% adalah cukup untuk meningkatkan fermentasi diet.

Eksperimen kedua menilai kesan suplementasi mulberi foliaj berbanding campuran urea-dedak padi ke atas pencernaan nutrient, kegunaan nitrogen, ciri-ciri fementasi rumen dan degradasi serat. Biri-biri diberi diet berasas jerami padi urea terawat dan tiga suplemen berbeza berikut: (i) mulberi, (ii) 50% mulberi digantikan dengan campuran urea-dedak padi dan (iii) mulberi digantikan dengan campuran urea-dedak padi. Pengambilan makanan, pencernaan nutrient, imbangan nitrogen, efisiensi sintesis protein mikrob rumen adalah serupa pada biri-biri yang memakan jerami padi urea terawat dengan suplemen foliaj mulberi atau campuran urea-dedak padi.

Suplementasi mulberi pada aras 30% dalam diet berasaskan jerami padi urea terawat menyediakan tenaga terfermentasi dan protein. Kadar degradasi protein dalam rumen menurun dalam biri-biri yang memakan suplmen campuran urea-dedak padi. Suplementasi mulberi atau campuran urea-dedak padi kepada diet berasaskan jerami padi urea terawat menyebabkan kesan yang sama pada degradasi jerami padi atau jerami padi urea terawat. Oleh itu mulberi atau campuran urea-dedak padi memberi satu sumber alternatif nitrogen terfermentasi dan tenaga untuk meningkatkan penggunaan jerami padi pada biri-biri.

Eksperimen ketiga menentukan kesan suplementasi foliaj mulberi dan mulberi-leucaena ke atas penggunaan makanan, fermentasi rumen dan pertumbuhan anak biri-biri yang diberi makanan asas jerami padi urea terawat. Dalam kajian pengeluaran gas *in vitro*, mulberi telah dicampurkan dengan sama ada satu daripada dua variati *Leucaena* (hybrid *Leucaena leucocephala* dan *Leucaena leucocephala* tempatan) pada 2 aras (25 dan 50%). Suplementasi *leucaena* kepada mulberi menurunkan pencernaan benar *in vitro* bahan organik (IVOMD), kadar produksi gas

dan pencernaan protein dalam rumen. Pencernaan protein dalam asid pepsin yang menganggarkan kesediaadaan protein dalam usus kecil telah meningkat. Tannin daripada hibrid leucaena yang disuplementasikan kepada mulberi pada nisbah 1:1 paling efektif untuk mengurangkan pencernaan protein dalam rumen, tetapi meningkatkan pencernaan protein dalam inkubasi asid pepsin. Dalam satu percubaan pemberian makanan, suplementasi campuran dengan nisbah 1:1 mulberry-leucaena pada paras 30% kepada diet berasaskan jerami padi urea terawat, menunjukkan kesan yang sama kepada mulberi atau suplementasi dedak padi ke atas pencernaan nutrien, keseimbangan N, sintesis mikrob rumen dan kenaikan berat badan. Oleh itu, suplementasi sama ada campuran mulberi-leucaena atau mulberi atau campuran urea-dedak padi menyediakan nutrient kritikal yang kurang dan diperlukan oleh mikrob rumen untuk merangsang fermentasi rumen dan efisiensi penggunaan foraj.

Adalah dirumuskan bahawa pengggunaan mulberi meningkat apabila molas juga disuplementasikan kepada diet berasaskan jerami padi. Tambahan lagi, suplementasi mulberi juga menyediakan tenaga dan nitrogen terfermentasi. Walau bagaimanapun, disebabkan oleh fermentasi mikrob yang cepat pada protein mulberi dalam rumen, campuran *leucaena* yang mengandungi tannin yang tinggi dengan mulberry boleh mengurangkan degradasi protein di dalam rumen (*in vitro*). Pemberian campuran *leucaena*-mulberry memberi kesan yang sama dengan supplementasi mulberry pada pertumbuhan anak biri-biri.

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Finally, my deep gratitude is extended to my husband, Markus Anda and my children, Marulini Piadiata Salokang and Onesmus Hopijayanto Salokang for their patience, continuous support, understanding and encouragement throughout my study.

I certify that an Examination Committee met on 14th January 2008 to conduct the final examination of Dwi Yulistiani on her Doctor of Philosophy thesis entitled "Strategic supplementation of mulberry (*Morus alba)* foliage for sheep fed rice straw" in accordance with University Putra Malaysia (Higher Degree) Act 1980 and University Putra Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

AZHAR B. KASIM, Ph.D.
Associate Professor,
Faculty of Agriculture
University Putra Malaysia
(Chairman)

ABDUL RAZAK ALIMON, Ph.D.
Professor,
Faculty of Agriculture
University Putra Malaysia
(Internal Examiner)

MOHD RIDZWAN B. ABDUL HALIM, Ph.D.
Associate Professor,
Faculty of Agriculture
University Putra Malaysia
(Internal Examiner)

BOB ORSKOV, Ph.D.
Professor Emeritus
(External Examiner)

_____
HASANAH MOHD GAZALI Ph.D.
Professor/Deputy Dean
School of Graduate Studies
University Putra Malaysia

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

Zainal Aznam B. Mohd Jelan, PhD
Professor
Faculty of Agriculture
University Putra Malaysia
(Chairman)

Halimatun Yaakub, PhD
Associate Professor
Faculty of Agriculture
University Putra Malaysia
(Member)

Liang Juan Boo, PhD
Associate Professor
Institute Biosience
University Putra Malaysia
(Member)

Norhani Abdullah, PhD
Professor
Faculty of Biotechnology and Biomoleculer Sciences
University Putra Malaysia
(Member)

AINI IDERIS, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 21 February 2008

DECLARATION

I hereby 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 or concurrently submitted for any other degree at UPM or other institutions.

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DWI YULISTIANI

Date: 5 February 2008

LIST OF TABLES