IN VITRO EVALUATION OF NAPIER GRASS-OIL PALM FROND COMBINATION AS RUMINANT FEED

Wong Meng Joo, [1]Mohamed Ali Rajion, Leong Zi Ping, Mahdi Ebrahimi & [1,2]Goh Yong Meng

[1]Department of Veterinary Preclinical Sciences
[2]Ruminant Diseases Research Centre
Faculty of Veterinary Medicine
Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

Abstract

The effects of different combinations of Napier grass (*Pennisetum purpureum*) and oil palm (*Elaeis guineensis* Jacq) fronds on ruminal fermentation patterns *in vitro* in goats were investigated. Rumen liquor from three 2-year-old Kacang-crossbred goats was mixed with buffer and substrates. Four dietary treatments were compared namely 100% concentrates (CON), 50% OPF with 50% concentrates (OPF 50), 50% Napier grass with 50% concentrates (NP 50), and 25% Napier grass, 25% OPF and 50% concentrates (NP-OPF)). Incubation of the mixture was carried out at 39°C for 24 h. Total gas production (GP) was recorded after 2, 4, 6, 8, 10, 12 and 24 h of incubation. Rumen fluid pH, methane gas, total volatile fatty acids and *in vitro* dry matter digestibility (IVDMD) were determined at the end of incubation. Long chain fatty acid (LCFA) profiles were obtained in separate runs to determine the apparent biohydrogenation (BH) of linoleic (C18:2n-6) and α-linolenic acids (C18:3n-3). Cumulative gas production was significantly higher for the CON group ($P<0.05$) but not significantly different in the other groups. The NP 50 diet produced significantly higher methane ($P<0.05$) while other groups did not differ significantly. For IVDMD, the NP-OPF group had a significantly higher digestibility than the NP 50 and OPF 50 groups. Rumen fluid pH, total VFA and apparent BH values for all treatments were not significantly different. In conclusion, the Napier-OPF combination represents a suitable feed for the small ruminant sector in Malaysia but more studies need to be done on effects of OPF on rumen biohydrogenation.

Keywords: *in vitro*, Napier grass, oil palm fronds, fermentation, biohydrogenation, goats

INTRODUCTION

The ruminant sector in Malaysia is not well developed, which is attributable to limited grazing grassland, suboptimum pasture quality and smallholder domination. Malaysia's food self-sufficiency did not show significant improvement in recent years. Malaysia produced only about 4.67% dairy products, 9.03% lamb/mutton and 24.07% beef (Abu Hassan *et al*., 1993).

Napier grass (*Pennisetum purpureum*) has been shown to be the most adaptable and productive fodder grass under Malaysian conditions. Napier grass is an appropriate

perennial fodder recommended for intensively managed livestock systems. Cut-and-carry feeding management of the grass is also well practiced.

Malaysia is a leading country in palm oil production where about 3.87 million hectares of land was used for oil palm plantations. Oil palm (*Elaeis guineensis* Jacq) fronds are abundantly available agricultural byproducts, with around 26 million tonnes produced each year (Wan Zahari *et al*., 2003). The OPF can be used as a source of alternative energy for ruminants. However, OPF cannot be used as sole feed due to its high lignin (205/kg DM) (Abdul Khalil *et al*., 2006) and neutral detergent fiber content (700g/kg DM) (Ishida and Abu Hassan, 1997).

Combinations of Napier grass and OPF can be good ruminant feeds which may help solve the the feed insufficiency problem related to the low ruminant production level.

MATERIALS AND METHODS

Three 2 year-old fistulated goats (Kacang crossbred, male, 31.62 ± 1.66 kg bodyweight) were used. The animals were fed twice daily with a combination of OPF, Napier grass and concentrates at a 1:1:2 ratio at 2.5% of BW in dry matter throughout a 10-day adaptation period.

Rumen liquor was collected from rumen fistulated goats early in the morning pre-feeding, pooled and squeezed through four layers of cheese cloth. The rumen fluid/buffer solution was prepared by mixing the rumen fluid and phosphate and bicarbonate buffer.

Incubation of the rumen fluid/buffer was carried out at 38°C for 24 h. Gas production was recorded at 2, 4, 6, ,8, 10, 12 and 24 hour of incubation. Rumen fluid pH, *in vitro* dry matter digestibility (IVDMD), methane production and total volatile fatty acids (VFA) were measured after 24 h incubation. The apparent biohydrogenation values of linoleic (18:2n-6) and α-linolenic acid (18:3n-3) were calculated according to Vlaeminck *et al*. (2008).

RESULT AND DISCUSSION

The effects of different feed combinations on cumulative gas production, methane production, IVDMD, rumen fluid pH and total VFA are presented in Table 1, Table 2, Table 3, Table 4 and Table 5, respectively. Apparent biohydrogenation for C18:2n-6 and C18:3n-3 is presented in Table 6.

The cumulative gas production for CON was significantly higher with no significant differences between the rest of the groups. In fact, The NP-OPF produced a higher gas production than OPF 50 and NP 50. This indicates that the NP-OPF combination is more fermentable than Napier grass or OPF alone.

Methane is produced by the reduction of carbon dioxide in the rumen, which cannot be further utilized and eventually removed by eructation. A higher methane production signifies higher energy losses by the animals. The NP 50 had yielded significantly higher methane gas than the CON. The groups that showed a significantly lower GP and IVDMD than group CON produced significantly higher methane. The levels of methane production in this study were comparable to reports by Navarro-Villa *et al*. (2011) who

found a negative relationship between *in vitro* methane output and amount dry matter degraded, i.e. there will be lower methane production in feed with better digestibility.

Table 1. Effect of different feed combinations on *in vitro* cumulative gas production

Treatment	Cumulative gas production (mL/g DM)
CON	$148.67^{a} \pm 5.98$
OPF 50	$85.85^{b} \pm 4.32$
NP 50	$94.59^{b} \pm 5.82$
NP-OPF	$96.97^{b} \pm 4.46$

All values are mean ± SE (n = 12)
* $^{a, b, c}$ values with different superscripts in a column differ significantly $P < 0.05$.

Table 2. Effect of different feed combinations on methane gas production

Treatment	Methane production (mL/g DM)
CON	$6.53^{b} \pm 0.48$
OPF 50	$7.08^{a,b} \pm 0.47$
NP 50	$8.79^{a} \pm 0.92$
NP-OPF	$7.24^{a,b} \pm 0.58$

All values are mean ± SE (n = 12)
$^{a, b, c}$ values with different superscripts within column differ significantly $P < 0.05$.

Table 3. Effect of different feed combinations on *in vitro* dry matter digestivity

Treatment	Digestibility (% DM)
CON	$44.65^{a} \pm 1.74$
OPF 50	$33.60^{c} \pm 1.34$
NP 50	$34.53^{b,c} \pm 2.70$
NP-OPF	$40.65^{a,b} \pm 1.90$

All values are mean ± SE (n = 12)
* $^{a, b, c}$ values with different superscripts within column differ significantly $P < 0.05$.

Table 4. Effect of different feed combinations on pH

Treatment	Digestibility (% DM)
CON	7.22 ± 0.02
OPF 50	7.24 ± 0.01
NP 50	7.24 ± 0.01
NP-OPF	7.24 ± 0.05

All values are mean ± SE (n = 12)

Table 5. Effect of different feed combinations on total volatile fatty acid

Treatment	Digestibility (% DM)
CON	24.91 ± 4.62
OPF 50	22.55 ± 4.78
NP 50	20.48 ± 4.85
NP-OPF	18.52 ± 4.89

All values are mean ± SE (n = 12)

Table 6. Effect of different feed combinations on apparent biohydrogenation

Treatment	Apparent Biohydrogenation	
	C18:2n-6	C18:3n-3
CON	0.75 ± 0.02	0.77 ± 0.06
OPF 50	0.70 ± 0.03	0.69 ± 0.05
NP 50	0.75 ± 0.03	0.78 ± 0.02
NP-OPF	0.68 ± 0.02	0.73 ± 0.03

All values are mean ± SE (n = 6)

The rumen fluid pH encountered ranged from 7.22 to 7.24 with no significant differences. The pH of the NP-OPF group was high and it was a good finding since various studies had suggested that a higher rumen pH will favour the growth and activity of cellulolytic bacteria, thereby enhancing fiber digestion, DM intake and growth performance (Zinn and Salinas, 1999).

In spite of the high apparent IVDMD and gas production observed, group NP-OPF yielded the lowest total VFA although there were no significant differences among all groups.

The treatment groups containing OPF had lower but non-significantly different apparent BH values than the other two groups. Previous studies showed that OPF contains tannin, which may favourably alter ruminal BH and promoting accumulation of healthy fatty acids. The lowered apparent BH values observed were probably due to the high tannin content of OPF. However, reports on the tannin effect on ruminal BH are few and contradictory. Khiaosa-Ard *et al*. (2009) had shown a positive effect on rumen vaccenic acid (VA) accumulation, while *in vivo* studies suggested non-significant or even negative effects (Benchaar and Chouinard, 2009).

The Napier grass-OPF combination can be a good ruminant feed since its use would reduce the farmer's feed costs and environmental waste, while producing even better results in certain aspects compared to the use of Napier grass and OPF alone.

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