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Feed Intake, Digestibility and Growth Performance of Goats Offered Napier grass Supplemented with Molasses Protected Palm Kernel Cake and Soya Waste

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ABSTRACT
The high costs of commercial concentrates limit livestock production in South-east Asia. The efficient use of local feed resources may minimize the costs and improve the productivity. Palm Kernel Cake (PKC) contains moderate levels of protein and energy, which is considered sufficient to meet the requirements of most ruminants. However, its protein degradability in the rumen is high resulting in losing its function as protein source for ruminant. This experiment was aimed to investigate the effect of feeding molasses protected PKC and soya waste on intake, nutrient digestibility and growth performance of young female goats. Eight goats were divided into 2 groups and allocated to respective feeding treatments. The treatments were T1 = napier grass (*Pennisetum purpureum*)+1.0% commercial pellet of live weight (LW) and T2 = napier grass+1.0% PKC of LW+100 g molasses+55 g soya waste. The results indicated that the T1 treatment increased ($p<0.05$) napier grass Dry matter (DM) intake (370 vs. 295 g day^{-1}) compared to T2 treatment but the total intakes of DM (584 vs. 668 g day^{-1}), organic matter (OM) (532 vs. 585 g day^{-1}), Neutral Detergent Fibre (NDF) (308 vs. 344 g day^{-1}) and crude protein (CP) (59.2 vs. 58.9 g day^{-1}) were similar ($p>0.05$) for both treatments, respectively. The T1 treatment also increased ($p<0.05$) apparent digestibility of DM (64.1 vs. 56.3%), OM (67.3 vs. 58.9%), NDF (55.9 vs. 45.2%) and CP (68.4 vs. 52.1%) compared to T2 treatment, but they had no effect ($p>0.05$) on average daily gain (59.0 vs. 72.1 g day^{-1}) and feed conversion ratio (10.4 vs. 9.6), respectively. It is concluded that supplementing a napier grass-based diet with molasses protected PKC and soya waste can be used as source of protein and energy, exploiting the use of local feed resources for goat production.

Key words: Palm kernel cake, molasses, soya waste, goats, growth performance

INTRODUCTION
Palm Kernel Cake (PKC) is an oil palm by-product and it is available in the tropics (Rhule, 1996), including South-East Asia. It is considered as a medium quality energy feed for ruminants with a moderate content of crude protein (Carvalho *et al.*, 2005), although its composition varies depending on source, the extent and methodology of oil removal and the proportion of endocarp remaining (Hindle *et al.*, 1995). Zahari and Alimon (2005) reported that supplementing the traditional rations of beef cattle with 30-50% PKC gave improved performance and increased Live weight (LW) gain. Long-term feeding of PKC can cause Cu toxicity in sheep (Wan Mohamed *et al.*, 1987) but its toxicity does not appear in cattle, buffaloes, goats and other animals.

Limited research has been conducted evaluating PKC as a major component of high-concentrate diets in growth performance of goats. A study conducted previously with growing goats have shown poor growth response (52.5 g day^{-1}), when goats received napier grass (*Pennisetum purpureum*) supplemented with 2.0% concentrate mixture (inclusion of 32% PKC) of LW (Rahman *et al.*, 2012). Alimon (2006) reported that protein content of PKC is only 16-18%, which would exclude it as a protein feed. In addition, protein degradability of PKC in rumen is high which results in losing its function as protein source for ruminants.

Research on PKC-based concentrate diet using additives or other feed ingredients should be carried out that may contribute to improve utilization of PKC-nitrogen (N) by slower degradation of N in the rumen. For example, the rate of N degradation is slow in the rumen, when easily fermented carbohydrates (e.g., molasses) are added in the ration (Rotger *et al.*, 2006; Kardaya *et al.*, 2009). In addition, inclusion of small quantities of soya waste (a by-product of tofu, soymilk and soy protein manufacturing) in the PKC-based diet may lift the protein content significantly, because it is high (23.8%) in protein content (Dong *et al.*, 2005). However, the information available on the slower degradation of PKC-N in the rumen is limited. Therefore, the objective of this study was to assess the effect of supplementation with molasses protected PKC and soya waste on feed intake, digestibility and LW gain of growing goats fed a basal diet of napier grass.

MATERIALS AND METHODS

Management of napier grass: Napier grass was harvested daily from established plots at the ISB (Institute of Biological Sciences) Mini Farm, University of Malaya, Malaysia. The grass was harvested (45-60 days post previous harvest) from four equal plots so that its maturity was controlled by cutting at different times in order to obtain similar quality throughout the experimental period. Each plot was used for 15 consecutive days and re-growths of three of the previously used plots were used again for completion of the experiment. The grass was harvested at about 1 m height and chopped to a size of about 5 cm.

Experimental animals and their management: Eight female goats (Boer×local) with 9-12 months of age were used in the present study. All animals were treated for internal parasites with Bomectin (Bomac Laboratories Ltd., Auckland, New Zealand). Prior to beginning the experimental feeding, all goats were fed napier grass *ad libitum* supplemented with 1.0% commercial pellet of LW for 14 d. After adaptation of similar feeding, the goats were divided into two groups of 4 animals each. Initial average weights were 14.1±1.70 (group 1) and 13.5±0.95 kg (group 2). Goats in group 1 were fed the 1.0% commercial pellet of LW (T1), whereas those in group 2 were given the 1.0% PKC of LW+100 g molasses+55 g soya waste (T2). Approximate metabolizable energy from daily offered supplements (except napier grass) for T1 and T2 diets were 2.70 and 3.70 MJ, respectively. Similarly, approximate crude protein from daily offered supplements (except napier grass) for T1 and T2 diets were 32 and 38 g, respectively.

Molasses was offered to animals with water. In addition, animals in both groups (groups 1 and 2) were allowed to consume napier grass *ad libitum*, allowing for about 10% refusals. The amount of commercial pellet and PKC was determined individually for the goats on the basis of their measured live weights. The goats were housed in individual pens equipped with feeding and watering troughs. The pens and troughs were cleaned every day before offering feed. All animals had free access to water and mineral lick block. Soya waste was bought every week at a local soybean processing factory, stored in plastic containers and kept it airtight (anaerobically) with a lid on it.

Feeding trial: The feeding trial was carried out for 90 days in which the feed intake and live weight changes were measured. The supplements (commercial pellet, PKC, molasses and soya waste) were offered to animals in one morning meal throughout the feeding period, while the napier grass was offered *ad libitum* two times a day at 0900 and 1400 h. Refusals were collected and weighed every morning to obtain an estimate of intake. Daily record of feed intake was maintained throughout the experiment. All the goats were weighed individually every week before feeding in the morning. The average daily gain was calculated by dividing the initial and final LW differences by total number of experimental days (90 days).

Digestibility trial: After completion of 90 days of feeding trial, four animals per treatment were transferred to metabolism crates on the 91st day. After allowing the animals an adjustment period of 3 days to the metabolism crates, feces was collected for 7 days. Feces voided by each goat was weighed and recorded every day, mixed and 20% of representative samples were taken and frozen at -20°C. The same was done for the feed offered and refusal samples collected. Composite samples of feed offer, refusal and feces were thawed to room temperature, mixed thoroughly and oven dried at 70°C for 48 h. The dried samples of feeds and feces were ground through 1 mm sieve and stored until analyzed. Nutrient digestibility (%) was calculated as a difference between nutrient intake and nutrient voided in the feces divided by nutrient intake and the quotient multiplied by 100.

Chemical analysis: For determination of total Dry matter (DM) content, samples of dried feeds, feces and refusal were dried at 70°C for 48 h in a forced draft oven. Ash content was determined by combusting samples at 550°C overnight and Organic matter (OM) content was calculated by difference (OM = 100-ash content). Nitrogen (N) content was determined using the Kjeldahl method (AOAC, 1990) and Crude protein (CP) was calculated as N×6.25. Neutral detergent fibre (NDF) was determined using the procedures of Van Soest *et al*. (1991).

Statistical analysis: Data from the experiment on feed intake, LW gain and digestibility were subjected in Student's t-test (Snedecor and Cochran, 1989) using SPSS package (SPSS).

RESULTS

Chemical composition of the experimental feeds: The chemical composition of feeds used in this experiment is shown in Table 1. The PKC contained lower quality in terms of low CP (10.6%) and high NDF (58.0%), while soya waste contained higher quality in terms of high CP (27.9%) and low NDF (30.5%). The nutritive value of pellet was intermediate to that of PKC and soya waste. On the other hand, napier grass contained lower quality in terms of low CP (7.3%) and high NDF (69.4%).

Table 1: Chemical composition of commercial pellet, palm kernel cake, soya waste and napier grass

Composition (% DM)	Pellet	Palm kernel cake	Soya waste	Molasses	Napier grass
OM	93.3	85.4	94.7	92.1	89.8
NDF	24.1	58.0	30.5	4.2	69.4
CP	15.0	10.6	27.9	0.1	7.3
Ash	6.7	14.6	5.3	7.9	10.2

DM: Dry matter, OM: Organic matter, NDF: Neutral detergent fibre, CP: Crude protein

Dry matter and nutrient intakes: The mean daily DM and nutrient intakes of the experimental goat during the feeding trial are indicated in Table 2. Commercial pellet, PKC, molasses and soya waste were readily accepted by goats with no refusals. Roughage DM intake was higher (370 vs. 295 g day^{-1}) in the group 1 (T1) as compared with the group 2 (T2), while intakes of total DM (584 vs. 668 g day^{-1}), OM (532 vs. 585 g day^{-1}), NDF (308 vs. 344 g day^{-1}) and CP (59.2 vs. 58.9 g day^{-1}) were higher in the group 2 as compared with the Group 1, respectively. However, significant ($p<0.05$) difference was only observed in roughage DM intake between treatments.

Live weight changes: Table 3 describes the growth performances of goats during the experimental period. The initial LW did not differ (14.1 vs. 13.5 kg $head^{-1}$) between groups 1 and 2. Similarly, the final LW did not differ (19.1 vs. 19.7 kg $head^{-1}$) significantly ($p>0.05$) between the groups. There was an increase in LWs of the goats in both treatment groups. During the whole experimental period, the total LW gains of groups 1 and 2 were 5.1 and 6.2 kg $head^{-1}$, respectively. The average daily gain did not differ significantly ($p>0.05$) between the groups. Goats fed T1 and T2 diets gained 59.0 and 72.1 g/head/day, respectively.

Dry matter and nutrient digestibility: The digestibility (%) of DM, OM, NDF and CP is presented in Table 4. Goats fed napier grass supplemented with commercial pellet (T1) showed higher ($p<0.05$) DM digestibility than the goats fed napier grass supplemented with molasses

Table 2: Dry matter (DM) and nutrient intakes of goats fed a basal diet of napier grass with supplementation

	Treatment	
Parameter	T1: Concentrate group	T2: PKC group
Roughage DM intake (g day^{-1})	370±29.43[a]	295±20.41[b]
Total DM intake (g day^{-1})	584±35.02	668±27.14
Total DM intake (g/kg $W^{0.75}$/day)	285±20.54	317±13.20
Total DM intake (kg/% LW)	3.25±0.27	3.39±0.17
Total OM intake (g day^{-1})	532±31.74	585±24.89
Total NDF intake (g day^{-1})	308±21.30	344±18.43
Total CP intake (g day^{-1})	59.2±3.33	58.9±2.43

Values are Mean±SEM of four animals in each group, The values in a row having different letters differ significantly at $p<0.05$, PKC: Palm kernel cake, OM: Organic matter, NDF: Neutral detergent fibre, CP: Crude protein

Table 3: Growth performance of goats fed a basal diet of napier grass with supplementation

	Treatment	
Parameter	T1: Concentrate group	T2: PKC group
Initial weight (kg)	14.1±1.70	13.5±0.95
Final weight (kg)	19.1±2.09	19.7±1.38
Total live weight gain (kg)	5.1±0.51	6.2±0.44
Live weight gain (g day^{-1})	59.0±5.92	72.1±5.13
FCR (kg DMI/kg gain)	10.4±1.88	9.6±0.95

Values are Mean±SEM of four animals in each group, PKC: Palm kernel cake, FCR: Feed conversion ratio

Table 4: Dry matter (DM) and nutrient digestibility of goats fed a basal diet of napier grass with supplementation

	Treatment	
Parameter	T1: Concentrate group	T2: PKC group
Apparent digestibility (%)		
DM	64.1±0.65[a]	56.3±1.30[b]
OM	67.3±0.85[a]	58.9±1.74[b]
NDF	55.9±0.31[a]	45.2±2.73[b]
CP	68.4±1.01[a]	52.1±4.34[b]

Values are Mean±SEM of four animals in each group, The values in a row having different letters differ significantly at $p<0.05$, PKC: Palm kernel cake, DM: Dry matter, OM: Organic matter, NDF: Neutral detergent fibre, CP: Crude protein

protected PKC and soya waste (T2). Similarly, goats fed T1 diet showed higher ($p<0.05$) digestibility of OM (67.3 vs. 58.9%), NDF (55.9 vs. 45.2%) and CP (68.4 vs. 52.1%) than the goats fed T2 diet, respectively.

DISCUSSION

Palm kernel cake is an important feed ingredient for ruminants and its protein value is higher than copra cake (Devendra, 1978). This by-product has moderate digestible energy and CP contents and high fiber content (Carvalho *et al*., 2005). However, its protein degradability in the rumen is high resulting in losing its function as protein source for ruminants. Protein protection techniques may be suggested as a means of improving utilization of PKC-N. For example, heating of soybean meal improves the efficiency of protein in ruminants as a decrease in protein degradation in the rumen and absorb in the small intestine (Plegge *et al*., 1985; Demjanec *et al*., 1995). However, heating of PKC has no effect on improvement of cow performance (Akbarillah and Hidayat, 2009). Some researchers reported that the rate of protein degradation is slow in the rumen, when easily fermented carbohydrates (e.g. molasses) are added in the ration (Rotger *et al*., 2006; Kardaya *et al*., 2009). In this study, protection of PKC-N from degradation in rumen has been performed using molasses.

Supplementation with molasses protected-PKC and soya waste (T2) resulted in higher total DM, OM and NDF intakes than supplementation with concentrate (T1), but the differences were not significant ($p>0.05$) between treatments. It however significantly ($p<0.05$) resulted in depression of the grass intake (Table 2). This depression of grass intake might be due to the high moisture content (78%) of soya waste. High moisture may cause a decrease in palatability which leads to a decrease in roughage DM intake. This finding is in line with previous findings of Clarke and Dyer (1973) and Fifield and Johnson (1978) who observed that DM intake of cattle decreased with wood fibers of high moisture content. Palm kernel cake is highly palatable for ruminants and its levels did not have an effect on voluntary feed intake (Chanjula *et al*., 2011). In this study, all supplementations (concentrate, PKC, molasses and soya waste) were accepted by goats with no refusals in both treatments.

Despite the decrease in grass DM intake in T2 treatment, there was no difference on the consumption of NDF between treatments. This might be a response to the high level of NDF in the PKC (Table 1) which contributed in an increase in NDF content in T2 diet. Despite the reduction in grass DM intake in T2 treatment, the both treatments had no effect on the consumption of CP (Table 2). This may have been due to the high CP content (27.9%) in the soya waste and medium CP content (10.6%) in the PKC (Table 1). However, the CP content of PKC used in this experiment was lower than the CP content of PKC (14.5-19.6%) as reported by Alimon (2006). The nutritive value of PKC varies considerably based on source (Rhule, 1996) and methodology of oil removal (Hindle *et al*., 1995).

The growth performance of the goats in the current study was similar between treatments. The current study shows that it might be possible to replace commercial concentrate by molasses-protected PKC and soya waste in the diet of growing goats without negative impact on growth performance. The daily LW gain of the molasses protected PKC-based diet (T2) of this study was higher than the PKC-based concentrate diet of previous study (Rahman *et al*., 2012), which where in the ranges of 10.2 to 52.5 g day^{-1} for the goats. Such differences in results could be attributed to differences in the nature of the supplements used. The similar performance of the goat in the T2 treatment in this study could be attributed to the readily fermented carbohydrates (molasses) used as compared to the T1 treatment. Kardaya *et al*. (2009) reported that molasses can provide levels of ammonia that are release slowly in the rumen. It indicates that molasses has a role to protect the protein from microbial degradation in the rumen which would be advantageous in terms of by-pass protein. It has been well established that the efficiency of urea or nitrogen utilization is very dependant on the quantity of readily fermentable carbohydrates present (Helmer and Bartley, 1971; Goodrich *et al*., 1972). Moreover, soya waste in this study might also be partially contributed to increase LW gain; hence its CP content was reasonably high (27.9%). Earlier studies showed that cattle and buffaloes fed PKC as supplements or basal diets generally result in improved growth performance (Hutagulung and Mahyuddin, 1985; Jelan *et al*., 1991) but the information available on the use of molasses protected-PKC in diets for goats is limited.

In the current study, supplementation of goats with concentrate (T1) significantly ($p<0.05$) improved the apparent DM, OM, NDF and CP digestibility compared to goats in the T2 group. The difference in digestibility of DM and nutrients of the feed observed in the present study could be attributed to the low CP content of the PKC (Table 1), because digestibility is much reduced when a ration contains little protein in proportion to the amount of readily digestible carbohydrate as reported by McDonald *et al*. (2011). Carvalho *et al*. (2005) reported that digestibility of PKC protein *in sacco* at 16 h is 52.4%. Meanwhile, CP digestibility in cow rations containing PKC was reported by 77.6% (Alimon, 2006). Despite the decrease in digestibility in T2 treatment, there were no differences on the total DM intake and LW gain between treatments. This suggests that protection techniques of PKC-N through molasses in line with expectations. Kioumarsi *et al*. (2011) also reported that the molasses were uses in the goats had positive effects on body function. However, further research is required to increase the DM and nutrient digestibility of PKC using molasses in the diet of goats. In addition, inclusion of soya waste in the PKC-based diet may increase the protein content significantly and research should be carried out in this regard.

CONCLUSION

Molasses-protected PKC and soya waste supplementation did not affect total DM intake, NDF intake, CP intake, LW gain and FCR, whereas it resulted in a reduced napier grass intake and apparent digestibility of nutrients than in those goats fed on pellet supplementation. Under this study, the molasses-protected PKC and soya waste can be efficiently used as a good source of energy and protein for goats fed with napier grass without affecting growth performance and indicates a good approach in exploiting the use of local feed resources for goat production.

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