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Nutritive value of palm kernel cake and cocoa pod husks for growing cattle

(Nilai pemakanan hampas isirung kelapa sawit dan lenggai koko bagi lembu yang membesar)

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Key words: nutritive value, palm kernel cake, cocoa pod husks, cattle

Abstrak

Data tentang pengambilan makanan, nilai pemakanan dan imbangan nitrogen dalam diet hampas isirung kelapa sawit (HIKS) dan lenggai koko (LK) untuk lembu yang membesar dilaporkan. Pengambilan bahan kering dan bahan organik didapati tidak berbeza secara ketara antara perlakuan. Kebolehcernaan bahan kering dan bahan organik menurun dengan peningkatan aras LK dalam diet. Nilai ketara kebolehcernaan protein kasar, serabut detergen asid, serabut detergen neutral, kandungan sel, ekstrak eter, abu dan tenaga masing-masingnya 72.8, 73.1, 76.0, 66.7, 83.6, 66.9 dan 75.1% bagi perlakuan I (HIKS). Bagi perlakuan II (70% HIKS + 30% LK), nilai masing-masing 63.2, 61.0, 65.1, 76.8, 80.8, 63.8 and 63.8% manakala bagi perlakuan III (50% HIKS + 50% LK), 56.8, 51.8, 55.8, 79.5, 82.2, 64.7 dan 58.9%. Nilai bagi perlakuan IV (30% HIKS + 70% LK) ialah 49.2, 42.1, 46.1, 84.7, 69.2, 62.1 dan 49.4%. Nilai penahanan nitrogen menurun dengan peningkatan aras LK dalam diet dan berbeza secara ketara (p <0.05) antara perlakuan. Nilai boleh cerna protein kasar, penahanan protein kasar, tenaga boleh cerna dan tenaga metabolisme masing-masingnya 120 g/kg, 82.5 g/kg, 3.196 Mcal/kg dan 2.621 Mcal/kg bagi perlakuan I. Nilai-nilai ini menurun dengan peningkatan aras LK dalam diet. Nilai pemakanan HIKS lebih tinggi daripada nilai pemakanan LK bagi lembu.

Abstract

The results of feed intake, nutritive value and nitrogen balance studies of palm kernel cake (PKC) and cocoa pod husks (CPH) diets for growing cattle were reported. Intake of dry matter and organic matter were not significantly different between treatments. Digestibility of dry matter and organic matter in the diets decreased with increasing CPH levels in the diets. The respective values for apparent digestibility of CP, ADF, NDF, cell contents, EE, ash and energy were 72.8, 73.1, 76.0, 66.7, 83.6, 66.9 and 75.1% for Treatment I (PKC); 63.2, 61.0, 65.1, 76.8, 80.8, 63.8 and 63.8% for Treatment II (70% PKC + 30% CPH); 56.8, 51.8, 55.8, 79.5, 82.2, 64.7 and 58.9% for Treatment III (50% PKC + 50% CPH); and 49.2, 42.1, 46.1, 84.7, 69.2, 62.1 and 49.4% for Treatment IV (30% PKC + 70% CPH). The values for nitrogen retention decreased with increasing levels of CPH in the diets and were significantly different between treatments. The digestible CP, CP retention, DE and ME values of Treatment 1 were 120 g/kg,

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82.5 g/kg, 3.196 Mcal/kg and 2.621 Mcal/kg respectively. These values decreased with increasing CPH levels in the treatments. Palm kernel cake had higher nutritive value than CPH for cattle.

Introduction

The use of palm kernel cake (PKC) in ruminant feeding systems has been widely reported (Hutagalung et al. 1986; Mustaffa-Babjee et al. 1986; Jalaludin et al. 1991). In 1995, Malaysia produced about 1.29 million tonnes of PKC (Porla 1997) of which a total of 0.90 million tonne (69.7%) was exported to the European Union, mainly to the Netherlands, Germany and United Kingdom. PKC contains potentially toxic levels of Cu for sheep, and local researchers have used molybdate and ferrous sulphate (Abdul Rahman et al. 1989) and Zn (Hair-Bejo and Alimon 1995) to protect against the toxicity of Cu in sheep.

Malaysia is the world's fourth largest producer of cocoa beans with production of 195 000 t in 1994. With an extraction rate of 70%, it is estimated that 450 000 t of cocoa pod husks (CPH) are available as feed for livestock. However, the harvested CPH rot rapidly resulting in low feeding value (Wong et al. 1988) and preservation is necessary to maintain its quality. Theobromine (3,7-dimethylxanthine) and tannin are also present in cocoa products and their deleterious effects on animals may restrict the use of cocoa by-products as animal feeds (Owusu-Domfeh 1972; Lim et al. 1989). Rations based on CPH have been reported locally to be economically viable in cattle production systems (Bacon and Anselmi 1986). There had been several reports on the use of PKC and CPH in cattle feeding systems as well as nylon bag degradation studies (Miyashige et al. 1987; Wong et al. 1992; Wong and Wan Zahari 1992), but only a few detailed in vivo studies on the digestibility of these feeds had been reported. The objective of this study was to determine the nutritive value of PKC and CPH-based rations for growing cattle using balance trials.

Materials and methods

Twelve Sahiwal-Friesian bull calves (3 animals/treatment) weighing about 170 kg were kept in individual pens and fed ad lib (25% above Kearl's recommendations 1982) four rations: PKC expeller (Treatment I), 70% PKC + 30% CPH (Treatment II), 50% PKC + 50% CPH (Treatment III), and 30% PKC + 70% CPH (Treatment IV). The fresh CPH were collected and kept in a cold room (4 °C) until used. The CPH were chopped into 1–3 cm pieces with a cocoa pod crusher and then fed to the cattle. The technique of the balance trial was as described by Schnieder and Flatt (1975). After a 3-week adaptation period, the total collection procedures were used to measure daily feed intake, faecal and urine output. Mean apparent digestibility coefficients of the dry matter (DM), organic matter (OM), crude protein (CP), acid detergent fibre (ADF), neutral detergent fibre (NDF), ether extract (EE), ash and energy from the PKC and CPH-based rations were determined. Chemical analyses of feed and faecal samples were as those recommended by AOAC (1975). The values of cell content were derived from the difference in values between the NDF (cell walls) and DM content. Urine samples were collected and analysed for nitrogen by Martin's method (1966). Theobromine content in feed samples was determined as described by Wong and Abu Hassan (1988). Data were subjected to analysis of variance using SAS (1979).

Results

Fresh CPH have high moisture content (16.5% DM) and are thus bulky when fed in this form. PKC and CPH contain high levels of fibre as shown by the high ADF and NDF levels *(Table 1)*. The CP content of PKC is moderately high for ruminants compared with the lower CP levels in CPH. The higher level of ash and lower EE content in CPH are reflected in its lower gross energy content. Cell contents were twice as high in CPH (42.1%) compared with PKC. The CP and energy content were highest in Treatment I and decreased with increasing levels of CPH in Treatments II, III and IV *(Table 1)*.

There were no significant differences (p >0.05) in dry matter intake (DMI) and organic matter intake (OMI) by the animals between treatments *(Table 2)*. Dry matter digestibility (DMD) and organic matter digestibility (OMD) for Treatment I were highest and significantly different (p <0.05) from those of Treatments II and III while Treatment IV had the lowest DMD and OMD.

There were significant differences (p <0.05) between treatments for digestibility of CP, ADF, cell contents, EE and energy *(Table 3)*. However, no significant differences (p >0.05) were

Table 1. Chemical composition of palm kernel cake, cocoa pod husks and four treatment rations (% DM basis)

Feed	Dry matter	Organic matter	Crude protein	Acid detergent fibre	Neutral detergent fibre	Ether extract	Ash	Cell content	Gross energy (Mcal/kg)
PKC	91.7	95.6	16.5	52.7	78.9	5.2	4.3	21.1	4.256
CPH	16.5	89.8	9.1	49.3	57.9	1.0	10.2	42.1	3.990
Ration									
I	91.7	95.6	16.5	52.7	78.9	5.2	4.3	21.1	4.256
II	69.1	93.9	14.3	51.7	72.6	3.9	6.1	27.4	4.176
III	54.1	92.7	12.8	51.0	68.4	3.1	7.3	31.6	4.123
IV	39.1	91.5	11.3	50.3	64.2	2.3	8.4	35.8	4.070

PKC = palm kernel cake
CPH = cocoa pod husks
Theobromine: PKC nil; CPH 0.18%

Table 2. Feed intake and apparent digestibility coefficients of dry matter and organic matter between treatments

Treatment	Dry matter intake (kg/day)	Organic matter intake (kg/day)	Dry matter digestibility (%)	Organic matter digestibility (%)
I	3.90	3.77	75.8a	77.6a
II	4.12	3.84	67.8b	68.1b
III	4.23	3.90	62.8b	62.7b
IV	4.18	3.80	56.4c	53.3c

Mean values with different letters differ significantly (p <0.05) between treatments

Table 3. Apparent digestibility coefficients of nutrients in palm kernel cake and cocoa pod husks of treatments

Treatment	Crude protein (%)	Acid detergent fibre (%)	Neutral detergent fibre (%)	Cell content (%)	Ether extract (%)	Ash (%)	Energy (%)
I	72.8a	73.1a	76.0a	66.7a	83.6a	66.9	75.1a
II	63.2b	61.0b	65.1b	76.8b	80.8a	63.8	63.8b
III	56.8b	51.8c	55.8c	79.5bc	82.2a	64.7	58.9b
IV	49.2c	42.1d	46.1d	84.7c	69.2b	62.1	49.9c

Mean values with different letters differ significantly (p< 0.05) between treatments observed in digestibility of ash between treatments. Treatment I had the highest digestibility for CP, ADF, NDF, EE, ash and energy but the lowest digestibility for cell content. Treatment IV had the highest digestibility for cell content (84.7%) and this was significantly different (p <0.05) from Treatments I and II.

Nitrogen intake of animals was highest in Treatment I and the amount was significantly different (p <0.05) from those of Treatments III and IV *(Table 4)*. The amounts of N excreted by the animals in the faeces and urine were lowest in Treatment I and significantly different (p <0.05) from the values obtained from Treatments III and IV. Nitrogen digestibility was highest in Treatment I and significantly different (p <0.05) from Treatments II, III and IV which had the lowest N digestibility of 49.3%. Nitrogen retention was significantly highest in Treatment I (p <0.05) compared with Treatments II, III and IV which also had the lowest N retention of 10.8%.

The nutritive value of PKC and CPH for Treatment I *(Table 5)* on a per kilogram basis is higher than the values for Treatments II, III and IV. This was reflected in the higher values for digestible CP, CP retention, digestible energy (DE) and metabolizable energy (ME) for Treatment I. Increasing the levels of CPH decreased the nutritive value of the diets.

The values of DE and ME intake by the cattle were highest in Treatment I and decreased with increasing levels of CPH in the diets *(Table 6)*. Energy (DE and ME) intake as a proportion of metabolic live-weight (W kg $^{0.75}$) was also highest in Treatment I and decreased with increasing levels of CPH in the diets.

Table 4. Nitrogen balance of palm kernel cake and cocoa pod husks treatments

Treatment	N intake (g/day)	N in faeces (g/day)	N in urine (g/day)	N digestibility (%)	N retention as % of intake
I	102.9a	28.1a	23.4a	72.7a	50.0a
II	94.3ab	34.7b	23.8a	63.2b	39.0b
III	86.6b	37.4b	28.5b	56.8b	23.9c
IV	75.7c	38.4b	29.1b	49.3c	10.8d

Mean values with different letters differ significantly (p< 0.05) between treatments

Table 5. Mean nutritive value of palm kernel cake and cocoa pod husks treatments for growing cattle

Treatment	Digestible CP (g/kg)	CP retention (g/kg)	DE (Mcal/kg)	ME (Mcal/kg)
I	120.0	82.5	3.196	2.621
II	90.4	55.8	2.664	2.184
III	72.7	30.6	2.428	1.991
IV	55.8	12.2	2.031	1.665

Table 6. Mean daily digestible and metabolizable energy intake by growing cattle

Treatment	Total DE intake (Mcal) from diet	Total ME intake (Mcal) from diet	DE intake (kcal/ kg $W^{0.75}$)	ME intake (kcal/ kg $W^{0.75}$)
I	12.46	10.22	264.7	217.1
II	10.97	9.00	233.1	191.1
III	10.27	8.42	218.1	178.9
IV	8.49	6.96	180.3	147.8

Discussion

The chemical composition of PKC and CPH was comparable with data published previously (Hutagalung et al. 1986; Jalaludin et al. 1991; Wong et al. 1992; Wong and Wan Zahari 1992). With high levels of fibre and moderately low CP contents, PKC and CPH were more suitable as ruminant feeds. Although the CPH-supplemented diets had higher DMI than the sole PKC diet, the differences were not significant. This could be possibly due to the bulkiness of the CPH which resulted in rumen fill and affected further feed intake. An earlier study (Nutritive value and optimal levels of cocoa pod husks in rations for cattle, 1987) showed that feeding solely CPH to cattle resulted in poor feed intake and the study was discontinued. The theobromine content of 0.18% in CPH is within the range as previously reported (Wong and Abu Hassan 1988). Theobromine toxicity has been reported in poultry fed cocoa bean shells (Lim et al. 1989). However, Wong and Abu Hassan (1988) have reported that intakes of theobromine 0.024 g/kg live-weight (LW) for 2 months had no adverse effects on sheep. Theobromine intake of cattle in this study ranged from 0.013 to 0.031 g/kg LW and theoretically should not result in toxicity problems for these animals. Owusu-Domfeh (1972) also suggested that toxicity has never been reported in ruminants due to the practice of feeding CPH to ruminants as it contains only 10% of the theobromine level observed in cocoa bean shells. Harvested CPH rot rapidly with a consequent decrease in feed value and treatments with urea, alkalis, ensiling or drying processes (Wong et al. 1988) do not preserve or improve the feed value of CPH.

The DMD and OMD values of Treatments I and III were comparable with those of earlier experiments on sheep (Wong and Abu Hassan 1988; Wong and Moh Salleh 1989). Digestibility of DM and OM in the rations decreased with increasing levels of CPH in the diets, suggesting that CPH had lower nutritive value than PKC. The CP, ADF, NDF, EE and energy in PKC had higher digestibility and diets with higher PKC contents indicated that these nutrients in PKC were more digestible than those in CPH. However, cell contents in diets with more CPH were more digestible than those in PKC diets which suggest that cell contents of CPH were more digestible than that of PKC. However, PKC had a higher cell walls (NDF) content which was better than CPH in terms of quality and digestibility. The non-significant ($p > 0.05$) difference in ash digestibility between treatments showed that ash from PKC and CPH were comparatively digestible.

The decrease in N retention with increasing levels of CPH in the diets was comparable with data reported earlier on sheep (Wong and Abu Hassan 1988) which suggest that N from CPH is less retained than N from PKC in the cattle. As such, supplementation with a protein source is necessary with diets high in CPH content.

The nutritive values of the four treatments as reflected in the DCP, DE and ME were sufficient to meet the nutrient requirements of growing cattle at above maintenance levels (Kearl 1982). Using the prediction equation, ME (gain) = 118 $W^{0.75}$ [1 + 1.145 (g)] for growing cattle derived by Kearl (1982), with ME for maintenance of 118 kcal/ kg $W^{0.75}$ and a factor of 1.145 for ME of weight gain (kg), it is possible to predict that at the experimental level of ME intake, animals in Treatment I can sustain daily weight gains of 0.75 kg. This predicted daily gain is comparable with the gains reported by Hutagalung et al. (1986), Mustaffa-Babjee et al. (1986) and Jalaludin et al. (1991) who fed solely PKC to cross-bred steers. By comparison, animals in Treatments II, III and IV could sustain daily weight gains of 0.55, 0.45 and 0.20 kg respectively.

The prediction equation used by Kearl (1982) to predict digestible protein (DP) requirement for maintenance and weight gain is as follows:

DP requirement (g/day) = 2.86 $kgW^{0.75}$ + 0.218 g (LWG) + 0.6631 kg (LW) – 0.001142 kg $(LW)^2$.

Using this equation, it is estimated that at the experimental level of DP intake, Treatments I, II, III and IV provide sufficient DP to sustain gains of 1.0, 0.7, 0.4 and less than 0.1 kg respectively. However, as shown with the previous equation, higher feed intake will be required to produce sufficient ME intake to achieve gains of 1 kg or more.

Researchers (Wong and Wan Zahari 1992) have suggested an inclusion level of 50% and 30% PKC in diets for cattle and sheep respectively. Studies here and elsewhere (Bacon and Anselmi 1986) would suggest that CPH inclusion levels could range from 30% to 50% in diets of ruminants. PKC supplemented with either CPH or other fibrous feeds can be practical rations for feedlot cattle. As the feed value of CPH deteriorate rapidly, methods to preserve the feeding value of fresh CPH are necessary.

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