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Effect of Dried Elaeis guineense Supplementation to Basal Hay Diet on Energy and Protein Metabolism of West African Dwarf sheep

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ABSTRACT

Considerable attention has been focused on the use of multipurpose trees as feed supplement for small ruminant during dry season (Larbi et al., 1993; Osakwe et al., 1999; Rittner, 1992). Multipurpose trees provide a cheap source of protein supplement during the dry period, when both the quantity and quality of pasture herbage is limited. Few experiments with nitrogen and energy balances have been performed with poultry (Steenfeldt et al., 1998), pigs (Jorgensen, 1998; and sheep (Osakwe et al., 2000, 2003), but information on nitrogen and carbon balances with Djallonke sheep are very scanty in literature. It was against this background that the effect of anti-nutritional factors (condensed tannins) in *Elaeis guineense* on quantitative energy and protein retention as well as utilization in WAD sheep was investigated. Twelve castrated West African Dwarf (WAD) sheep averaging (22.0 ± 2.1 kg BW) were used in nitrogen and energy balance trials. Dried leaves of *Elaeis guineense* were offered as supplement at two levels 25% (diet 2) and 50% (diet 3) of dry matter intake (DMI), replacing hay in the basal hay diet. The basal hay diet without supplementation was the control. Measurements were performed by means of nitrogen and carbon balances and with the use of indirect calorimetry. The digestibility and utilization of protein were influenced *($P<0.05$)* by supplementation. Metabolisability of energy (ME/GE) was on the average 42.9 (SEM 3.9) % being significantly *($P<0.05$)* different among treatments. Protein digestibility decreased linearly ($P<0.05$) with supplementation. Protein retention and utilization showed that supplementation led to a negative balance. A significant *($P<0.05$)* decrease in heat loss (709 kJ day $^{-1}$) was observed at the higher level of supplementation. The lowest *($P<0.05$)* heat loss was observed in diet 2 which amounted to 45% of total energy intake, giving rise to a loss of 8.4% of the energy retained in fat and protein by these animals. It was concluded that *Elaeis guineense* is a plant of low fodder value especially when fed as dry feed, no wonder it is fed fresh in most parts of West Africa.

Key words:, *Elaeis guineense,* Protein, Energy, Fat utilization and retention, WAD sheep.

INTRODUCTION

Multipurpose trees provide a cheap source of protein supplement during the dry season, when both the quantity and quality of pasture herbage is limited. These trees can be integrated into these high potential crop-livestock production systems as live fences, feed gardens, fodder banks, alley farms, wind breaks and multi-strata systems as sources of homegrown supplements for low-quality crop residues during dry season.

Inspite of considerable attention that has been focused on the use of multipurpose trees as feed supplement for small ruminant during dry season (Larbi *et al*., 1993; Osakwe *et al*., 1999; Rittner, 1992), less attention has been paid to the influence of anti-nutritional factors and in particular-condensed tannins on the quantitative protein, fat and energy metabolism. Few experiments with nitrogen and energy balances have been performed with poultry (Steenfeldt *et al*., 1998), pigs (Jorgensen, 1998) and sheep (Osakwe *et al*., 2000, 2003), but no results based on nitrogen and carbon balances with Djallonke sheep can be found in literature. Jackson and Barry (1996) reported that forages with low concentration of condensed tannins could improve the efficiency of nitrogen digestion.

It was against this background that the effect of supplementation of *Elaeis guineense*, on quantitative energy and protein retention as well as utilization in WAD sheep was investigated.

MATERIALS AND METHODS

Twelve West African dwarf castrated sheep (average 23 ± 2.4 kg BW) were used in balance experiments including measurements of the gas exchange in a respiration chamber. Dried leaves of *Elaeis guineense* were offered as supplement at two levels (25% (diet 2) and 50% (diet 3) of DMI) replacing hay in the basal diet. The basal hay diet without supplement was used as the control diet.

Four animals each were randomly assigned to the control, diets 2 and 3 respectively. The animals were housed in individual metabolism crates and adapted for 10 days to the experimental diets. This was followed by a 7 days nitrogen balance trial during which feed, faeces and urine were collected daily. After the nitrogen balance trial, the animals were transferred to respiration chambers for another trial during which 24 hr measurement of gas exchange of carbon dioxide, methane and oxygen was carried out.

The gas exchange measurement was carried using an open circuit respiration system with four chambers. The chamber volume is 5,000 cubic litres, each is equipped with air conditioners that maintain a constant humidity of 60-70% (±2%) and a temperature of 20^{o}C (±0.3^{o}C) within the chambers. The animals were put in the chambers for 4x24 hr, for the measurement of their gas exchange and they received the experimental diet and water. About 35,000 litres/day of air is pumped in and out of each chamber. During a measuring period of 24 hr, aliquot sample of the spent/waste air is collected in gas receptors for the analysis of carbon dioxide, methane and oxygen. In addition the air intake was also analysed. The gas analysis was carried out under a standardised condition of 0 ^{o}C, 0 % humidity and 760 mm Hg. Carbon dioxide and methane were measured with Uras 10 using the principle of infrared-absorption-gas-analyser. Oxygen was measured with Magnos 2T using the principle of paramagnetic oxygen-analyser. In addition to the experimental diet, animals received a mineral premix supplement (10 g/d). Feed was offered twice a day at 0800 and 1600 hr, and water provided *ad libitum.*

Analytical methods Feed samples were ground in a hammer mill to pass a 1mm mesh sieve for chemical analysis. Nitrogen content was determined by the Kjeldahl method and ash by burning at 550^{o}C (AOAC, 1990), Crude protein was calculated from Nx 6.25. Neutral detergent fibre (NDF), Acid detergent fibre ((ADF), and Acid detergent lignin (ADL) were determined as described by Goering and Van Soest (1970). The difference between NDF and ADF was designated as hemicellulose, and between ADF and ADL as cellulose. Samples of faeces were dried at 65 ^{o}C for 48 h, ground through a 1 mm diameter screen and together with urine were analysed for N (AOAC, 1990). Gross energy of feed and faeces were measured by bomb calorimetry using benzoic acid as a standard (26437 J/g). Analyses of extractable condensed tannins were carried out by the method described by Markkar *et al*., (1993). Total extractable phenol and tannin phenol were analysed by the method described by Singleton and Rossi (1965). Carbon content in feed, faeces and urine was determined according to the principle of electric conductivity by means of a carmograph apparatus (Schiemann *et al*., 1971). Retention of protein (RP), fat (RF) and energy (RE) were calculated by means of carbon and nitrogen balances with the set of constants and factors described by Brouwer (1965): RP, g = Retained Nitrogen x 6.25
RF, g = (carbon balance – carbon in RP)/0.767 ; RE, kJ = RP, g x 23.86 + RF, g x 39.76
Analysis of Variance (ANOVA) was used to analyse the data using the (SAS, 1985).
Significant treatments were differentiated using Duncan's Multiple Range Test (Duncan,1955).

RESULTS

The chemical composition and gross energy content of the experimental diets and *Elaeis guineense* is presented in Table 1. *Elaeis guineense* has a relatively low CP (9.0 %) and a relatively high GE content (19.8 kJ/kg DM). Intake of metabolizable energy, digestible protein, digestibility and utilization of protein of sheep supplemented with *Elaeis guineense* are summarized in Table 2. There were significant differences ($P<0.05$) in the daily intake of ME and DP of sheep in the different treatments. The daily intake of ME and DP were lowest ($P<0.05$) in diet 3. The digestibility and utilization (RP/DP) of protein was measured in individual nitrogen balance experiments. Digestibility and utilization of protein were strongly ($P<0.05$) influenced by supplementation and decreased with level of supplementation. Indeed supplementation led to a negative utilization. Fat retention (RF) and protein retention (RP) were calculated from carbon balances, and the mean values of RF and RP are shown in Figure 1. The RP values were lower and negative in the supplemented groups compared with the control. The metabolisability of energy (ME/GE) was significantly ($P<0.05$) different among treatments, with the control being more superior to diets 2 and 3, respectively. The metabolisability was on the average 42.9 (SEM 3.9) %.
As the ME intake varied significantly with supplementation, the energy retained in protein and fat when compared with the ME intake showed a significant decrease with supplementation.

DISCUSSION

Naturally occurring polyphenols, particularly condensed tannins inhibit utilization of protein and energy from multipurpose trees. In the present investigation, the mean intake of ME and DP were significantly (P<0.05) lowest in diet 3, indicating a depressive effect of condensed tannins on nutrient and energy consumption. The high acid detergent lignin could also be a causative factor. The significant (P<0.05) decrease in digestibility with supplementation and the negative utilization observed with supplementation could possibly be due to the effect of tannin as well as lignin on protein degradability and digestibility of cell wall carbohydrates by rumen microbes. This observation is consistent with the reports of Reed et al. (1990). The total amount of energy retained in protein and fat showed that supplementation led to a negative balance. This could be ascribed to the lower (P<0.05) protein digestibility and hence reduction in the utilization of protein. Similar observation of reduced dietary protein by microbes was found to be responsible for lower protein retention by goats fed legume straw by Antoniou and Hadjipanayiotou (1985).
A significant (P<0.05) decrease in heat loss (709 kJ day^{-1}) was observed at the higher level of supplementation. The lowest (P<0.05) heat loss was observed in diet 3 which amounted to 45% of total energy intake, giving rise to a loss of 8.4% of the energy retained in fat and protein by these animals. This observation is consistent with the findings of Kumar and D'Mello (1995) who reported that inhibition of cellulose digestion should lead to reduction in the yield of metabolisable energy in the rumen.

CONCLUSION

In conclusion, the results presented here suport the observation made by Aschfalk (1997) that *E. Guineensi* is a plant of low fodder value. Nevertheless, with a CT, CP and GE content of (1.8 %, 9.0 % and 19.8kJ/g), respectively, it could serve as an easily available fodder during the dry season and should be fed fresh. The implication of this study to livestock farmers is that farmers engaged in ruminant production can utilize no more than 25% of dried *Elaeis guineense* leaves as supplement to hay diet during dry season feeding.

Table 1: Chemical composition of *Elaeis guineense* and experimental diet (%dry matter)

Item	*Elaeis guineense*	Control	Diet 2	Diet 3
CP	9.0	13.1	12.1	11.1
Ash	9.3	10.5	10.2	9.9
Ether extract	2.1	2.0	1.5	2.0
Crude fibre	32.9	30.5	31.1	31.7
NFE	32.6	38.3	38.6	39.0
NDF	70.0	61.0	63.3	65.5
ADF	54.5	35.4	40.2	45.0
ADL	19.1	3.7	7.6	11.4
Cellulose	35.4	31.7	32.6	33.6
Hemicellulose	15.5	25.6	23.1	20.6
Total phenols [1]	2.4	-	0.6	1.2
Tannin Phenol [1]	2.0	-	0.5	1.0
Condensed tannins [2]	1.8	n.a.	0.5	0.9
GE [kJg^{-1} DM]	19.8	17.9	18.4	18.9
Mineral premix [3]	n.a	1.0	1.0	1.0

[1]As tannic acid equivalent; [2]As leucocyanidin equivalent; n.a.: Not applicable; [3]Composition/kg: vit A 600,000 IU, vit D3 75,000 IU, vit E 300 mg, Zn 3,000 mg, Mn 480 mg, Co 12 mg, Se 10 mg.

Table 2 Intake of ME, digestible protein and utilization of sheep supplemented with Elaeis guineensi

Item	Control	Diet 2	Diet 3	SEM
Dry matter intake (g/d)	490.8	479.4	489.3	3.09
Dry matter digestibility	0.703[a]	0.595[b]	0.534[c]	0.99
Metabolizability [MJ/GE]	0.517[a]	0.400[b]	0.370[b]	0.04
Heat loss (H/GE)	0.568 [a]	0.503 [ab]	0.453 [b]	0.03
Ret. Energy (RE/GE)	-0.051	-0.103	-0.083	0.013
Digested protein (DP), (g/d)	45.6[a]	33.9[b]	25.0[c]	5.2
Digestibility (%)	0.709[a]	0.582[b]	0.46[c]	0.11
Utilization (RP/DP), %	16.0	-12.1	-39.2	13.8

a,b,c Means in a row with different superscripts differ significantly (P<0.05)

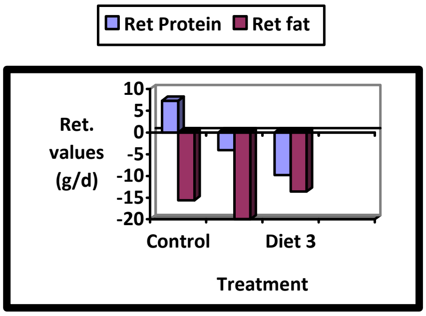

Figure 1: Effect of Elaeis guineensi supplementation on retained protein and fat

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