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ORIGINAL RESEARCH ARTICLE

Response of West African Dwarf sheep to a total mixed ration fed with different inclusion levels of Coconut oil

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ABSTRACT
An experiment was conducted to investigate the effect of feeding refined coconut oil (CO) to West African dwarf sheep (WAD) on dry matter intake, animal performance, diet digestibility and nitrogen metabolism. Twelve WAD sheep aged 12-18 months and weighing between 14 and 20kg were used for the study. They were randomly alloted to a total mixed ration containing different levels of coconut oil : D1 (0%), D2 (1.5%) and D3 (3.0%) in a completely randomised design. The experiment lasted 84 days. Dry matter intake was significantly (P<0.05) higher for D2 than D3 but similar for D1 and D3. The average daily gain (ADG) was similar for all the diets while feed conversion improved significantly (P<0.05) with coconut oil supplementation up to 1.5% above which there was a decline. There were no significant differences in the digestibility of all the nutrients except acid detergent fibre (ADF) that decreased with increasing coconut oil supplementation. Nitrogen balance (g/d) also decreased (P<0.05) with increased level of coconut oil supplementation. Based on this study, coconut oil could be used as a lipid supplement for WAD sheep. However, the level of supplementation should not be higher than 1.5% if a total mixed ration is fed.

Keywords: WAD sheep, total mixed ration, coconut oil, performance, nitrogen metabolism

INTRODUCTION

Lipid sources such as oils, oilseed and animal fats are used commercially by livestock producers to increase energy density of the diet. Lipid sources also have other benefits such as altering the fatty acid composition of meat and milk, reducing the dustiness of feed, and increasing the absorption of fat-soluble nutrients (NRC, 2001). Despite these benefits, adding lipid to the diet at high supplementation rates can reduce feed intake (Allen, 2000). Beauchemin and McGinn (2006) found that the use of canola oil as a feed additive reduced animal performance due to lower feed intake and decreased fibre digestibility. Shibata and Terada (2010) reported a decrease in digestion in the stomach of organic matter and neutral detergent fiber by oil supplementation.

Coconut oil is a rich source of energy which contains approximately 921 g/kg saturated fatty acids, 62 g/kg monounsaturated fatty acids and 16 g/kg polyunsaturated fatty acids, thereby having the potential for methane inhibition by shifting consumed energy to productive purposes (Bhatt *et al.*, 2011). Machmuller *et al.* (2003), Kongmum *et al.* (2011) and Pilajun and Wanapat (2011) reported that dry matter dissapearances were reduced with coconut oil addition. They suggested that the depression in dry matter disappearance observed after oil supplementation was most probably due to negative effect of coconut oil on neutral detergent fibre digestion. Jordan *et al*. (2006 a, b) found that high levels of coconut oil (42% of the DM) in beef cattle fed with forage-concentrate 50:50, reduced the consumption and digestibility of the diet, but inferior levels of oil (between 10 - 28% of the DM) did not affect these indicators. It is therefore generally recommended that fat supplementation should not exceed 6-7% of the ration as they may have negative effect on intake and digestibility of nutrients. The objective of this study was to determine the response of WAD sheep fed a total mixed ration with different inclusion levels of coconut oil.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Sheep Unit of the Teaching and Research Farm, University of Ibadan, Nigeria. The location is 7° 27'N and 3° 45'E at altitude 200-300 m above sea level. The climate is humid tropical with mean temperature of 25-29°C and the average annual rainfall of about 1250 mm.

Experimental animals, diets and animal management

Twelve WAD sheep aged between 12-18 months and weighing between 14 and 20kg were used for the study. They were housed in individual pens with concrete floors that has been previously washed, disinfected and covered with wood shavings as beddings. The beddings were replaced weekly. The animals were allowed two weeks of adaptation before commencement of the study. The animals were fed a total mixed ration (Table 1) containing different levels of coconut oil (CO): 0% CO(D1), 1.5% CO (D2) and 3.0% CO (D3). The animals were weighed before the commencement of the study and four animals were randomly alloted to each dietary treatment. Feeding was done twice daily at 8.00 hr and 15.00 hr. Fresh and clean water was provided daily. The study lasted 84 days including the 2-weeks of adaptation.

Table 1: Ingredient composition (kg/100kg) of experimental diets

Ingredients	D1	D2	D3
Wheat offals	50.0	48.5	47.0
Cassava peels	25.0	25.0	25.0
Coconut oil	0.0	1.5	3.0
Groundnut haulms	20.0	20.0	20.0
Urea	1.0	1.0	1.0
Di-calcium phosphate	1.5	1.5	1.5
Limestone	1.0	1.0	1.0
Salt	0.5	0.5	0.5
Multivitamin premix	1.0	1.0	1.0

Growers premix: Vitamin A (7500000IU), Vitamin D3 (1000000IU), Vitamin E (1800mg), Vitamin B1(500mg), Vitamin B2 (1000mg), Vitamin D- Pantothenic acid (3200mg), Vitamin B6 (180mg), Vitamin B12 (5mg), Vitamin C (5000mg), Vitamin K (700mg), Nicotinic acid (4000mg), Folic acid (50mg), Choline chloride (63000mg), Manganese (35000mg), Cu (1500mg), Cobalt (180mg), Iron (10000mg), Iodine (720mg), Zinc(1500mg).

Measurements

Dry matter intake and digestibility

Feed left over from previous day was collected each morning and weighed. The weight was deducted from the feed offered to determine the daily feed intake. At the end of 70 days data collection period, the animals were transferred to metabolic cages fitted with facilities for total collection of urine and faeces for 12 days (7-day adaptation and 5-day data collection). Faecal and urine samples collected for each animal were bulked together. An aliquot (10%) sample of the urine was taken and stored in air tight bottles and kept frozen until required for laboratory analysis. An aliquot sample of the faeces was also taken and dried in an oven at 65 ℃ to a constant weight. It was milled and stored in air tight polythene bags for chemical analysis.

Chemical analysis

The experimental diets and faecal samples were analyzed for proximate composition while urine was analysed for nitrogen content according to AOAC (1990). Neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined according to Van Soest *et al.* (1991). Cellulose and hemicellulose were calculated.

Table 2: Chemical composition (g/100) of experimental diets

		Diets	
Nutrients %	D1	D2	D3
Dry matter	92.11	92.00	92.19
Crude protein	11.83	12.22	12.48
Ether extract	2.67	2.71	2.89
Crude fibre	40.72	42.31	41.42
Ash	6.83	7.10	7.61
Nitrogen free extract	37.95	35.60	35.60
Neutral detergent fibre	71.31	73.55	71.70
Acid detergent fibre	53.86	55.31	54.37
Acid detergent lignin	13.17	14.77	13.67
Hemicellulose	17.43	18.24	17.33
Cellulose	40.69	40.54	40.70

Experimental design and statistical analysis

The experimental design was the completely randomized design. Data were subjected to a one-way ANOVA (SAS, 2009). Differences in means were determined using least significance difference (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Chemical composition of experimental diets

The chemical composition of the experimental diets is shown in Table 2. The total mixed rations ranged in crude protein concentration from 11.83 to 12.48% of

Table 3: Performance characteristics of WAD sheep fed experimental diets

		DIETS		
Parameter	D1	D2	D3	D4
Initial weight (kg)	15.50	15.75	15.75	-
Final weight (kg)	20.00	20.75	19.88	-
Average daily weight gain (g/day)	64.29	71.43	59.00	11.25
Dry matter intake (g/day)	720.47^{ab}	730.47^{a}	647.30^{b}	3.24
Crude protein intake (g/day)	85.23	89.27	80.80	3.24
Ether extract intake (g/day)	20.88	20.22	20.29	0.81
Acid detergent fibre intake (g/day)	513.77^{ab}	534.76^{a}	464.13^{b}	43.71
Neutral detergent fibre intake (g/day)	388.00^{ab}	404.02^{a}	351.50^{b}	34.37
FCR	11.20^{b}	10.22^{a}	10.97^{b}	0.12

ab: means within the same row with different superscripts are significantly different (P<0.05)

D1= 0% coconut oil inclusion; D2= 1.5% coconut oil inclusion; D3= 3.0% coconut oil inclusion; FCR= feed conversion ratio

Table 4: Digestibility of WAD sheep fed experimental diets

Parameter	Diets			
	TI	TII	TIII	SEM
DM Intake (g/day)	790.66[a]	759.51[a]	543.85[b]	46.72
DM digestibility (%)	48.44	44.55	35.58	5.47
CP digestibility (%)	52.00	44.00	52.33	5.33
EE digestibility (%)	73.67	70.00	59.67	5.62
ADF digestibility (%)	78.67[a]	75.33[a]	59.67[b]	1.53
NDF digestibility (%)	62.00	61.00	65.67	2.39

a, and b: means in the same row with different superscripts are significantly different (P<0.05)
DM=Dry matter intake ; CP= Crude protein ; EE= Ether extract ; ADF= Acid detergent fibre ; NDF= Neutral detergent fibre

Table 5 : Nitrogen metabolism of WAD sheep fed experimental diets

Parameter	Diets			
	TI	TII	TIII	SEM
Nitrogen intake (g/day)	14.96[a]	14.85[a]	12.45[b]	0.94
Faecal nitrogen (g/day)	7.17	8.41	5.43	1.96
Urinary nitrogen (g/day)	0.37[ab]	0.19[b]	0.49[a]	0.07
Nitrogen balance (g/day)	7.42[a]	6.25[a]	5.24[b]	0.44
Nitrogen retention (%)	49.60	42.08	42.00	5.01

a,b: means in the same row with different superscripts are significantly different (P<0.05)

dry matter. The NDF fraction ranged from 71.31 to 73.55% while ether extract ranged from 2.67 to 2.89% of the dry matter.

Feed intake and weight gain

Dry matter intake was significantly (P<0.05) higher for D2 (1.5%) than D3 (3%) as contained in Table 3. However, the intake of dry matter from D1 (0%) and D3 (3%) were similar. A decrease in dry matter (DM) intake from the inclusion of CO has been widely reported (Sutton et al., 1983; Machmuller and Kreuzer, 1999; Lovett et al., 2003). The reduction in DM intake with increasing addition of CO is consistent with Haddad and Younis (2004) who reported a decrease in DM intake with addition of 25 and 50 g/kg saturated fat in the diets of Awassi lambs. Previous reports in growing lambs (Machmüller et al., 1998), as well as in adult sheep (Machmüller and Kreuzer, 1999), fed rations supplemented with 30–35 g/kg coconut oil, showed that DM intake was not affected, whereas inclusion of 70 g/kg coconut oil in the adult sheep ration caused substantial concentrate refusals.

The average daily gain (ADG) was similar for all the diets (Table 3). Comparable ADG in control and CO supplemented groups was probably due to similar NDF digestibility in all the groups. Unlike our findings, Dutta et al. (2008) reported a gradual increase in daily gain up to 50 g/kg fat supplementation, but, at higher level of supplementation, growth depression occurred. They attributed the response to increasing CO supplementation to higher ME intake. Bhatt et al. (2009) reported similar growth performance during pre-weaning, and higher ADG post-weaning in Malpura lambs fed a milk replacer. Feed conversion also improved significantly (P<0.05) with coconut oil supplementation up to 1.5% but above this level it declined.

Digestibility of nutrients and nitrogen metabolism

There were no significant (P<0.05) differences in the digestibility of all the nutrients except acid detergent fibre that decreased with increasing coconut oil supplementation (Table 4). Kongmum *et al.* (2011) reported that supplementation with coconut oil showed apparent reduced NDF digestibility. An increase in the digestibility of ether extract and a decrease in digestibility of organic matter and neutral detergent fibre were also reported by Bhatt *et al.* *(*2011) with increased level of fat supplementation. The reduction in ADF digestibility with increasing level of coconut oil supplementation is also similar to the reports of Manso et al. (2006) and Dutta et al. (2008) for NDF digestibility in lambs fed rumen protected fat (i.e., calcium salts of palm oil) and fed palm oil respectively. Banta *et al* (2008) observed that the inclusion of fat beyond a threshold could affect rumen microbial function and therefore the digestibility of fibre. Nitrogen balance (g/d) decreased (P<0.05) with increased level of coconut oil supplementation (Table 5). Similar observation was reported by Bhatt *et al.* (2011) that nitrogen retention decreased with increased level of fat supplementation.

CONCLUSION AND RECOMMENDATION

The results showed that inclusion of coconut oil in the diet of West African dwarf sheep could be beneficial if the level does not exceed the threshold that may inhibit fibre digestion. Further research is required to determine the effects of coconut oil on ruminal bacterial population especially as it relates to fibre digestion.

CONFLICT OF INTEREST

There is no conflict of interest whatsoever in the conduct of this study and the publication of this research work.

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