

Utilization of Diets Containing Increasing Levels of Dried Desiccated Coconut Waste Meal (DCWM) by Growing Crossbred Anglo-Nubian Goats in Samoa

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ABSTRACT : Sixteen growing crossbred Anglo-Nubian goats, 10-12 months old, pre-experimental average body weights of 18.3 ± 0.28 kg were randomly allotted to four diets to investigate the efficiency of utilisation of diets containing increasing levels of desiccated coconut waste meal (DCWM) in the tropical environment of Samoa, South Pacific region. The four diets were designated as 1, 2, 3 and 4. Diet 1 that has no DCWM served as the control, while diets 2, 3 and 4 contained different levels of DCWM. Voluntary concentrate intake, growth rate, feed efficiency and nutrient digestibility coefficients were measured. Gross energy (GE) and organic matter (OM) values of the diets increased linearly with increase in the levels of DCWM in the diets. Voluntary concentrate intake decreased with increasing proportion of DCWM in the diets. Forage intake increased with increase in the levels of DCWM diets offered to the growing goats. Total voluntary feed intakes were statistical significant ($p < 0.05$) and the goats on diet 4 had the least intake followed by those on diet 3. Goats on diets 1 and 2 were different in total feed intake but not at a significant level ($p > 0.05$). Feed efficiency (FE) followed the trend of voluntary concentrate intake and daily live weight gains. Dry matter digestibility (DMD) was significantly different ($p < 0.05$) among the goats offered the different diets. DMD improved with increasing levels of DCWM. The goats accepted all the diets that were compounded with the different levels of dried DCWM and this seems to suggest that DCWM have no deleterious effects. However, the best level at which dried DCWM could replace brewers dried grains in the diets of growing goats is at 38.5% (diet II). Based on voluntary feed intake, live-weight gain and apparent nutrient digestibility coefficients of the goats it could be concluded that DCWM based diets merits further attention as a locally available feed source in ruminants nutrition in the Pacific Island countries where feed availability is seasonal. (*Asian-Aust. J. Anim. Sci.* 2001. Vol. 14, No. 3 : 316-320)

Key Words : Desiccated Coconut Waste Meal, Goats, Feed Intake, Growth, Digestibility, Tropical

INTRODUCTION

In the Pacific Island countries, availability of locally produced feed resources is seasonal. To improve the livestock industry there is the need to match livestock production with locally available feed resources. In the South Pacific region the coconut tree is regarded as the tree of life, an important source of food, building material, energy, foreign exchange and raw material for industries. Copra meal (CM) and desiccated coconut waste meal (DCWM) are two important by products of the coconut industry. Copra cake is the residual product after the extraction of oil from the dried meat of coconut while DCWM is a by-product from coconut cream production.

The protein content is low in lysine and histidine (Solomona, 1988). The high fibre content limits its usage in the diets of simple stomach animals. In ruminant DCWM provide a very useful protein and energy supplement (Solomona, 1988). Today, a number

of scientific reports exist in the South Pacific region on the utilization of copra cake in simple stomach animal nutrition (Ochetim, 1987a, b; Ochetim, 1988). DCWM is available throughout the year, therefore it is necessary to evaluate it in livestock nutrition. The aim of this paper is to report on the effect of increasing levels of DCWM in concentrate diets on performance and nutrient utilization by crossbred Anglo-Nubian goats in the tropical environment of Samoa, a South Pacific Island country.

MATERIALS AND METHODS

Experimental site

The study was conducted at the Goat Unit, School of Agriculture, The University of the South Pacific, Alafua Campus, Apia, Samoa (Latitude $\approx 13.5^\circ$ S, Longitude $\approx 172^\circ$ W).

Feed ingredients and preparation of experimental diets

The feed ingredients used were desiccated coconut waste meal, brewers' dried grains, malt screening, salt and mineral/vitamin premix. Desiccated coconut waste meal (DCWM) was collected wet. This was dried under the shade for 4-7 days until the product became brown. During the period the product was continuously

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turned for even drying and proper aeration. Brewers' grains were collected wet from Western Samoa Breweries Ltd, Apia. These were spread in an open but concrete floor, turned regularly until they were dry. Also malt screenings, the waste obtained during the process of sieving of barley to remove extraneous materials before the malt is used for brewing of beer were obtained from the same brewery.

The feed stuffs were compounded into four diets (table 1). The four diets were designated as 1, 2, 3 and 4. Diet 1 which has no DCWM served as the control. Diets 2, 3 and 4 contained different levels of DCWM. Urea (46% N) was used as the protein source with other ingredients.

Animals, management and feeding

Sixteen crossbred Anglo-Nubian goats between 9-12 months of age, pre-experimental average body weight of 18.3 ± 0.28 kg were randomly allotted to the four diets. In each treatment there were four replicates. The goat were housed and fed in individual pens. Each pen had plastic feed and water troughs. These were properly secured to reduce wastage of feed. The concentrate portion was offered *ad libitum* to the goats for 56 days. It was supplemented with guinea grass (*Panicum maxima*). Prior to the start of the trial the goats were drenched with Levicare (Ancare, Auckland, New Zealand). Feeds not consumed within 24 hours were collected, weighed and discarded. Feed refusals were not analyzed because it was assumed that the composition of feed consumed was the same as that offered. Prior to the collection of data, the animals were allowed a 7-day adaptation period. Feed offered was increased or decreased depending on the voluntary intake by goats. Records of individual feed intake and live-weight changes were maintained to calculate live weight gain, and voluntary feed intake.

Digestibility studies

At the end of the growth trial, digestibility study

was carried out. The total faecal collection method was used (Aregheore, 1997). The feed intake of the goats was adjusted to a similar level for all diets before a 7-day collection period. The forage portion was fed in two equal portions at 9:00 and 16:00 h. Prior to morning feeding, the faeces voided were carefully collected, weighed and recorded to determine the actual faecal output before a sample was taken for moisture determination. Faeces were dried in a forced air oven at 70°C for 24 h. Daily dried faeces for each goat over the collection period were bulked, sampled and milled for analysis. Partial apparent digestibility of nutrient contents of the concentrate diets were calculated using the formula of Crampton and Lloyd (1959) as follows:

$$D = \frac{100 (T - B)}{S} + B$$

Where, D = percentage apparent digestibility,

T = coefficient of digestibility of total ration (grass+concentrate),

B = coefficient of digestibility of basal ration,

S = percentage of concentrate feed in the total ration.

Analytical procedures

The AOAC (1995) method was used for proximate analysis of diets. Crude fibre analysis was according to the procedure of Naumann and Bassler (1976). Gross energy (MJ/kg DM) done of concentrates, forage and faecal samples was determined by a bomb calorimeter (Adiabatic bomb, Parr Instrument Co., Moline, IL) using thermochemical benzoic acid as standard.

Data on voluntary feed intake, growth rate, feed efficiency and nutrient digestibility were subjected to analysis technique (ANOVA) (Steel and Torrie, 1980). Where differences were significant Bonferroni t-statistics were utilized.

RESULTS

Chemical composition of diets

Chemical composition of the experimental diets, forage and other ingredients are presented in table 2. The Fiji Agricultural Chemistry Laboratory, Nausori, performed the proximate analysis of the experimental diets, DCWM and brewers' dried grains and forage. It was observed that with increase in the level of DCWM the CP content was diluted. Gross energy value of the diets increased linearly with increasing levels of DCWM in the diets. The control diet was higher in crude fibre than the other three diets. However, a reverse trend was observed with organic

Table 1. Ingredient composition of experimental diets fed to goats (on air-dry basis %)

Ingredient (%)	Diets			
	1	2	3	4
Desiccated coconut waste meal	-	38.5	48.5	58.5
Brewers' dried grains	46.0	25.5	15.5	5.5
Malt waste	48.0	30.0	30.0	30.0
Urea (46% N)	3.5	3.5	3.5	3.5
Mineral/vitamin premix ¹	1.5	1.5	1.5	1.5
Salt	1.0	1.0	1.0	1.0
Total	100.0	100.0	100.0	100.0

¹ Summit multi-mineral salt contains the following: salt, calcium, magnesium, copper, iron, zinc, selenium (3 ppm), vitamin A, D and E with added copra meal and molasses.

matter (OM) and gross energy values. OM and GE values increased with increasing levels of DCWM in the experimental diets.

Voluntary feed intake, average daily live weight gain and feed efficiency

There was reduction in voluntary concentrate intake with increases in the level of DCWM in the diets. Voluntary concentrate intake decreased significantly ($p < 0.05$) with increasing proportion of DCWM in the diets (table 3). However, forage intake increased linearly with increasing proportion of DCWM diets offered to the growing goats. Diets 1 and 2 had same value in forage voluntary intake. The highest level of forage intake was with diet 4 followed by diet 3. There were significant differences between diet 4 and others in both concentrate and forage intake ($p < 0.05$). The goats consumed more of the forage than the experimental concentrate diets 3 and 4 offered ($p < 0.05$). However, total voluntary feed intake (concentrate+forage) were different from the individual intakes recorded for concentrate and forage separately. Total voluntary feed intakes were statistical significant ($p < 0.05$) and the goats on diet 4 had the least intake followed by those on diet 3. Goats on diets 1 and 2 were different in total feed intake but not at a

significant level ($p > 0.05$).

Average daily live-weight gain was higher ($p < 0.05$) in diet 2 (38.5% DCWM) than in the control diet (0% DCWM) and diets 3 and 4 (48.5% and 58.5% DCWM, respectively). Daily live-weight gain for diet 1 (control) was 116 g/head/day while diets 2, 3 and 4 were 160, 90 and 66 g/head/day. A negative linear trend across the diets with increasing levels of DCWM content was observed in daily live-weight gain.

Feed efficiency [feed/gain, (FE)] values followed the trend of voluntary feed intake and daily live weight gain. Feed efficiency was better ($p < 0.05$) in diet 2 (4.2) followed by diet 1 with 5.8. Diets 3 and 4 had feed efficiency values of 7.1 and 9.0, respectively.

Digestibility study

Data on apparent nutrient digestibility coefficients are presented in table 4. Dry matter digestibility (DMD) was significantly different among the goats offered the different diets ($p < 0.05$). DMD was higher in diet 4 that had the least voluntary concentrate intake. Crude protein (CP) digestibility was higher in diets 2 and 4 ($p < 0.05$). Organic matter digestibility (OMD) followed a similar pattern as CP digestibility. Gross energy (GE) digestibility significantly improved

Table 2. Proximate chemical composition of experimental diets, forage, DCWM and BDG

Nutrients (%)	1	2	3	4	Forage*	DCWM	BDG
Dry matter (DM)	90.3	90.2	90.4	92.4	93.4	89.6	89.5
Analysis on DM							
Crude protein	16.7	16.8	15.7	15.5	9.0	18.8	25.6
Crude fibre	33.6	31.9	31.8	31.6	25.3	31.2	38.3
Ether extract	2.6	4.3	5.2	5.8	5.3	16.8	8.5
Ash	9.6	9.4	7.1	6.9	1.2	4.8	4.6
Organic matter, OM	90.4	90.6	92.9	93.1	94.7	95.2	95.4
Gross energy, MJ · kg ⁻¹ DM	17.3	23.1	27.1	29.7	7.5	18.3	21.6

* Forage (Guinea grass, *Panicum maximum*), DCWM, desiccated coconut waste; BDG, brewers dried grains.

Table 3. Feed intake, body weight gain and feed efficiency*

Parameters	Diets			
	1	2	3	4
Initial average body weight, kg	17.8 ± 0.34	18.5 ± 0.23	18.5 ± 0.26	18.2 ± 0.29
Final average body weight, kg	24.3 ± 2.10	27.5 ± 2.94	23.6 ± 2.38	21.9 ± 3.02
Weight gain, 56 days	7.2 ± 1.76	90 ± 2.71	5.1 ± 2.12	3.7 ± 2.73
Average daily gain, kg/day	0.128 ± 0.03 ^b	0.160 ± 0.05 ^a	0.090 ± 0.04 ^c	0.066 ± 0.05 ^d
Concentrate intake, g/day	368 ± 1.78 ^a	358 ± 2.80 ^b	258 ± 2.45 ^c	188 ± 3.92 ^d
Forage intake, g/day	309 ± 3.62 ^c	309 ± 3.90 ^c	385 ± 2.75 ^b	406 ± 2.63 ^a
Average daily feed intake, g/day (concentrate + forage)	677 ± 5.40 ^a	667 ± 6.70 ^b	643 ± 5.20 ^c	594 ± 6.55 ^d
Feed efficiency [FE], feed/gain	5.3 ± 1.80 ^{bc}	4.2 ± 1.34 ^c	7.1 ± 1.30 ^{ab}	9.0 ± 1.31 ^a

^{a,b,c,d} Mean values on the same row with different superscript differ significantly ($p < 0.05$).

* Mean ± SED.

Table 4. Effect of level of desiccated coconut waste meal on apparent nutrient digestibility*

Nutrients (%)	Diets			
	1	2	3	4
Dry matter	69.7 ± 2.10 ^{ab}	66.1 ± 1.80 ^b	68.9 ± 2.08 ^b	72.3 ± 2.00 ^a
Crude protein	76.8 ± 1.45 ^c	81.4 ± 2.52 ^b	74.6 ± 2.16 ^c	87.1 ± 1.76 ^a
Crude fibre	62.2 ± 3.02 ^b	65.0 ± 2.90 ^{ab}	66.9 ± 3.15 ^a	67.9 ± 2.80 ^a
Organic matter	72.5 ± 3.62 ^b	78.6 ± 3.40 ^a	72.5 ± 3.82 ^b	73.9 ± 3.10 ^b
Gross energy	68.3 ± 3.58 ^c	77.7 ± 3.08 ^b	79.2 ± 3.40 ^b	83.8 ± 2.68 ^a

^{a,b,c,d} Mean values on the same row with different superscript differ significantly ($p < 0.05$).

Mean ± SED.

($p < 0.05$) with increase in the levels of DCWM in the concentrate diets.

DISCUSSION

Energy value of diets increased with increases in the level of DCWM. Therefore, the goats consumed smaller amounts of concentrates to meet their requirements for growth. It has been reported that animals tend to consume less if a diet is high in energy (Montgomery and Baumgardt, 1965; Adeleye, 1982; Aregheore, 1988, 1999; Aregheore et al., 1988a, b). On the other hand, animals tend to eat more of a diet if it is low in energy. Therefore, the high concentrate intake observed in goats fed diet 1 (control) compared to diets 2, 3 and 4 could be due to its energy content (Montgomery and Baumgardt, 1965).

In the present study, average daily concentrate intake decreased significantly with increasing levels of DCWM in the diets (table 2). This was most likely due to increased digestible energy intake from the diets containing increasing levels of DCWM. The results obtained in voluntary concentrate intake in this trial confirmed the reports of McCullogh, (1970a, b) and Adeleye (1982), who reported that increase digestible energy affects voluntary intake of animals. It is also well known that animals on *ad libitum* feeding will attempt to equalise their digestible energy consumption (Montgomery and Baumgardt, 1965), and this was the observation in this experiment. The average intake of diet 1 (control) was higher than that of diets 2, 3 and 4. The observation on feed intake in the goats on diet 1 might be due to a possible restriction of rumen capacity on the goat's ability to maximise its digestible energy intake. In this experiment, the data on voluntary feed intake of the goats offered the different diets are at variance with Escano and Russoff (1972), Adeneye and Oyenuga (1976) who reported that a reduction in dietary energy supply lower voluntary feed intake of ruminant livestock. Rather in this experiment, with increase in the dietary energy, there was a reduction in feed

intake. The reduced concentrate intake of the goats with increasing levels of DCWM in the diets (diets 2, 3 and 4) could not be associated with a reduction in dietary energy supply (table 1) or due to palatability problems. Throughout the experiment there was no incidence of feed refusal and all animals were healthy.

Average daily live-weight gain decreased with increases in levels of DCWM in the diets. Generally, a diet with high digestible organic matter provides more energy and therefore more production, i.e. high live-weight gain, and this was the case in this experiment. DOM values for goats offered diets 1, 2, 3 and 4 were 490, 524, 466 and 439, respectively. Diet 2 had the highest DOM value of 524 and the least DOM was in diet 4; and the goats on diet 2 had the best live-weight gain amongst the other diets. However, the two reasons earlier given above may be responsible for the better live-weight gain obtained in the goats fed diet 2. The high live-weight gain obtained in the goats on diet 2 indicated that the best level of inclusion of DCWM in the concentrate diets of goats is 38.5% replacement level of brewer's dried grains.

The normal voluntary intake for ruminants is between 40-90 g/kg BW^{0.75} or 1-2.8% of body weight and the values of intake for the experimental diets were within this range. Van Soest (1994) reported that voluntary intake is the most important factor that determines the level of efficiency of ruminant productivity. It was observed in this experiment that diets 3 and 4 had higher gross energy values compared to diets 1 and 2 and these could support high live weight gain. Consequently, the low live weight gains obtained for the goats on diets 3 and 4 is difficult to explain because the animals did not reject the diets, although their voluntary concentrate intake was low while forage intake high.

The improved digestibility of nutrients in diets 3 and 4 above the control and diet 2 is of significant interest. In general there is a trend towards decreasing feed intake with decreasing digestibility (Aregheore and Job, 1991), but this was not the case in this trial. The first reason that can be adduced for the observed

trend might be due to the high level of forage intake by the goats on diets 3 and 4 which may have triggered the action of rumen microbes to act on the diets. A second reason that may be responsible for improved digestibility of nutrients could be that the smaller amount of concentrate ingested resulted in improved microbial fermentation leading to high digestion rate and consequently improved utilisation of available nutrients. In this experiment a negative relationship existed between live-weight gain and nutrient digestibility especially in the goats on diets 3 and 4.

The results of this experiment indicated that DCWM could be used in diets for small ruminants. Also, the results showed the potential usefulness of DCWM as feed ingredient in ruminant production in the Pacific Island countries. However, it has to be properly processed and supplemented to achieve good results.

CONCLUSIONS

An assessment of the experimental diets proved that dried DCWM could be fed to goats without deleterious effects. However, the 38.5% inclusion level seems to be the best in order to avoid a reduction in intake of the diets and slow growth rate of goats. Based on the data on voluntary feed intake and live-weight gain of goats fed the experimental diets, it could be concluded that DCWM merits further attention as a readily available local by-product feed source in ruminant nutrition in the Pacific Island countries where feed availability is seasonal.

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