LIQUID DIETS CONTAINING POULTRY WASTES FOR RUMINANTS

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Mature sheep were fed a control corn–soybean meal diet, the same diet mixed with water to give a dry matter:water content ratio of 1:4, or a corn–wet, caged layer manure (CLM) diet containing 80% moisture. Digestible dry matter, nitrogen and energy were highest for the liquid control diet. The CLM diet gave results comparable to that of the dry control diet. Feeding the same diets to growing lambs confirmed the superiority of the liquid control diet as compared to the same ration fed in the dry form. Weight gain and feed:gain ratio were superior for the CLM diet as compared to the dry control.

Des moutons adultes ont reçu un régime alimentaire témoin de maïs et de tourteau de soja, un régime semblable mais dilué dans l'eau dans la proportion de 1–4, ou un régime de maïs et de fumier de volaille (CLM) à 80% d'eau. C'est la ration témoin liquide qui a donné les plus fortes valeurs pour la digestibilité de la matière sèche, de N et de l'énergie. Le régime à CLM a donné des résultats comparables à ceux du témoin sec. L'administration des mêmes rations à des agneaux a confirmé la supériorité du témoin liquide sur le témoin sec. Le gain de poids et l'indice de conversion ont été plus forts dans le régime à CLM qu'avec la ration témoin sèche.

There is a great deal of work reported in the literature on the nutrient composition of poultry wastes (Blair 1974; Couch 1974; Chang et al. 1975) and also on its feeding value for ruminants (Tinnimit et al. 1972; Thomas et al. 1972; Oliphant 1974). However, in spite of the work reported, only limited quantities of this material are being used as feed for ruminants. Part of the reason for the lack of use may stem from the adverse publicity associated with the feeding of such a product. However, a far greater detriment would appear to be the problems associated with handling the material and the economics of incorporating it into animal diets.

Most ruminant studies to-date have investigated the feeding of dried poultry wastes. With the increasing cost of fossil fuel, the drying of such wastes has become almost prohibitively expensive. If poultry wastes are to find favor in a ruminant feeding program a less costly method of processing and handling must be found.

Flipot et al. (1975) have reported that sheep will readily consume diets containing relatively high levels of wet, caged layer manure (CLM). Although wastes utilized in such a manner would eliminate the high cost of drying, the problem of handling such a product (containing around 70% moisture) might well negate its acceptance in a ruminant feeding program.

Fitzgerald and Kay (1974) fed liquid diets to calves and suggested a number of possible advantages of feeding cattle with a pipeline system whereby the feed would be suspended in water. The work of Fitzgerald and Kay (1974), Renton and Forbes (1973) and Raven and Robinson (1961) indicates that utilization of nutrients is similar whether fed in dry or liquid diets. Indeed the reports of the latter workers would suggest an improvement in nitrogen retention with the liquid diets. Liquid diets for ruminants may also reduce feed wastage as has been shown to occur when "wet" and "dry" rations have been fed to pigs (Braude and Rowell 1967; Forbes and Walker 1968).

The present study was designed to investigate the acceptance by sheep of diets containing 80% moisture with a sizeable portion of the nutrients coming from poultry wastes. If such a diet would permit satisfactory performance of ruminant animals, the possibility of utilizing wet CLM in a feeding system employing a pipeline for feed distribution could well be feasible.

MATERIALS AND METHODS

Diets

Manure was collected every other day from hens fed a corn–soya laying diet containing 17% protein and stored in a cooler at 40 C. On a dry weight basis the manure contained 27.5% protein (N × 6.25), 8.5% calcium and 2.3% phosphorus. The experimental diet containing CLM (Table 1) was mixed twice a week and kept refrigerated at 4 C during the feeding trials. This diet was calculated to contain 15% protein (N × 6.25) and estimated to have a TDN value of around 70 when calculated on a 10% moisture basis. CLM was included in the experimental diet to provide a level of dry matter (DM) equivalent to that contained in 30% of the control diet (Table 1); hence, 154 kg of the experimental diet equaled the DM present in 100 kg of the control diet (Table 1). Soybean meal replaced CLM as a source of supplemental nitrogen in the control diet and 15% oat hulls were added to simulate the fibre level present in the experimental diet. The control diet was fed dry (10% moisture) and in a wet form equal to the moisture content of the CLM diet to which water had also been added.

Table 1. Formulation of diets

	Control (%)	Experimental (%)
Ingredient		
Corn	60.5	62.5
Soybean meal (49%)	19.5	–
Oat hulls	15.0	5.0
Mineral mix	2.0	–
Molasses	3.0	2.5
Caged hen manure (approx. 70% moisture)	–	30.0†
Total (%)	100.0	100.0
Analysis (at 10% moisture)		
Crude protein (N × 6.25) (%)	15.0	15.0
Crude fibre (%)	7.5	7.4
Crude fat (%)	2.4	2.2
Moisture (%) 'As is'	10.0	25.0
Wet	80.0	80.0

†84 kg of wet hen manure added to give 30 kg of material containing 10% moisture.

Animal and Feeding Regime

In the first trial, three mature wethers (averaging 37 kg) were placed on each of the dietary treatments. Feed intake and digestibility of the diets were measured using the following schedule: adjustment period to the diet, 10 days; determination of feed intake, 7 days; adjustment to the metabolism crates and to restriction of feed to 90% of ad libitum intake, 4 days; collection period 5 days.

Feed intake on the control diet had been estimated at around 1,000 g DM per day. Thus during the adjustment period 1,200 g DM for each of the three diets was offered. Control diet DM intake was measured daily and averaged 980 g. During the 7-day feed measurement period, the sheep were offered 1,200 g DM control diet, while the sheep on the liquid diets were offered 1,000 g DM. Half of the daily allotment of feed was offered in the morning and the other half in the afternoon in order to help eliminate the problem of "settling out" with the liquid diets. As can be noted from Table 2, the average DM consumption per day was less than 1,000 g; however, individual sheep on the control diet consumed slightly more than 1,000 g.

Table 2. Daily feed intake during preliminary measurement period

Replicate	Diets: Dry control (g)	Wet (80% water): Control	Wet (80% water): Cage layer manure
1	856	950	990
2	1,074	976	905
3	953	1,000	960
Mean	961±63†	975±14	952±25

†±, standard error of mean.

During the period of adjustment to the metabolism crates and also the 5-day collection period, 90% of the DM intake shown in Table 2 was offered each of the respective groups, again with twice-a-day feeding. Feed refusal was minimum during the adjustment period and was not recorded.

In the second trial, two male and two female lambs weighing an average of 27.1 kg were placed on each of the 3 dietary treatments and allowed a 14-day acclimatization period. The animals were then weighed weekly and feed intake recorded on a daily basis for an 8-wk experimental period. All animals were injected intramuscularly with vitamins A, D and E prior to being placed on the feeding trials.

Feed, Feces and Urine Sampling

Samples of each ration were taken daily during the collection period, frozen, then pooled and freeze-dried prior to analyses. Aliquots equivalent to 10% of the daily production of feces and urine were collected and frozen daily. At the end of the collection period, the aliquots were combined, mixed and samples taken for analysis. Nitrogen in both feed and fecal samples was determined by a macro-Kjeldahl procedure similar to that described by the Association of Official Agricultural Chemists (1965). Adiabatic bomb calorimetry (Parr-Co. Ltd., Illinois) was used for the determination of gross energy of all samples. The crude fibre contents of control and experimental diets shown in Table 1 was carried out according to the method of Clancy and Wilson (1966) whilst corresponding crude fat content was measured by a 24-h extraction process with petroleum ether as solvent in a Soxhlet apparatus.

Statistical Analysis

The probability of a significant difference between means was ascertained by the *t*-test (Steel and Torrie 1960).

RESULTS AND DISCUSSION

During the preliminary measurement period, one sheep consumed all the 'wet control' diet offered to it (Table 2); however this 'restricted' feeding regime was not thought to be of any significance in interpretation of the results.

Sheep on the two liquid diets consumed virtually no free water. In spite of this, their total intake of water was higher than that of the sheep fed the dry control ration (Table 3). Although there was variation among treatments with respect to apparent water retention, the results obtained suggest that 'apparent' absolute retention was similar for the three dietary regimes.

An attempt was made to keep DM intake constant during the collection period, but small differences in average daily intake did occur (Table 4). Dry matter digestibilities for the dry control and the liquid CLM diets were similar, while the liquid control diet gave a higher value.

Daily nitrogen intake varied slightly between the three dietary treatments. Digestibility of nitrogen by sheep fed the liquid

Table 3. Water balance of sheep fed dry and liquid diets

	Diets		
	Dry	Wet (80% water)	
	Control	Control	CLM
Water balance (ml/day)			
Free water	2,490	–	–
Feed water	190	3,615	3,615
Total water intake	2,599	3,615	3,615
Fecal water	206	514	183
Urinary water	1,003	2,113	2,275
Apparent water output	1,200	2,627	2.458
Apparent water retained	1,396±292†	988±189	1,157±67

†Standard error of the mean.

Table 4. Digestibility of dry matter, energy and nitrogen for dry and liquid diets fed to sheep

	Diets		
		Wet (80% water)	
	Dry control	Control	CLM
Dry matter intake (g/day)	842	885	832
Dry matter digestibilty (%)	77.2±1.37†*a*	81.9±1.38 *b*	75.1±0.27 *a*
Nitrogen intake (g/day)	25.9	27.3	28.4
Nitrogen output (g/day)			
Feces	5.1	4.7	6.0
Urine	16.0	14.2	16.6
Nitrogen digestibility (%)	80.2±0.20 *a*	82.9±0.31 *b*	79.0±0.41 *a*
Nitrogen retained (%)	18.5	30.9	20.6
Digestible energy (kcal/g)	3.02±0.06 *c*	3.36±0.02 *b*	2.55±0.01 *a*

†Standard error of the mean.
a–c For each parameter values bearing the same letter are not significantly different ($P \leq 0.05$).

control diet was significantly higher ($P \leq 0.05$) than from those fed the other two treatments. Nitrogen retention was also much higher for the liquid control diet than for the other dietary treatments.

Digestibility of energy was highest for the liquid control diet and lowest for the liquid CLM treatment, while the dry control ration resulted in a value approximately mid-point between these two., All these means were significantly different ($P < 0.05$).

Weight gain and feed:gain ratios for the lambs fed the experimental diets also suggested superiority of the liquid control diet (Table 5). Performance of those lambs fed the CLM diet was rather surprising in view of the lower digestible energy value of this diet in relation to the wet control ration (Table 4). Since the lambs were growing at a relatively fast rate, energy may not have been as limiting a factor in relation to protein as it might have been in older animals.

The results obtained from the present study agree with the work of Fitzgerald and Kay (1974) and Raven and Robinson (1961) showing that dietary nutrients are well utilized from liquid diets. The data give little or no evidence that water content of the diet affects nitrogen digestibility by increased "washout." Indeed the liquid control diet gave a higher percentage nitrogen digestibility than the dry control ration, which is in agreement with the work of Raven and Robinson (1961). The data further support the suggestion of Fitzgerald and Kay (1974) of the possibility of feeding

Table 5. Weight gain and feed intake of lambs fed dry and liquid diets for an 8-wk period

	Diets		
	Dry	Wet (80% water)	
	Control	Control	CLM
Avg wt gain (kg)	6.5±0.85†*a*	7.9±1.21 *a*	7.3±1.24 *a*
Avg feed intake (kg OM)	41.2±3.40 *b*	40.7±4.30 *b*	40.9±2.57 *b*
Feed:gain	6.93±0.75 *c*	5.34±0.39 *c*	6.03±0.43 *c*

†Standard error of the mean.
a–c For each parameter, means bearing the same letter are not significantly different ($P \leq 0.05$).

cattle with a pipeline system whereby the feed would be suspended in water.

Wet, caged layer manure would appear to be a readily acceptable feedstuff for ruminants. Its high level of nitrogen and minerals should allow it to be used to advantage with those corn silage or grain rations for which nitrogen is limiting. The health aspects of recycling animals wastes by feeding and the proper method of stabilizing such a product still remain to be completely answered. However, the excellent review of this subject by Fontenot and Webb (1975) suggests that the feeding of animal wastes with proper precautions can be a safe practice.

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