

## POULTRY WASTES AS A FEEDSTUFF FOR SHEEP

PAUL FLIPOT<sup>1</sup>, MARY McNIVEN<sup>2</sup>, and J. D. SUMMERS<sup>2</sup>

<sup>1</sup>Research Station, Agriculture Canada, P.O. Box 90, Lennoxville, Quebec J1M 1Z3 and

<sup>2</sup>Department of Animal and Poultry Science, University of Guelph, Guelph, Ontario N1G 2W1.

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Six wethers averaging 37 kg were used in a double 3×3 latin square design to evaluate poultry wastes as a feedstuff; small silos were used to measure the ensiling characteristics of these diets. Poultry excreta (CLE) were treated with tannic acid (3%) or paraformaldehyde (2%) and incorporated at a level of approximately 64% (wet weight) into test diets for sheep. Soybean meal and water replaced this material in the control diet. Dry matter and water intake of the CLE diet treated with 2% paraformaldehyde was lower ( $P < 0.05$ ) than that of the other two diets. Dry matter, total N and energy digestibilities were decreased ( $P < 0.05$ ) in diets containing CLE. Nitrogen retained as a percent of total N intake was not different for the control and the CLE tannic-acid-treated diets. The ensiling characteristics were not adversely affected by CLE.

Dans cette expérience, disposée en double carré latin 3 × 3, nous avons utilisé six moutons castrés d'un poids moyen de 37 kg afin d'évaluer la valeur nutritive des déjections de poules en batterie (CLE); des mini-silos furent utilisés pour mesurer la capacité de fermentation de ce produit. Les déjections ont été mélangées aux rations expérimentales des moutons dans une proportion approximative de 64% (base humide), après avoir été traités à l'acide tannique (3%) ou au paraformaldéhyde (2%). Dans le régime témoin, les excreta étaient remplacés par du tourteau de soja et de l'eau. La consommation de matière sèche et d'eau a été inférieure ( $P < 0.05$ ) chez les moutons alimentés avec les CLE traités au paraformaldéhyde, comparativement aux deux autres régimes. La digestibilité de la matière sèche, de l'azote total et de l'énergie était inférieure ( $P < 0.05$ ) dans les rations contenant des CLE. La concentration d'azote retenu, en pourcentage de l'azote total absorbé, était la même dans le régime témoin et celui contenant des CLE traités à l'acide tannique. Les CLE n'ont pas eu d'effet néfaste sur les caractéristiques de fermentation ou d'ensilage.

The accumulation of large quantities of animal wastes has become a problem for modern agriculture, as the nitrogen content of these wastes can be a major pollutant of streams and rivers. The poultry industry, because of its high concentration of animals on limited land area and high nitrogen content of the manure produced, is one agricultural industry with a high potential for pollution.

Since protein is one of the limiting nutrients in livestock feeding, the use of poultry wastes in the feeding of animals has been receiving increased attention. Several

workers have investigated poultry excreta as a nitrogen source for ruminants (El-Sabban et al. 1970; Lowman and Knight 1970). Tinnimit et al. (1972) reported that the acceptability of dehydrated poultry excreta was excellent when fed to growing sheep at levels up to 80% in a mixed ration. Retention of digested nitrogen was 18 – 72%, depending on rate of intake, and these values compared favorably with comparable values of 16 – 65% for soybean meal rations. Thomas et al. (1972) reported that sheep fed 25 and 50% dehydrated poultry feces in the diet gained 0.16 and 0.15 kg/day, respectively, which was signifi-

cantly less than the control diet (0.21 kg/day).

Fresh poultry excreta contain approximately 75% water. They are therefore expensive, as well as difficult, to dry. If poultry excreta are to find a place in the feeding of ruminant animals, economics will be a major factor influencing their use. Of extreme importance, then, is the question as to whether they can be utilized without drying.

It is well known that urea improves the ensiling characteristics of corn silage (Klosterman et al. 1961; Owen et al. 1969). Huber et al. (1973) also reported an improvement in ensiling characteristics of corn silage treated with ammonia. Wet poultry excreta would thus appear to have potential as an additive to silage or as an additive to dry hay to make haylage. One of the major objections against the use of chicken excreta as a feedstuff is the possible danger from pathogenic organisms. The ensiling process may well destroy pathogens. Harmon et al. (1975) reported that the coliform population was not higher for the silages containing broiler litter than for the control silages. Additives such as paraformaldehyde, tannic acid, formic acid, pro-

ponic acid or acetic acid could be used to stabilize the poultry wastes and reduce the rate of fermentation. These might protect protein breakdown in the silo and perhaps also in the rumen.

There is little or no information available concerning the feeding of fresh poultry feces to ruminants. Hence, the present study was undertaken to provide information as to the acceptability and potential nutritive value of wet caged hen excreta when fed to mature sheep.

## MATERIALS AND METHODS

### Diet Preparation

Cage layer excreta (CLE) were collected every 2 days from layers fed a commercial type corn-soya diet (17% protein) and stored in a cold room at 5 C. Diets, with the formulation and chemical composition as shown in Table 1, were prepared once weekly in 500-kg horizontal mixers. For the control, CLE was replaced by water and soybean meal in order to obtain the same moisture and protein content. Tannic acid and paraformaldehyde were added as preservatives on a dry weight basis of 3 and 2%, respectively, thus making the two additional treatments. After mixing, these diets were kept in a cold room at 5 C throughout the experiment.

Table 1. Formulation and chemical composition of the diets

Ingredients	Control (kg)	Tannic acid (kg)	Paraformaldehyde (kg)
Chopped alfalfa hay	31.9	28.0	28.3
Water (added)	47.7	-	-
Chicken manure	-	64.2	64.5
Corn	4.4	3.9	3.9
Molasses	1.7	1.7	1.7
Vitamins	0.3	0.3	0.3
Iodized salt	0.2	0.2	0.2
Soybean meal (49% protein)	13.8	-	-
Tannic acid	-	1.7	-
Paraformaldehyde	-	-	1.1
Total	100	100	100
<i>Chemical composition (on dry matter basis):</i>			
Dry matter (%)	46.4	47.2	47.8
Total nitrogen (mg/g)	45.1	39.4	38.9
Soluble nitrogen (mg/g)	19.0	13.6	16.7
Non-protein nitrogen (mg/g)	9.2	13.5	17.0
Gross energy (kcal/g)	4.4	4.0	3.9

### Silage Preparation

Grab samples of each diet were taken during mixing, packed into 300-g glass jars capped with a rubber stopper and fitted with a valve to permit gas release. The material was allowed to ferment for 42 days in darkness and at room temperature. Duplicate silos were made for each of the three experimental rations. A fourth silo was prepared using a similar diet made with untreated CLE.

### Animals

Six wethers averaging 37 kg were used in a double 3×3 latin square design. Sheep were treated for internal parasites with Tramisol. The intake and digestibility of the diets were measured using the following schedule: an adjustment period of 10 days; 7 days for the determination of intake; 4 days for adjustment to the metabolism crates, at which time the intake dropped to 90% of ad libitum consumption; a collection period of 5 days.

### Diet, Feces and Urine Sampling

Samples of each diet were taken daily during the collection period and then frozen. Five percent aliquots of feces and urine were also collected daily and frozen, then aliquots were pooled at the end of each collection period.

### Analytical Procedure

Dry matter content was determined by toluene distillation (Association of Official Agricultural Chemists 1970). The pH of urine and silage was measured using a glass electrode. Total N was

determined by the macroKjeldahl procedure (Association of Official Agricultural Chemists 1970). Soluble N was determined by the same method after extraction of 20-g samples with 200 ml of 0.1 N HCl (Brady 1960). Ammoniacal N was measured by distillation over MgO (AOAC 1970). Soluble NPN was measured as the nitrogen in the supernatant obtained from 10 ml of extract, mixed with 10 ml of 1.6 N TCA solution and kept in a cold room overnight, and then centrifuged for 20 min at 5,000 rpm. Lactic acid was measured by the colorimetric method of Barker and Summerson (1941), and volatile fatty acids by the method of Y. T. Yao and J. B. Buchanan-Smith (1972 unpublished). Energy was determined by combustion in a Parr oxygen bomb calorimeter.

All data were subjected to analysis of variance and Tukey's *w*-procedure used to compare treatment means (Steel and Torrie 1960).

### RESULTS

Total N, soluble N and gross energy were higher (Table 1) in the control (SBM) diet than in the two test diets. Non-protein nitrogen (NPN) was lower in the SBM than in diets containing CLE.

Data for the various parameters measured are shown in Table 2. The dry matter intake of the CLE diet treated with 2% paraformaldehyde was significantly ( $P < 0.05$ ) lower than that of the other two diets. Sheep fed this diet consumed less water, and had

Table 2. Dry matter intake, water balance and urine pH of sheep fed soybean meal or chicken manure as a source of nitrogen

	Control	Tannic acid	Paraformaldehyde	SE mean
Dry matter intake (g/day)	901.0 <i>b</i> *	935.7 <i>b</i>	389.3 <i>a</i>	46.2
Water balance (ml/day)				
Free water	2,273.5	2,440.2	1,052.3	
Feed water	1,044.3	1,053.0	427.5	
Total intake	3,317.8 <i>b</i>	3,493.2 <i>b</i>	1,479.8 <i>a</i>	185.4
Fecal water	320.1	382.2	136.0	
Urinary water	1,471.2	1,657.2	813.3	
Total output	1,791.3 <i>b</i>	2,039.4 <i>b</i>	949.3 <i>a</i>	112.3
Retained water (%)†	45.9 <i>b</i>	41.5 <i>ab</i>	35.9 <i>a</i>	2.0
Urine pH	9.32	9.34	9.32	.04

\*Means in same line with different letters are significantly different ( $P < 0.05$ ).

†Not taking into account insensible water losses.

Table 3. Apparent digestibility of dry matter, nitrogen and energy of diets containing soybean meal or chicken manure as a source of nitrogen

	Control	Tannic acid	Paraformaldehyde	SE mean
Dry matter (%)	69.9 <i>c</i> *	59.3 <i>b</i>	54.8 <i>a</i>	0.9
Total nitrogen (%)	80.8 <i>b</i>	71.8 <i>a</i>	71.5 <i>a</i>	0.7
Energy (%)	68.6 <i>c</i>	58.2 <i>b</i>	53.5 <i>a</i>	1.1
DE kcal/kg	3,018.4 <i>c</i>	2,328 <i>b</i>	2,086.5 <i>a</i>	0.1

\*Means in same line with different letters are significantly different ( $P < 0.05$ ).

correspondingly lower water excretion and percentage retention of water. The different diets had no significant effect on the pH of the urine.

Dry matter, total N and energy digestibilities were significantly decreased in diets containing CLE (Table 3). Paraformaldehyde treatment significantly ( $P < 0.05$ ) reduced the apparent digestibilities of dry matter and energy of the diet compared to the tannic-acid-treated diet.

Nitrogen intake and excretion were significantly ( $P < 0.05$ ) lower for the CLE paraformaldehyde-treated diet (Table 4). However, nitrogen retained as a percent of total N intake was not significantly different for the control and the CLE tannic-acid-treated diet. Energy intake and fecal energy were lower for the CLE paraformaldehyde-treated diet than for the other two treat-

ments, while urinary energy was highest for the sheep fed the control diet. The difference between energy intake and loss in urine and feces was also highest for the control, followed by the CLE tannic-acid-treated and the CLE paraformaldehyde-treated diets.

Ensiling characteristics of the experimental diets and untreated CLE are presented in Table 5. The pH was higher for the CLE diets than for the soybean control ration. Total N, soluble N and NPN were not significantly affected by treatment. However,  $\text{NH}_3\text{N}$  as a percent of total N was increased ( $P < 0.05$ ) for the CLE haylage. The highest level of  $\text{NH}_3\text{N}$  was observed in untreated and tannic-acid-treated CLE. Lactic acid production was significantly ( $P < 0.05$ ) decreased for the paraformaldehyde-treated CLE group. Acetic acid pro-

Table 4. Nitrogen and energy retention of sheep fed diets containing soybean meal or chicken manure as a source of nitrogen

	Control	Tannic acid	Paraformaldehyde	SE mean
Nitrogen balance (g/day)				
Nitrogen intake	40.6 <i>b</i> *	36.9 <i>b</i>	15.1 <i>a</i>	2.2
Fecal nitrogen	7.8	10.2	4.4	
Urinary nitrogen	23.6	18.8	9.7	
Total output	31.4 <i>b</i>	29.0 <i>b</i>	14.1 <i>a</i>	1.9
Nitrogen retained (% of intake)	22.7 <i>b</i>	21.4 <i>b</i>	6.6 <i>a</i>	2.5
Energy balance (kcal/day)				
Energy intake	3,938.9 <i>b</i>	3,699.6 <i>b</i>	1,529.8 <i>a</i>	193.8
Fecal energy	1,235.2 <i>b</i>	1,549.6 <i>b</i>	709.4 <i>a</i>	83.7
Urinary energy	225.9 <i>b</i>	130.7 <i>a</i>	83.9 <i>a</i>	15.7
Intake — (fecal+urine) loss (% of intake)	62.9 <i>c</i>	54.6 <i>b</i>	48.1 <i>a</i>	1.3
Intake — (fecal+urine) loss (kcal/kg)	2,767.6 <i>c</i>	2,184.0 <i>b</i>	1,875.9 <i>a</i>	0.1

\*Means in same line with different letters are significantly different ( $P < 0.05$ ).

Table 5. Ensiling characteristics of reconstituted haylage containing soybean meal or manure from caged layers

	CLM				SE mean
	SBM	Untreated	Tannic acid	Paraformaldehyde	
Dry matter	49.0 <i>ab</i> *	52.2 <i>b</i>	49.6 <i>ab</i>	48.4 <i>a</i>	0.5
pH	4.4 <i>a</i>	5.0 <i>bc</i>	4.9 <i>b</i>	5.4 <i>c</i>	0.07
Nitrogen					
Total N (mg/g)	40.1	35.7	37.7	39.2	1.3
Soluble N (% of total)	46.5	46.1	38.9	48.3	2.9
Ammoniacal N (% of total)	5.4 <i>a</i>	14.9 <i>c</i>	13.9 <i>c</i>	9.5 <i>b</i>	0.7
NPN (% of total)	35.3	46.7	39.2	48.7	2.6
Organic acids (mg/g)					
Lactic	52.97 <i>b</i>	64.23 <i>b</i>	45.78 <i>b</i>	12.43 <i>a</i>	0.4
Acetic	21.03	28.03	29.50	8.09	4.5
Propionic	0.64 <i>a</i>	1.16 <i>c</i>	0.94 <i>b</i>	0.83 <i>b</i>	0.02
Butyric	0.05 <i>a</i>	0.35 <i>b</i>	0.45 <i>c</i>	0.45 <i>c</i>	0.01
Energy (kcal/g)	4.37 <i>b</i>	4.00 <i>a</i>	3.98 <i>a</i>	3.99 <i>a</i>	0.05

\*Means in same line with different letters are significantly different ( $P < 0.05$ ).

duction was not significantly different among haylages. However, propionic and butyric acid increased in CLE haylage, but no significant difference was observed between the tannic-acid- and paraformaldehyde-treated diets. Gross energy was lower ( $P < 0.05$ ) for the CLE haylages than for SBM haylage.

### DISCUSSION

The difference in nitrogen and energy content between SBM and CLE diets may be explained by the chemical composition of the feedstuffs used. Crude protein content of the CLE was obviously overestimated by the average value of 27%, on a dry weight basis. Part of the reason for this discrepancy may have been due to free ammonia during mixing and fermentation during storage, while no attempt was made to keep the diets isocaloric.

After 3 days of storage, no fecal odor could be detected in the tannic-acid-treated CLE diets. However, the diet containing CLE treated with paraformaldehyde emitted a distinct odor. This may have caused the reduction in feed intake, although Barry et al. (1973) reported an increase in dry matter intake of sheep fed formaldehyde-treated

silage (1.7% of w/w of the dry matter). The odor could have been due to the high level of paraformaldehyde used, rather than to feces per se.

Digestibility of dry matter, total N and energy was highest for the control diet. This agrees with Tinnimit et al. (1972), who reported lower digestibility of dry matter, energy and nitrogen in sheep eating diets containing dried poultry feces.

Nitrogen retained as a percent of nitrogen intake was as good for the tannic-acid-treated CLE as for the soybean meal diet. Again, this agrees with Tinnimit et al. (1973), who reported the same trend with dried poultry feces. The low nitrogen retention value for the paraformaldehyde-treated CLE diet is probably related to the low nitrogen intake of this group, and perhaps to the level of paraformaldehyde which may have limited microbial growth. Hence, by overprotecting the protein, a decrease in digestibility in the lower gastro-intestinal tract may have resulted (Amos et al. 1974).

The pH of the haylage containing CLE was higher than that of the control diet. Huber et al (1972) also reported an increase in pH and ammoniacal N in plant corn silage treated with ammonia.

The decrease in lactic acid with the paraformaldehyde group is in agreement with Davidson et al. (1973), who reported that lactic acid content was lower with formalin-treated than with untreated grass silage. According to De Vuyst et al. (1969), the higher propionic acid content in the CLE diets might be explained by the deamination of alanine. Butyric acid levels observed in CLE haylage were similar to those reported by Henderson et al. (1971) in urea-treated corn silage.

The data suggest that wet CLE treated with tannic acid can be successfully used for the feeding of sheep. More work is required to find the most suitable 'additive' to stabilize the chicken feces, and thus reduce odor and make the product more palatable. Work is also required on the risk of pathogenic organisms.

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