three treatments produced an average feed conversion of 7.40 lb. of feed per pound of gain. This would translate to 6.29 lb of grain (7.40 X 85 percent) per pound of gain. Although the head chop feed conversions may look high, in reality, they are quite acceptable considering the nature of the ration.

Carcass data are presented in Table 5. In general, the cattle on the wheat head chop showed a trend for a somewhat lower dressing percent and carcass grade compared to cattle on the other three treatments.

Animal Wastes as Protein Sources for Ruminants

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Story in Brief

In a continuing effort to determine if animal waste products can conceivably be recycled as feed ingredients, beef feedlot wastes (FLW) and dehydrated (DPW) and fermented (FPW) poultry wastes were tested as sources of crude protein or nitrogen for ruminants. FLW was tested as 40 percent of a growing lamb ration. In contrast to previous findings, the FLW samples tested this year were not only very low in crude protein (<12 percent) but that protein was of low digestibility, 40 percent or lower. This study suggested that composting may decrease the protein value of beef feedlot wastes.

DPW (30 percent crude protein) and FPW (22 percent crude protein) were fed as 15 and 25 percent of a growing-finishing lamb ration. Both products were palatable at those levels. When compared to rations containing soybean meal as the source of protein, rations containing 15 percent DPW and FPW supported similar gains over a 90 day feeding period. At 25 percent DPW and FPW, performance was slightly lower. Organic matter digestibility was not changed by either 15 or 25 percent DPW or FPW. Estimates of digestibility for the crude protein in DPW

and FPW were 66-75 percent and 55-59 percent, respectively. Thus, although the protein in poultry wastes was not as digestible as common natural protein sources, it was sufficiently digestible to be of interest as a feed ingredient.

Introduction

Previous work has suggested that animal wastes may contain considerable portions of digestible nutrients. Recycling of the wastes through animals could conceivably reduce the load of waste material for ultimate disposal in addition to possibly providing an inexpensive nutrient source. In work reported in 1971 (Okla. Agr. Exp. Sta. M.P. 87) wastes from beef cattle feedlots were found to contain as much as 44 percent ash. The organic matter remaining, however, varied from 42 to 56 percent digestible. Furthermore, the high nitrogen content (15-20 percent crude protein equivalent) was 60-71 percent digestible. It was of further interest, therefore, to test animal wastes as a source of nitrogen for the ruminant animal.

Since most poultry are also raised in confinement, accumulation of their wastes also presents a disposal problem. Poultry excreta contains about 30 percent crude protein equivalent and so also could serve as a source of N for ruminants. In the present studies, the digestibility of poultry litter and its ability to support lamb growth were also studied.

Materials and Methods

Trial 1. Studies With Beef Feedlot Wastes

Beef cattle feedlot wastes were collected from two sources. The first (FLW-4) was from the accumulated mound at Texas County Feedlot, Guymon, Okla. This year, most of the mound had been removed and so only a small portion was left to sample. The second source (FLW-5) was from the Hitch Feedlot, Guymon, Okla., and represented a batch of material which had been taken from selected areas in one pen. This material had been composted, using a mixing process with a front end loader to aerate the pile. These materials varied between 45 and 50 percent ash but, in contrast to previous samples tested, were only about 12 percent crude protein equivalent.

A new depletion—repletion technique was used to study the value of the nitrogen contained in these samples. Twelve growing lambs were fed a protein (or nitrogen) deficient ration, ration 1 in Table 1, for 3 weeks to deplete their protein reserves. A digestibility and nitrogen balance trial was conducted during the last 7 days of this depletion period. Total feces and urine collection techniques were used. Following the

Table 1. Composition of Rations for Feedlot Waste-Protein Study

Ingredient	1 Depletion	2 Low Protein	3 High Protein	4 FLW-4	5 FLW-5
		% in Ration, 100% D.M. basis			
Cottonseed hulls	35.0	35.0	35.0	7.4	7.4
Molasses, dried	6.0	6.0	6.0	6.0	6.0
Corn starch	10.0	10.0	10.0	10.0	10.0
Ground corn	48.1	42.1	36.1	32.6	32.6
Dicalcium phosphate	0.4	0.3	0.1	0.2	0.2
Limestone	0.1	0.2	0.4	-	-
Salt	0.4	0.4	0.4	0.4	0.4
Soybean meal	-	6.0	12.0	3.4	3.4
FLW-4[1]	-	-	-	40.0	-
FLW-5[2]	-	-	-	-	40.0
		Chemical composition, % D.M. basis			
Ash	3.15	3.86	4.08	22.72	24.16
Organic matter	96.85	96.14	95.92	77.28	75.84
Cellulose	17.12	18.26	17.70	11.70	11.25
Crude protein	7.43	11.10	12.64	10.88	10.54

[1] Texas County Feedlot — samples taken from remains of accumulation pile — June, 1972.
[2] Hitch Feedlot — composted feedlot waste.

depletion phase, the lambs were allotted 3 per group to rations 2-5 shown in Table 1. Ration 3 was a positive control with soybean meal (SBM) supplied to satisfy NRC requirements for growing lambs. Ration 2 was a negative control with half the allowance of SBM as used in ration 3. In rations 4 and 5, FLW-4 and FLW-5 were substituted at the 40 percent level, primarily at the expense of cottonseed hulls.

The contribution of protein by the feedlot wastes was approximately equivalent to the SBM allowance in Ration 2 (see chemical composition in Table 1). This would allow for maximum efficiency of utilization of protein. The rations were designed to contain sufficient digestible energy for growth and nitrogen retention as long as the nitrogen source was a usable one. However, since the energy values of the FLW samples were unknown, the energy levels were probably not the same in all rations. Digestion and nitrogen retention trials were conducted during weeks 2 and 4 of the repletion phase. Methods of analysis for feed, feces and urine were routine.

Trial 2. Studies with Poultry Wastes

Samples of dehydrated poultry wastes (DPW) and fermented poultry wastes (FPW) were supplied by the Merry Lea Corporation, Kansas City, Missouri. DPW was poultry excreta collected without any litter and dehydrated. FPW was the same material which had been processed by a fermentation system and dried. The DPW averaged 30 percent crude protein and the FPW, 22 percent. Both materials were tested primarily as protein sources in lamb growing rations.

Forty eight lambs weighing approximately 46 lb. were randomly allotted to the 6 ration treatments illustrated in Table 2. All lambs were housed in individual pens and were provided feed and water free choice. All lambs were weighed every 15 days.

Twelve similar lambs were used to determine digestibility of these rations. The lambs were allotted two per block to a 6 x 6 latin square design in which the rotation allowed for all lambs to be exposed to all rations. Each rotation consisted of a one week adaptation period followed by a one week collection period. Feces and feed were analyzed by routine methods.

Results and Discussion

Trial 1. Feedlot Wastes

The results of the digestion and nitrogen balance trials with feedlot wastes are reported in Tables 3 and 4. Digestibility of dry matter was depressed by the inclusion of FLW in these rations but this would be expected based on their high ash content. The digestibility of organic matter was not decreased and actually appeared to be increased in the FLW-5 rations. Digestibilities were not changed appreciably in the SBM rations (medium and high protein controls).

Nitrogen digestibility was obviously increased by the addition of SBM to the rations (Table 4). It also appeared to increase as the re-

Table 2. Composition of Rations Containing Dehydrated Poultry Waste (DPW) and Fermented Poultry Waste (FPW).

	Composition, %, moisture free basis					
Ingredient	Pos. Control	15% DPW	25% DPW	15% FPW	25% FPW	Neg. Control
Cottonseed hulls	35.0	35.0	35.0	35.0	35.0	35.0
Molasses	5.0	5.0	5.0	5.0	5.0	5.0
Corn starch	10.0	10.0	10.0	10.0	10.0	10.0
Ground corn	34.8	27.4	22.2	24.2	17.2	44.0
Soybean meal	14.4	6.6	1.6	9.8	6.7	5.0
DPW	—	15.0	—	15.0	—	—
FPW	—	—	25.0	—	25.0	—
Salt	0.6	0.6	0.6	0.6	0.6	0.6
Limestone	0.2	0.2	0.2	—	—	0.2
Dicalcium phosphate		0.2	0.4	0.4	0.5	0.2
Vit. A	+	+	+	+	+	+
Vit. D	+	+	+	+	+	+

Table 3. Dry Matter Intake and Apparent Digestibilities of Dry Matter, Organic Matter and Cellulose when Rations Containing High Levels of FLW-4 and FLW-5 were Fed to Sheep.

	Period	D.M. Intake gm/day	Apparent digestibilities Dry matter	Organic matter	Cellulose
			%	%	%
Med. Protein control					
Digestibility on basal	1	648	67.6	64.3	30.7
Digestibility on test	2	898	63.7	64.0	29.4
ration	3	875	71.3	71.6	35.8
High protein control					
Digestibility on basal	1	756	66.4	66.4	35.9
Digestibility on test	2	914	65.4	65.7	20.2
ration	3	917	70.1	69.3	32.6
FLW-4 (TCF)					
Digestibility on basal	1	667	64.9	65.1	30.6
Digestibility on test	2	896	56.7	70.3	40.8
ration	3	867	57.2	64.9	40.4
FLW-5 (HF)					
Digestibility on basal	1	788	59.2	59.5	21.4
Digestibility on test	2	860	52.2	67.2	30.7
ration	3	864	55.8	70.4	42.0

Table 4. Parameters of N-Utilization When Feedlot Wastes Contribute Major Portions of the Dietary-N in Sheep Rations.

	Period	Nitrogen Intake	Nitrogen digestibility	Nitrogen balance
		gm/day	%	gm/day
Medium protein control				
Basal ration	1	7.69	43.4	1.83
Test ration	2	15.87	56.1	5.82
	3	15.54	63.0	6.32
High protein control				
Basal ration	1	8.98	38.6	2.04
Test ration	2	18.49	58.6	5.94
	3	18.55	64.9	6.06
FLW-4 (TCF)				
Basal ration	1	7.92	40.7	2.05
Test ration	2	15.61	38.7	3.36
	3	15.09	44.5	3.13
FLY-5 (HF)				
Basal ration	1	9.37	29.3	2.07
Test ration	2	14.17	36.2	1.98
	3	15.30	44.3	3.32

pletion trial progressed from period 2 to period 3. Nitrogen balance was increased markedly by SBM supplementation and to approximately the same degree by the two levels of SBM. Thus, the medium protein control was apparently supplying sufficient protein to satisfy requirements under these circumstances and the extra SBM in the high protein control was being provided in excess of requirements. Nitrogen digestibility was not increased over the basal ration by the addition of FLW-4 or FLW-5. This is in contrast to the high digestibilities noted in the previous years work. Since this years products were lower in total nitrogen, it would suggest that the digestible forms of nitrogen had been lost in the composting processes. As a result of the low nitrogen digestibility, nitrogen balance was improved only slightly if at all, even though the nitrogen content of these rations were equivalent to the medium protein control.

In conclusion, even though the organic matter of the feedlot wastes studied this year was fairly digestible, it appears the nitrogen was of low value ($\leqslant$40 percent digestible). Digestible nitrogen may be lost in composting operations.

Trial 2. Poultry Wastes

The growth performance of lambs fed the DPW and FPW rations is reported in Table 5. Performance has been reported for 30 day periods as well as the entire 90 day feeding period. Gains during the first 30 days were exceptionally good averaging 0.34 kg (0.75 lb) per day except for the lambs on the negative control which obviously grew more slowly. Substitution of DPW or FPW for SBM did not appear to be deleterious during this period except possibly for the 25 percent DPW group which appeared to gain less than the positive control. From the standpoint of protein requirement, this stage of growth is the most critical period.

Although consumption of feed increased in the second 30 day period, gains were extremely low. This could be accounted for by a period of extremely warm weather. During the last 30 days the gains increased somewhat and approached normal gains.

The animals on the positive control and 15 percent DPW or FPW appeared to gain faster overall (0-90 days) than those on 25 percent DPW or FPW rations. However, these differences were not statistically significant ($P > .05$). Some substitution of the corn in the ration was made by the DPW and FPW. Thus, performance figures could be confounded by a change in energy content since the energy value of DPW and FPW were not known.

The daily feed consumptions did not show any palatability problems with DPW or FPW at the levels used. Feed required per unit of gain appeared to be slightly higher for the DPW and FPW rations.

Digestibilities of the same rations are shown in Table 6. Dry matter

Table 5. **Growth Performance of Lambs Fed Rations Containing Dehydrated Poultry Waste (DPW) or Fermented Poultry Waste (FPW).**

Component	Positive Control	15% DPW	25% DPW	15% FPW	25% FPW	Negative Control
Number of lambs	8	8	8	8	8	8
Initial weight, kg	20.6	20.5	20.6	20.6	20.7	20.7
Avg. daily gain, kg						
0-30 days	0.341^{1-2}	0.350^{1}	0.288^{1-2}	0.390^{1}	0.345^{1}	0.240^{2}
30-60 days	0.167	0.131	0.104	0.160	0.104	0.139
60-90 days	0.218	0.235	0.220	0.109	0.182	0.183
0-90 days[3]	0.238	0.239	0.204	0.220	0.210	0.188
Average daily feed cons., kg						
0-30 days	1.15	1.24	1.15	1.27	1.22	0.95
30-60 days	1.60	1.85	1.64	1.71	1.91	1.40
60-90 days	1.43	1.60	1.43	1.37	1.54	1.44
0-90 days	1.39	1.56	1.41	1.45	1.56	1.26
Feed efficiency, kg feed/kg gain						
0-30 days	3.40^{2}	3.63^{1-2}	4.25^{1}	3.32^{2}	3.59^{1-2}	3.90^{1-2}
30-60 days	9.90	17.03	22.55	10.69	19.57	11.37
60-90 days	7.49	7.46	6.73	8.90	9.72	8.20
0-90 days[3]	5.89	6.66	7.10	7.15	7.50	6.81

[1-2]Means with different superscripts are significantly different ($P < .01$).
[3] Means for 0-90 days were not significantly different ($P > .05$).

Table 6. **Apparent Digestibilities of Rations Containing Dehydrated Poultry Waste (DPW) and Fermented Poultry Waste (FPW).**

Component	Positive Control	15% DPW	25% DPW	15% FPW	25% FPW	Negative Control
Dry matter	64.6	63.8	60.4	63.0	61.9	58.7
Organic matter	65.6	65.8	63.9	65.5	65.4	60.0
Cellulose	27.5	43.6	45.9	43.0	49.5	28.4
Crude protein	58.0	54.2	56.0	52.3	50.7	44.2

digestibility decreased as the content of DPW and FPW increased in the ration. Since organic matter digestibility did not decrease, however, the depression in dry matter digestibility would be assumed to be due to the high proportion of insoluble ash in the DPW and FPW. It would appear then that the organic matter in the poultry waste products was about 65 percent digestible. Since cellulose digestibility in the DPW and FPW rations was higher, the cellulose in the DPW and FPW products themselves must be quite digestible. The source of this cellulose is unknown.

Digestibility of crude protein decreased only slightly (non-significant) by the addition of DPW but somewhat more with FPW. Using standard values for digestibility of the protein in the other ration ingredients, it was possible to estimate the protein digestibility for the test ingredient. These estimates were 66-75 percent for DPW protein and 55-59 percent for FPW protein. Thus, the fermentation process used in producing FPW decreased both the protein content and digestibility.

The Effect of a Variable Protein-Energy Ratio on Feedlot Performance and Carcass Traits of Steer Calves

Donald R. Gill and R. R. Frahm

Story in Brief

Steer calves averaging 205 days in age were weaned and placed on two fairly high energy feedlot rations. One ration was formulated using the National Research Council recommendation of 8.1 percent digestible protein and the other ration was reduced from a high of 11.14 percent digestible protein to 8.00 percent digestible protein in steps throughout the course of the feeding period.

Feedlot gains on the variable protein ration were higher with the largest differences evident during the first third of the feeding period. These data suggest that the NRC recommendation of 8.1 percent digestible protein may not be adequate for young cattle on moderate to high energy rations. Feed efficiency, rate of gain, and cost of grain were all improved when comparing the variable protein ration to the ration formulated to the NRC recommendation.