FEEDING ENSILED POULTRY WASTES TO CATTLE

D. L. Cross
Department of Animal Science
Clemson University
Clemson, South Carolina

Introduction

It is estimated that poultry produces approximately 50 million tons of waste annually (Fontenot, 1975). It is a common practice of many producers to add poultry wastes to cropland. However, with more intensified poultry operations, land area becomes a limiting factor, and waste disposal becomes an expense as well as a pollution problem. An alternative to land disposal is to recycle poultry wastes into cattle diets. The ability of cattle to utilize the uric acid in poultry excreta (Oltjen, 1968) as well as their ability to digest fiber suggests that poultry excreta could be of considerable value as feed for ruminants.

Legal Aspects of Recycling

Currently, poultry wastes are not approved by the Food and Drug Administration as a feed additive. The same guidelines that are used for a food additive are being used by the F.D.A. to determine whether poultry wastes will be approved as a feed additive. However, there is increasing interest in mitigation of restrictions on the feeding of waste products to food-producing animals. This is evidenced by the fact that several states have approved legislation allowing for the recycling of poultry wastes into poultry and cattle diets (California, Colorado, Georgia, Iowa, Mississippi and Oregon). Other states are presently considering such legislation. The most recent (1975) official publication of the Association of American Feed Control Officials has a tentative definition for dried poultry waste which is as follows:

> 60.31 Dried Poultry Waste (D.P.W.) is a product composed of freshly collected feces from commercial laying or broiler flocks not receiving medicants. It shall be thermally dehydrated to a moisture content of not more than 15 percent. It shall not contain any substances at harmful levels. It shall be free of extraneous materials such as wire, glass, nails, etc. The product shall be labeled to show the minimum percent protein, minimum percent fat and percent fiber. (Proposed 1973). NRC-5-14-015
>
> It may be used as an ingredient in sheep, lamb, beef and dairy cattle, broiler and layer chicken feeds. Broiler and laying rations shall be limited to 20% and 25% D.P.W., respectively.

The simplest route for approval as a feed additive by the F.D.A. may be through submission for GRAS (generally recognized as safe) status. Substances of natural biological origin that have been widely consumed for their nutrient properties prior to January 1, 1958, without detrimental effects, may be classified as GRAS without promulgation in the Federal Register (Taylor, 1975).

Nutritive Value of Poultry Wastes

Research concerning the nutrient composition of broiler litter and poultry manure has been reported by several workers (Noland et al., 1955; Wehunt, 1960; Parker and Perkins, 1964; Chance, 1965; Bhattacharya and Fontenot, 1965 and 1966; Harms and Ammerman, 1968; Lowman and Knight, 1970; Bieley et al., 1972; Bunch, 1972; Young and Nesheim, 1972; Blair and Knight, 1973; Bridson, 1973; Smith, 1974). Undoubtedly, the greatest value of poultry wastes for cattle will be from crude protein content. On a moisture-free basis, broiler litter contains from 18-30% crude protein equivalent, while cage-layer manure generally contains 25-35% crude protein equivalent. Numerous factors can affect the crude protein content; however, the largest contribution to loss of nitrogen is through ammonification and depends on condition and age of the waste. Numerous samples of turkey and broiler litter have consistently averaged from 18-23% crude protein equivalent in our laboratory (some of these samples were from built-up litter and some were from houses where only two groups of broilers had been raised on the litter). Cattle require two major minerals: calcium and phosphorus. Broiler litter contains approximately 1.6 and 2.0% calcium and phosphorus, respectively. It also contains about 60% T.D.N., and 1108 kcal of digestible energy and 990 kcal of metabolizable energy per pound, on moisture-free basis (Fontenot, 1975). Table 1 shows the nutrient content of turkey litter and broiler litter as analyzed in our laboratory. Both are similar in nutritive content, except for percent ash which is higher in turkey litter. This could be due to clean-out procedures or age of the litter.

Whether the nutritive value of litter increases with each subsequent group of broilers is a question which should be answered in order to determine the earliest stage at which broiler litter can be ensiled without sacrificing nutritive value. The effect of 1, 2 or 3 groups of broilers on the nutritive content of litter is presented in Table 2. Most of the nutrients, except neutral detergent fiber, tended to increase after two groups of broilers were reared on the litter. There was very little difference in the nutritive components of litter after the third group was housed on the litter as compared to group 2.

Generally, cattle can efficiently utilize approximately one-third of their dietary nitrogen in the form of non-protein nitrogen. Also, ruminants can utilize uric acid nitrogen as well or perhaps even better than nitrogen from urea (Oltjen, 1968). It is important, therefore, to know the existing form of the nitrogen in broiler litter in order to evaluate its efficacy as a protein supplement for cattle. Table 3 presents data concerning the effect of 1, 2 or 3 groups of broilers on the nitrogen components of broiler litter. It is interesting to note that only approximately one-third of the total nitrogen is in the form of non-protein N after two or three groups are reared on the litter. Also, uric acid N as a percent of non-protein nitrogen increases after two or three groups of broilers were reared on the litter. Since uric acid is the major renal excretory form of nitrogen in avian species, one would expect a major portion of the total nitrogen to be in the form of uric acid N. However, as can be seen in Table 3, uric acid nitrogen made up only a small percentage of the total N in broiler litter (approximately 18% after two or three groups were reared on the litter). Thus, the major nitrogen component in broiler litter is true protein nitrogen. Approximately two-thirds of the total nitrogen was in the form of true protein nitrogen after two or three groups. Thus, after two or three groups of broilers are reared on litter, approximately one-third of the nitrogen is in the form of non-protein N, and the remainder is in the form of protein nitrogen. It appears that broiler litter should be a highly acceptable protein supplement for cattle after two groups of birds are reared on it.

Feed Value for Cattle

Several researchers have reported on the feeding of broiler litter to ruminant animals (Fontenot, 1970 and 1971; Long et al., 1969; Noland et al., 1955; Southwell et al., 1958; Drake et al., 1966; and Stonestreet et al., 1966). The feeding of ensiled broiler litter has been reported also (Cregar et al., 1973; Harmon et al., 1975). We fed ensiled turkey litter to dairy heifers and found it to be an acceptable feed ingredient (Table 4). Inclusion of 15% TLS increased ($P<.05$) gains over controls. Gains of the control heifers were similar to those of the heifers receiving higher levels of TLS in their diets. The ash content of the turkey litter reduced the gross energy content of the diets containing TLS. The heifers compensated by eating more feed in order to meet their energy needs, with a consequent reduction in feed efficiency. When the dietary consumption was corrected for ash content, feed efficiency was similar for all treatments. Thus, in comparison to corn silage, the turkey litter was utilized efficiently without a reduction in average daily gain.

Ensiling Poultry Litter and Cage-House Manure

In order to determine the proper moisture level and required length of time to ensile broiler litter, we ensiled broiler litter for either 3, 6 or 9 weeks at different moisture levels (28%, 36%, 39%, 42%, and 45%). Table 5 shows the effects of these treatments on pH of the litter. From these data it appears that 6 weeks is an adequate ensiling period and that maximum acidity was reached at the 42 or 45% moisture levels. Also, the effect of these treatments on several other factors pertinent to the nutritive value were observed but are not reported herein.

Since cage-layer operations do not use a litter material, we were interested in determining whether cage-house manure could be combined with forages and ensiled. Also, the proper moisture level for maximum fermentation was of concern. Table 7 presents data concerning the effect of moisture level and forage source on pH of the various combinations of manure and forage. Manure and forage were mixed on an approximately equal weight basis. Hay and manure at 44% moisture was the most desirable combination from a pH standpoint. Percent lactic acid increased up to about 6% (dry basis) in the hay-manure combinations. This material had a pleasant odor (similar to haylage) following ensiling. Data pertaining to the nutritive value of these were collected but are not presented herein.

One of the primary concerns in evaluating the safety of ensiled poultry wastes for cattle is the bacteriological properties of the ensiled product and how the bacterial content compares to other common feed ingredients. Table 8 pertains to the viability of microorganisms in fresh poultry litter, broiler litter silage, corn silage and concentrate feed. From these data, it appears that broiler litter silage compares favorably to corn silage and concentrate feed. Also, we ensiled 115 tons of broiler litter silage in an oxygen-limiting silo and sampled the litter before ensiling and after 6 weeks in the silo. Table 9 presents data concerning some important bacteriological parameters observed in this litter. Total bacterial counts were markedly reduced after 6 weeks in the silo, and coliforms were not detectable after 6 weeks. The presence of salmonella was confirmed and quantitated in the fresh litter; however, salmonella was not present after 6 weeks of ensiling. This suggests that the ensiling process renders the litter relatively safe for consumption by cattle from a bacteriological standpoint.

There is some interest in the feasibility of ensiling poultry litter in bunker or trench silos in order to avoid the expense of the oxygen-limiting structures. We are presently conducting a field demonstration study involving the ensiling of built-up broiler litter in an above-the-ground bunker-type silo. The average percent moisture of this litter in the silo was 43.2%. The average pH before and after ensiling was 8.35 and 7.16, respectively. Feedlot cattle (140 head) are presently being started on a ration containing 60% of this litter and 40% ground corn and will be monitored for growth rate and feed efficiency throughout the study.

Mechanical and Technical Considerations for Ensiling Wastes in Large Quantities (Based on Research and Field Experience)

If one desires to ensile litter in an upright silo, some factors should be considered:

1. It is hard to blow litter into a tall silo at the moisture level where maximum fermentation was reached in the small-scale silos. We ensiled broiler litter at 37% moisture in a 60 foot tall silo without problems. When the litter is too wet, it clogs the blower pipe. One can overcome this to a certain extent if a higher horsepower tractor (approximately 90 HP) is used or if a shorter silo is available. Bunker or trench silos present no problems in this respect.

2. A magnet should be included in the feeding system to remove metal which invariably gets into the litter.

3. In our experience, the most acceptable place to add water to the litter is in the poultry house. A portable moisture tester can be used to monitor the moisture content. After some experience, one should be able to predict the moisture content by squeezing the litter. It first begins to stick together at approximately 35% moisture.

4. A front-end loader can be used to clean out the house and load trucks. The clean-out process provides for considerable mixing of the litter, which is helpful in getting an even moisture distribution.

Table 1. NUTRIENT CONTENT OF TURKEY AND BROILER LITTER (DRY MATTER BASIS)

	Broiler Litter (%)[a]	Turkey Litter (%)[b]
Dry matter	72.7	81.0
Ash	12.9	36.6
Crude protein equivalent	18.1	18.2
Neutral detergent fiber	44.9	34.5
Ether extract	1.9	2.3
Nitrogen free extract	21.3	8.7
Calcium	1.6	---
Phosphorus	2.0	---

[a]Three groups of broilers were housed on this litter for 8 weeks each; thus, 24 weeks total.

[b]Confinement reared turkeys were housed on this litter for 1 year.

(Cross and Hughes, 1975)

Table 2. THE EFFECT OF 1, 2 AND 3 GROUPS OF BROILERS ON THE NUTRIENT CONTENT OF BROILER LITTER

	Group		
Nutrients (% of Dry Matter)	1	2	3
Dry matter	74.1	70.4	72.7
Ash	9.4	11.7	12.9
Crude protein equivalent	12.7	17.5	18.1
Neutral detergent fiber	56.4	46.6	44.9
Ether extract	1.9	2.3	1.9
Nitrogen free extract	19.7	22.0	22.3
Calcium	1.2	1.5	1.6
Phosphorus	1.4	1.7	2.0

(Cross and Hughes, 1975)

Table 3. THE EFFECT OF 1, 2 AND 3 GROUPS OF BROILERS ON NITROGEN COMPONENTS OF BROILER LITTER

	Group		
Nitrogen Component (%)	1	2	3
Total nitrogen	2.0	2.8	2.9
Non-protein N/N x 100	47.3	37.3	33.0
Uric acid N/NPN x 100	16.6	50.8	55.8
Uric acid N/N x 100	7.5	18.7	17.6
True protein N/N x 100	52.7	62.7	67.0

(Cross and Hughes, 1975)

Table 4. PERFORMANCE OF DAIRY HEIFERS FED GRADED LEVELS OF TURKEY LITTER SILAGE (TLS)

	Treatment[a]			
Item	0% TLS	15% TLS	30% TLS	45% TLS
Ration ingredient (% of dry matter):				
Turkey litter silage	0	15	30	45
Corn silage	90	75	60	45
Concentrate	10	10	10	10
Number of heifers	6	6	6	6
Average daily gain (kg)	.42[b]	.58[c]	.51[bc]	.43[bc]
Feed/gain	12.5	12.5	14.3	16.7
Ash content of feed (%)	4.7	9.8	14.1	19.0
Gross energy content of feed (Kcal/kg)	4296	4048	3743	3584
Ash corrected gross energy (Kcal/kg)	4508	4488	4357	4425
Ash corrected feed/gain	11.9	11.3	12.2	13.5

[a]Diets were isonitrogenous. Turkey litter and corn plant were ensiled separately in concrete upright silos.

[bc]Means in the same row bearing different superscripts are significantly

Table 5. THE EFFECT OF MOISTURE LEVEL AND LENGTH OF THE ENSILING PERIOD ON pH OF BROILER LITTER

	Length of Ensiling Period (weeks)[a]			
Moisture Level (%)	0	3	6	9
28[b]	7.8	7.5	7.0	7.1
33	7.8	7.2	7.0	6.6
36	7.9	6.4	6.2	6.2
39	7.8	6.4	6.1	6.1
42	7.8	6.2	5.8	5.9
45	7.8	6.1	5.6	5.6

[a]Ensiled in small-scale silos.

[b]Moisture content of broiler litter in house at time of ensiling.

(Cross, 1975)

Table 6. THE EFFECT OF MOISTURE LEVEL AND LENGTH OF THE ENSILING PERIOD ON LACTIC ACID CONTENT OF BROILER LITTER

	Length of Ensiling Period (weeks)			
Lactic Acid (% of Dry Matter)	0	3	6	9
36	.3	1.5	2.5	3.2
39	.3	2.5	3.7	3.6
42	.3	2.8	4.1	4.0
45	.2	3.6	4.4	4.3

(Cross, 1975)

Table 7. PH OF MANURE-FORAGE COMBINATIONS AT VARYING MOISTURE LEVELS[a]

	Forage		
Moisture (% of Dry Matter)	Hay	Peanut Hulls	Straw
33	5.91	6.09	6.31
36	5.84	5.79	6.16
39	5.70	5.68	5.92
44	5.52	5.80	5.98
49	5.72	6.05	6.44
54	5.77	6.25	6.77

[a]Ensiled in small-scale silos for 60 days.

(Cross and Welter, 1975)

Table 8. VIABILITY OF MICROORGANISMS IN FRESH POULTRY LITTER, BROILER LITTER SILAGE, CORN SILAGE AND CONCENTRATE FEED

	Materials Assayed			
Microorganisms	Fresh Poultry Litter	Broiler Litter Silage	Corn Silage	Concentrate Feed
Total bacterial counts (organisms/g)	4.6×10^9	2.5×10^6	6.4×10^7	2.4×10^6
Anaerobes	+++	+++	+++	+++
Slenite broth-SS agar	-++	---	---	+++
Gram negative	+++	+++	-++	+++

(Cross, 1975)

Table 9. VIABILITY OF MICROORGANISMS IN BROILER LITTER BEFORE AND AFTER 6 WEEKS OF ENSILING[a]

	Period	
Microorganisms	Before Ensiling	6 Weeks Post Ensiling
Total bacterial counts	3.55×10^8	7.75×10^4
Coliforms	2.15×10^3	0.0
Confirmed salmonella	4.55×10^3	0.0

[a]Ensiled in an oxygen-limiting silo (115 tons of litter ensiled). Litter was sampled from bottom of ensiled material using a bottom unloader.

(Cross and Johnson, 1975)