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PROCESSING AND FEEDING VALUE OF POULTRY MANURE AS A FEED INGREDIENT FOR SHEEP

H.M. El Shaer, S.A. Attia-Ismail and H.M. Kandil

Department of Animal and Poultry Nutrition, Desert Research Center, Mataria, Cairo, Egypt

SUMMARY

Two experiments were conducted to evaluate the effects of various treatments of poultry manure on energy and nitrogen losses and the control of pathogens; and to asses the fermentation characteristic and feeding values of different ratios of bermudagrsss hay and poultry manure silages (BGH-PM silages). Results of the first experiment showed that ensiling process had the least nitrogen and energy losses and was free of pathogens. In feeding and metabolism trials, 32 sheep were divided into four groups assigned to four diets: 100% bermudagrass hay (T1) as a control treatment, the other diets were silages (BGH-PM silage) contained 70:30 (T2), 60:40 (T3) and 50:50 (T4) bermudagrass hay and poultry manure. DMI and nitrogen retention values were highest for sheep fed 70:30 BGH-PM silage compared to the other treatments. All apparent digestion coefficient of nutrients were improved by increasing proportion of poultry manure in silages. The tested liver function enzymes of sheep were in clinical normal ranges.

Keywords: Poultry manure, excreta processing, sheep, feed value, rumen metabolites, blood metabolites

INTRODUCTION

Nowadays, there has been tendency, in Egypt, to increase cultivable lands in order to produce more grains for human consumption at the expense of the production of forages for animal feeding. Therefore, the feed gab which already exists, has go widened. In replacement of the drop in forage production, non-conventional feedstuffs have been used. Of the by-products investigated in this respect is poultry waste which should be processed before being fed to animals to eliminate pathogens and to reduce losses of nutrients (Fontenot, 1983).

Drying poultry waste using different methodologies, resulted in various losses of energy and nitrogen (Harmon et al., 1974 and Attia-Ismail, 1992). However, acceptability of dehydrated poultry waste by sheep was excellent and efficient in eradicating bacteria found in poultry excreta (Fontenot et al., 1971).

Ensiling is a plausible way for processing poultry waste which could be used successfully on farm for it is inexpensive and simple (Fontenot, 1983 and El Shaer et al., 1991). In addition to providing a practical and economical system for recycling excreta, ensiling inhibits sporulation of pathogens (McCaskey and Martin, 1988).

This study was conducted to evaluate the effect of several processing methods of poultry excreta on nitrogen and energy losses as well as potential bacterial pathogens. Feeding value of diets containing different proportions of poultry litter ensiled with bermudagrass hay and impact on some clinical and ruminal metabolites in sheep were studied.

MATERIALS AND METHODS

Two experiments were involved in this study. The first one was conducted to determine the effect of various treatments of poultry manure on energy and nitrogen loss, in addition to the effect on odor and pathogens. The second experiment was feeding and metabolism trials for sheep fed bermudagrass hay and its silage with poultry manure (BGH-PM silages).

The first experiment

A large quantity of fresh poultry manure from caged laying hens was thoroughly mixed and subjected to the following treatments:

1- Fresh PM, no treatment, 2- Air-drying PM at ambient temperature (28-30oC) 3- Solar drying at 60-70 oC to a constant weight, 4- Sun drying/autoclaving at 1.0 Kg/cm2 at 120 oC., 5- Oven drying at 60 oC for 24 hrs., 6- Oven drying at 100 oC for 24 hrs. and 7- Ensiling chopped bermudagrass hay (BGH) and PM at different proportions of 70:30, 60:40 and 50:50, respectively.

Silage making

Bermudagrass hay (IFN 1-00-716) was chopped (2-5 cm length), ensiled with caged layer manure (BGH-PM silage) in the following ratios on wet basis: 70:30, 60:40 and 50:50. Weighed quantities, in proportions according to the above mentioned ratios, of the fresh poultry manure and bermudagrass hay, mineral and vitamin mix and little quantity of water were mixed thoroughly and ensiled carefully in huge plastic drums (three replicates for each silage). The silos were, opened after 45 days and silage samples were collected for subsequent analysis. Physical and fermentative characteristics (pH, lactic acid, water soluble carbohydrates and volatile fatty acids) were determined in six samples for each silage.

The losses of energy and nitrogen were determined in the fresh and treated samples (6 samples for each treatment) by difference. The nitrogen contents were determined by Kjeldahl method. Energy values were, also estimated using benzoic acid (Shannon and Brown, 1969). Microbial counts [standard plate count (SPC)] and coliform count were made by the standard methods (the American Public Health Association, 1978).

The second experiment:

Experimental diets:

Four diets were offered ad. lib. to animals as follows: 100% bermudagrass hay (BGH) as a control diet (T1);70:30 (T2), 60:40 (T3) and 50:50 (T4) bermudagrass hay and poultry manure silages. Feed ingredients and their chemical analysis are presented in Table 3.

Feeding and metabolism trials:

Thirty two crossbred weather lambs (initial body weight averaged 31.1 kg +0.32) were grouped by weight (8 animal/ group) and randomly assigned to the four experimental diets (treatments). They were housed in four stalls and group fed ad. lib. for two months. The animals were weighed at the beginning of the experiment, then on biweekly basis. Water was always made available to animals throughout the experimental period. The diets were offered to animals daily at 0800 and 1700 h, and residues were weighed the next morning at 0700.

At the end of the feeding trial (2 months), four animals were randomly chosen from each treatment (group) and placed in metabolism cages for a 7-day preliminary period followed by a 7-day collection period. Feces and urine were collected daily, sampled and recorded. Representative samples of the four diets and rots as well as feces were taken daily and dried and saved for routine analysis (A.O.A.C., 1975). At the end of the collection period, ruminal fluid samples were obtained using stomach tube 2 hrs after feeding. Blood samples were collected 2 hrs post feeding simultaneously with rumen liquor collection. Rumen liquor samples were analyzed for pH, ammonia-nitrogen (Schwartz and Schoeman, 1964) and total volatile fatty acids (Barnett and Reid, 1956). Blood samples were analyzed for blood urea nitrogen (Coulombe and Larreau, 1963). Glutamic oxaloacetic transaminase (GOT), glutanic pyruric transaminase (GPT), gama glutamine transferase (GGT) and alkaline phosphatase (ALP) were also determined (Reitman and Frankel, 1957). The statistical analysis was done according to Snedecor and Cochran, (1976) and Duncan, (1955).

RESULTS AND DISCUSSION

Processing poultry manure as feed ingredients

Mean losses of nitrogen and energy differed significantly among poultry manure treatments (Table 1). Solar dry, autoclave and oven dry (60oC) treatments were close in percent losses of both nitrogen and energy. Oven dry (100oC) process showed the highest nitrogen loss (5.95%) than even that of fresh manure. It could be attributed to the excessive evaporation. The maximum energy loss value was achieved using the fresh manure without any processing (8.39%). Similar trends were obtained by many workers (Shannon and Brown, 1969 and Harmon et al., 1974). Ensiling poultry manure process showed the lowest energy and nitrogen losses.

Various treatments of poultry manure resulted in variable degrees of odor in the materials (Table 1). Autoclaving and ensiling treatments produced the least odorous materials. Salmonella, Escherichia coli and Staphylococcus were totally eliminated by any of the treatments applied to poultry manure (Table 1).

Table 1. Effect of poultry manure process on mean losses of nitrogen and energy; odor and pathogens

	Fresh	Airdry	Solar dry	Auto-clave	Oven dry 60°C	Oven dry 100°C	Ensi-lng
Mean loss of:							
N%	4.33^{b}	2.51^{de}	3.45^{c}	3.84^{bc}	3.01^{a}	5.95^{a}	2.25^{e}
Energy%	8.39^{a}	7.64^{b}	5.90^{c}	5.11^{d}	4.99^{d}	4.78^{d}	4.02^{e}
Order	+ + +	+ +	+	-	+	+	-
Pathogens:							
Salmonella	+ + +	-	-	-	-	-	-
E. Coli	+ + +	-	-	-	-	-	-
Staphy1/	+ + +	-	-	-	-	-	-
Strept. 2/	+ + +	+	-	-	+	+	- -
Bacillus	+ + +	+	-	-	-	-	-

Ensling: Means of the three silages (70:30, 60:40, 50:50 BGH-PM silages).

a,b,c,d,e: Means (six samples) in the same raw with different superscipts differ ($P<0.05$).

Staphy. 1/= Staphylococcus; Strept. 2/= Streptococcus.

Table 2. Fermentation characteristics of ensiling ratios of bermudagrass hay and poultry manure (BGH-PM silage)

Item	70:30	60:40	50:50	Sx
pH	5.30^{a}	5.00^{a}	4.40^{b}	0.13
Lactic acid, % of DM	4.25^{c}	5.07^{b}	5.92^{a}	0.24
Water soluble carbohydrate % of DM	2.18^{b}	2.52^{a}	2.60^{a}	0.06
Total Volatile fatty acids % of DM	1.10^{c}	1.91^{b}	2.85^{a}	0.25

a,b,c Means (six samples each) in the same raw with different superscripts differ ($P<0.05$).

Bacillus was eradicated by all treatments except for the air-dry treatment. However, it seems that processing poultry wastes by heat, particularly solar-drying, or ensiling were effective methods for eliminating pathogenic microorganisms. Such findings are in agreement with those obtained by Caswell et al. (1978) and McCaskey and Martin (1988). Perhaps a natural means of destroying microorganisms, such as ensiling poultry litter with grasses, would be more convenient and economical than the use of artificial heat. The obtained results concluded that the ensiling process seems to be a convenient method for preserving and rendering poultry manure silages safe from potentially pathogenic microorganisms.

Chemical composition of the experimental diets

The chemical composition of bermudagrass hay (T1) and ensiled mixtures of bermudagrass hay-poultry manure is presented in Table 3. The addition of poultry manure to bermudagrass hay (BGH) at the time of ensiling decreased the dry matter (DM) content because of the decrease in the proportion of BGH which contained high DM content (90.5%). There was an increment in ash content (up to 12.5%) of the silages by adding poultry manure due to higher ash content in poultry waste (Table 3). Calcium content of BGH-PM silages increased dramatically by the inclusion of poultry manure (up to 4.32%), and so was phosphorus content. Poultry waste can replace mineral supplement in rations for ruminants, (Oliphant, 1974 and Fontenot, 1983). The decreased levels of CF as well as the increased content of CP in the silages were found as a result of inclusion poultry manure in the silage mixtures. These results agree with those reported by other investigators, (Oliphant, 1974, Fontenot, 1983 and El Shaer et al., 1990). The diet contained 50:50 BGH:PM silage (T4) appeared to be more nutritious as it had the highest CP and NFE contents (12.7 and 51.3%, respectively) while CF content was lowest (20.1%).

Metabolism trials

Dry matter intake (DMI) and digestibility

The voluntary DMI and digestion coefficient of nutrients data are presented in Table 4. The higher proportions of poultry manure in the silages the lower the DMI. Sheep in T2 (70:30 BGH-PM silage) and T3 (60:40 BGH-PM silage) tended to consume more (P <0.01) dry matter than those fed the control diet (bermudagrass hay, T1). Sheep in T4 (60:40) consumed the lowest (P <0.01) amounts of silage (665 g/head/day). Apparent digestion coefficients of all nutrients (OM, CP, CF, EE and NFE) were significantly (P <0.01) higher for animals fed diets of T3 and T4 than those in T1 and T2 (Table 4). Therefore, the inclusion of increasing levels (up to 50%) of the poultry manure improved the digestibilies of nutrients in the BGH-PM silages. Such higher digest-ibility values could be attributed to the fact that poultry manure is rich in nitrogen and mineral contents and bermudagrass is rich in energy content as well. So, associative effects of ensiling such feed ingredients could be the reason for improved nutrient digestion of those diets when fed to sheep. However, there was no any digestive disturbance or palatability problems in the experimental animals. These results are in good agreement with those reported by other researchers on sheep fed poultry excreta ensiled with different feed ingredients, i.e. corn, legumes and grasses forages (Caswell et al., 1978; Fontenot, 1983, Abdelmawla et al., 1987 and El Shaer et al., 1990).

Table 3. Feed ingredients and proximate compositions of diets during feeding and metabolism trials, on DM basis

Item	BGH	BGH-PM silage			Poultry manure
	T_1	T_2 70:30	T_3 60:40	T_4 50:50	
Chemical composition %					
DM	90.5	71.50	65.20	61.90	30.70
Ash	5.0	9.10	12.20	12.50	23.10
CF	29.9	32.00	24.70	20.10	15.10
CP	8.9	10.80	11.90	12.70	26.50
EE	2.6	2.80	2.90	3.40	3.60
NFE	53.6	45.30	48.30	51.30	31.70
Ca	0.44	2.10	3.45	4.30	7.70
P	0.19	0.93	1.22	1.41	3.02

1/ Bermudagrass hay, coastal (Cyndon dactylon, IFN 1-00-716).
2/ Mixtures of bermudagrass hay- poultry manure silages.

Nitrogen utilization

Nitrogen intake, as presented in Table 4, varied significantly among the four treatments. The low protein basal diet showed the lowest fecal and urinary nitrogen excretion due to the lowest nitrogen intake. Feeding poultry manure included in the silages resulted in higher ($P<0.01$) fecal and urinary nitrogen excretion compared to feeding bermudagrass hay (T1). However, nitrogen retention values were lowest ($P<0.01$) for sheep fed silages contained higher proportions of poultry manure (T3 and T4). It is due to lower consumption of silages, in addition to higher amounts of nitrogen excreted in urine and feces (Table 4). Sheep fed the 70:30 BGH-PM silage (T2) retained more nitrogen than those fed the control diet (BGH, T1). Such trends were found by Abdelmawla et al. (1987) and Kwak et al. (1987).

Table 4. Intake, digestibility and nitrogen utilization by sheep fed bermudagrass hay with poultry manure (BGH-PM silages)

Item	T_1	T_2	T_3	T_4	$\overline{Sx}$
Intial live weight, kg	30.5±1.2	31.0±0.4	30.3±0.8	30.0±0.7	
Dry matter intake:					
g/head/day	710[b]	778[a]	740[a]	665[c]	9.59
% body weight	2.3	2.5	2.4	2.1	
Apparent digestibility, %					
Organic matter	55.6[b]	56.8[b]	59.9[a]	59.6[a]	0.55
Crude protein	51.5[b]	52.3[b]	57.3[a]	58.1[a]	0.88
Ether extract	38.7[c]	51.9[b]	68.2[a]	76.1[a]	4.37
Crude fiber	53.3[b]	53.3[b]	60.8[b]	67.3[a]	0.49
Nitrogen free extract	53.5[b]	56.1[a]	56.7[a]	56.9[a]	0.41
Nitrogen Utilization:					
Nitrogen intake, g/day	10.1[c]	12.9[b]	13.8[a]	13.0[ab]	0.29
Nitrogen excretion g/day:					
Fecal	3.85[c]	4.55[b]	5.40[a]	5.12[a]	0.18
Urine	5.64[b]	6.71[b]	8.35[a]	8.97[a]	0.40
Total	9.49	11.26	13.75	14.09	
Nitrogen retention:					
g/day	0.61[b]	1.64[a]	0.05[c]	-1.09[d]	0.18
% of N intake	6.04[b]	12.70[a]	0.36[c]	-8.38[d]	1.34
% of N absorbed	9.80[b]	19.70[a]	0.59[c]	-13.8[d]	2.10

a,b,c,d: Means (4 animals each treatment) the same raw with different superscript differ ($P<0.01$).

Ruminal fluid and blood metabolites

Some ruminal fluid and blood metabolites are summarized in Table 5. Ruminal pH values increased ($P<0.01$) as the proportions of poultry manure increased in ensiled diets. Feeding silages containing higher proportions of poultry manure (T3 and T4) resulted in higher ($P<0.01$) ruminal Ammonia-N. It might due to its high content of non-protein nitrogen (NPN). It was also, reflected on blood urea-nitrogen (BUN) concentration which was doubled for sheep fed 50:50 BGH-PM silage (T4) compared to those fed the control diet (T1) as shown in Table 5 (16.3 Vs 8.79 mg/dl). The low ruminal ammonia-N and BUN concentrations with animals fed bermudagrass hay only (T1) might be related to their low protein intake

(Table 4). Similar trends were reported by Salyor and Long (1974); Richter and Kalmbacher, (1980), and El Bedawy et al. (1989). Generally, the results showed that the nitrogen in ensiled poultry manure was utilized efficiently by sheep. The total VFA's concentrations were higher (P <0.01) for sheep in T3 and T4 compared to those in T1 and T2. The higher ruminal propionate by sheep fed BGH-PM silages, particularly those in T4, might due to the low roughage levels of their silages (El-Bedawy et al., 1989).

Table 5. Rumen and blood metabolites of sheep fed bermudagrass hay ensiled with poultry manure (BGH-PM silages)

Item	T_1	T_2	T_3	T_4	$\overline{Sx}$
Reminal parameters:					
Ruminal fluid pH	6.00^{bc}	5.85^{c}	6.15^{ab}	6.29^{c}	0.05
Ruminal NH_3-N, mg/dl	12.70^{c}	20.00^{b}	23.10^{ab}	25.80^{a}	1.48
Total VFA's,umole/ml	85.20^{b}	90.40^{b}	118.20^{a}	115.20^{a}	4.44
VAF's,moles/100 moles:					
Acetic	77.10^{a}	74.20^{a}	68.50^{b}	64.10^{b}	1.52
Propionic	18.40^{c}	22.00^{b}	23.80^{ab}	26.20^{a}	0.86
Butric	6.65^{c}	7.90^{a}	7.12^{b}	5.61^{c}	0.25
Blood parameters:					
Bun, mg/dl1/	8.79^{c}	13.10^{b}	14.70^{ab}	16.30^{a}	0.84
GOT[2], IU/L	40.20^{c}	42.60^{c}	50.10^{b}	57.20^{a}	2.11
GPT[3], IU/L	8.31^{c}	9.01^{c}	13.20^{b}	16.10^{a}	1.15
GGT[4], IU/L	20.50^{c}	25.70^{c}	31.90^{b}	41.70^{a}	3.72
ALP[5], IU/L	39.10^{d}	52.20^{c}	63.70^{b}	80.20^{a}	4.52

a,b,c,d: Means (4 animals each) in the same row bearing different superscripts differ (P<0.01).

1- Blood urea nitrogen, 2- Glutamate oxalate transaminase, 3- Glutamate pyruvate transaminase, 4- Gama glutamine transferase and 5- Alklaine phosphatase.

Examination of liver function enzymes (Table 5) revealed that concentrations of serum GOT, GPT, GGT and ALP increased by feeding elevated levels of poultry manure included in the silages. The highest values (P<0.01) were recorded for sheep fed 50:50 BGH-PM silage. However, values of such enzymes seem to be within the normal values as the general normal clinical chemistry ranges for sheep are: 10-60 IU/L GOT, 5-20 IU/L GPT, 10-45 U/L GGT and 20-180 IU/L ALP (Reitman and Frankel, 1957). Therefore, high levels of poultry manure ensiled with bermudagrass hay fed to sheep did not exhibit clinical or sub-clinical effects. The results concluded that feeding ensiled poultry manure to sheep was safe which agree well with those reported by Zindell et al. (1979) and Fontenot (1983).

In conclusion, judging from the previous results, ensiling bermudagrass hay with poultry manure at level of 70:30 could be used efficiently and suggested to be a good diet for sheep without any harmeful effect on animals.

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المعاملات التصنعية لمخلفات الدواجن وتقييمها غذائيا كمكونات علفية للاغنام .

حسن محمد الشاعر – صلاح عطية اسماعيل – حمدى محمد قنديل

قسم تغذية الحيوان والدواجن، مركز بحوث الصحراء، المطرية، القاهرة، مصر.

اجريت هذه الدراسات بهدف تقييم تأثير المعاملات الحرارية والسيلجة على الفقد من الطاقة والنيتروجين والمحتوى البكتيرى لمخلفات الدواجن وكذلك التقييم الغذائى لسيلاج مخلفات الدواجن مع دريس حشيشة برمودا (النجيل) لامكانية استخدام هذه المخلفات كمكونات علفية لتغذية الاغنام .

وقد شملت هذه الدراسة تجربتين : ففى الاولى تم معاملة مخلفات الدواجن الطازجة على درجات حرارة مختلفة بالاضافة الى طريقة السيلجة . وفى الثانية : اجريت تجارب تغذية وهضم شملت عدد (٣٢) حولى غنم قسمت عشوائيا الى ٤ معاملات بالتساوى حيث غذيت الاولى منها على دريس حشيشة البرمودا (مجموعة المقارنة T_1) وقد غذيت باقى المجموعات على سيلاج يحتوى على نسب ٣٠ ، ٤٠ ، ٥٠٪ من مخلفات الدواجن بالاضافة الى حشيشة البرمودا: T_2 ، T_3 ، T_4 على الترتيب .

اوضحت نتائج هذه الدراسات ان طريقة السيلجة كانت الافضل فى الحفاظ على محتوى مخلفات الدواجن من الطاقه والبروتين والقضاء تماما على جميع انواع البكتريا المرضية اذا ما قورنت بالمعاملات الحرارية المختلفة. كما اوضحت نتائج تجارب الهضم ان تغذية الاغنام على السيلاج المحتوى على ٣٠٪ مخلفات دواجن ، ٧٠٪ دريس حشيشة البرمودا كانت الافضل غذائيا حيث كانت كمية المادة الجافة المأكولة وكمية النيتروجين المحتجز أعلى من مثيلاتها فى المعاملات الاخرى. كما تحسنت جميع قيم معاملات الهضم للعناصر الغذائية المختلفة بإضافة مخلفات الدواجن فى السيلاج بنسب مختلفة والتى لم يكن لها تأثير على انزيمات وظائف الكبد مما يؤكد امكانية استخدام سيلاج مخلفات الدواجن فى علائق الاغنام.