Nutritive value of ensiled pig excreta, poultry litter or urea with molasses or bakery by-products in diets for lambs

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(Received 2 October 2012; Accepted 3 March 2014; First published online 17 May 2014)

Abstract

The objective of this study was to evaluate the nutritive value of maize stover silage diets containing pig excreta (PE), poultry litter (PL) or urea as nitrogen (N) sources, and sugarcane molasses (MOL) or bakery by-products (BBP) as energy sources. The study was designed as a 6 × 6 Latin square with six ruminal cannulated Hampshire rams (56 ± 5.7 kg body weight) in a 3 × 2 factorial arrangement of treatments. The quality of silages was good because of acceptable pH (4.1), texture and odour. Gas production was higher for diets with silage containing PL than that containing PE (287 vs. 269 mL/g DM). The fermentation rate of diets with MOL was higher than with BBP (0.07 vs. 0.05/h). The *in vitro* degradation, feed intake and N excretion of diets that contained PL were higher than with PE silage. Feed intake for diets with silage that contained BBP and PL or PE was lower than that containing MOL. Rumen pH was increased in lambs fed diets with silage that contained urea (6.38) or PL (6.25), compared with lambs fed diets containing PE silage (6.04). Dry matter (DM) and organic matter (OM) disappearances were higher for diets with silage containing PL compared with those containing PE or urea (650 vs. 606 and 594 g/g DM; 620 vs. 574 and 594 g/g OM, respectively). The N retention and total tract digestion were similar for all treatments. It was concluded that diets with PL and MOL silage had higher nutritive values than those containing PE or urea.

Keywords: Digestion, fermentation rate, nitrogen balance, silage quality
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Introduction

In the last decades, the livestock industry has experienced exponential growth that has created the need to control animal waste pollution and minimize its environmental impact (Perez Espejo, 2006). In pig production systems, faecal nitrogen (N) excretion, which amounts to 17% of the intake, consists of the undigested protein fraction and endogenous N losses, mainly digestive secretions and desquamation of intestinal cells. The remaining amino acids, after protein deposition and obligatory losses, are catabolized and excreted mainly as urea (Dourmad & Jondreville, 2007). In poultry litter (PL), crude protein (CP) content is about 20%, mainly as uric acid (Deshck *et al*., 1998), though Van Ryssen (2011) recorded broiler litter containing *ca.* 50% true protein. Thus, pig excreta (PE) and PL are potential N sources for ruminant nutrition. Maize stover, the above-ground residue of maize plants grown for grain, is used intensively for ruminant feeding. It has a low crude protein content (<40 g/kg DM), but our findings (Bórquez *et al.*, 2009; 2010) showed that ensiling this by-product with fresh cattle manure and bakery by-products (BBP) or sugarcane molasses (MOL) produced silages with acceptable quality. Their dietary inclusion (250 g/kg dry matter) in total mixed rations offers an alternative feed to finishing lambs. Using this approach, we hypothesized that ensiling maize stover with PE, PL or urea as N source with either BBP or MOL as energy source would produce silages with acceptable nutritional values, which would not depress feed intake, ruminal fermentation, digestion and N balance in lambs. Experimental transmission of bovine spongiform encephalopathy to sheep has been demonstrated, but the low prion level in non-nervous tissues (i.e. gut) in litter and the low probability of cross-species infection represent minimal risk of animal excreta as source of transmissible prion disease (Novakofski *et al*., 2005). Therefore, the objective of this study was to evaluate in

URL: http://www.sasas.co.za
ISSN 0375-1589 (print), ISSN 2221-4062 (online)
Publisher: South African Society for Animal Science
http://dx.doi.org/10.4314/sajas.v44i2.3

lambs the nutritional value of total mixed rations with maize stover silage fortified with pig excreta, poultry litter or urea as N sources, and with molasses or bakery by-products as energy sources.

Materials and Methods

This experiment was conducted under the supervision and approval of the Academic Committee of the Faculty of Veterinary Medicine and Animal Science, Universidad Autónoma del Estado de México, according to regulations established by the Animal Protection Law, enacted by the Estado de México in México.

Fresh PE and dried PL were collected from commercial intensive farms. Pig excreta were a composite sample from a pen with finishing pigs. Dehydrated PL was a composite sample from a broiler enterprise. The chemical composition of maize stover, fresh PE, dehydrated PL, BBP and MOL was determined. The dry matter (DM) (934.01), crude protein (CP) (954.01) and ash (942.05) were analysed following the procedures of the AOAC (1997). The neutral detergent fibre (NDF) was analysed by the method of Van Soest *et al*. (1991) while acid detergent fibre (ADF) and acid detergent lignin (ADL) were analysed according to the methods of the AOAC (1997; 973.18) using an $ANKOM_{200}$ fibre analyser unit (ANKOM Technology Corporation, Fairport, NY, USA). The NDF was assayed without alpha amylase, but with sodium sulphite. Both NDF and ADF are expressed without residual ash. Maize stover, urea, water, PE, PL, BBP and MOL were used to prepare the silages. Water was added to the material to a level of 400 g/kg DM. The control silage was prepared with urea as N source without PE and PL. Urea was dissolved in water and then mixed with BBP, MOL, and finally with maize stover. Silages were manually compacted in dark plastic bags (60 x 90 cm) and stored indoors (20 °C) for a 30-day fermentation period (Table 1).

Silages were evaluated according to Frenkel (1984) as follows: i) quality appearance (acceptability: odour, 0 - 12 points; tissue structure, 0 - 5 points; colour, 0 - 3 points) making a silage with 18 to 20 points as excellent, 10 - 17 points acceptable, 4 - 9 points regular to bad; and 0 - 3 points bad; ii) mass texture (arbitrary scale 1 - 5; 1 = dry and 5 = pasty). The pH of aqueous extracts of silages was measured using a pH meter (Benchtop Cole Parmer 05669-20, Vernon Hills, IL, USA) in 20 g of a silage samples (as is) blended in 200 mL distilled water (Shaver *et al*., 1984). A pH of 4.2 was considered good; 4.3 - 4.5 was regular; and >4.5 was bad, according to Butler & Bailey (1973).

Table 1 Ingredients and chemical composition of silages

	Poultry litter		Pig excreta		Urea	
	MOL	**BBP**	**MOL**	**BBP**	**MOL**	**BBP**
Ingredients, g/kg DM						
Maize stover	385	385	294	294	630	630
Poultry litter	385	385				
Pig excreta			529	529		
Urea					30	30
Sugarcane molasses	230		177			340
Bakery by-product		230		177	340	
Chemical composition, g/kg DM						
Dry matter	431	416	369	342	422	388
Crude protein	165	170	119	131	160	151
Ash	110	111	96	77	73	91
Neutral detergent fibre	425	385	351	370	383	444
Acid detergent fibre	290	214	201	198	237	250
Acid detergent lignin	61	60	44	44	48	52
Silage quality						
Acceptability (range: 10 - 17)	13	14	11	10	10	10
pH	4.0	4.1	4.1	4.2	4.2	4.2
Texture (1 = dry, 5 = pasty)	2.5	3.0	2.5	3.0	3.0	3.0

MOL: sugarcane molasses; BBP: bakery by-product; DM: dry matter.

For the *in vivo* trial, six diets with similar protein (145 g CP/kg DM) and energy (10.3 MJ ME/kg DM) contents were formulated according to the NRC (2007) for growing lambs (Table 2). The diets were randomly assigned in a Latin square design (6 x 6; six treatments and six periods) to six Hampshire male rams (56 ± 5.7 kg body weight) fitted with ruminal cannulae. The sheep were housed in individual metabolism cages in a naturally ventilated barn. Water and diets were offered at 08:00 and 18:00, and lambs had *ad libitum* access to feed (10% refusal).

There were six 18 d experimental periods, each one with a 10 d adaptation (Brown *et al*., 2006) and 8 d sampling period. During the sampling period urine, orts and faeces were collected daily (days 10 to 18). At each daily collection, 100 g/kg faeces were amassed and stored at −18 °C. Urine was collected in plastic buckets containing 100 mL 5N HCl. Urine samples (10 mL/100 mL urine) were transferred to polyethylene bottles and stored at −18 °C. At the end of the experiment, the daily samples of feed offered and feed refused per animal and period were thawed, pooled and ground for DM, ash and CP according to AOAC (1997); while NDF, ADF and ADL were determined according to Van Soest *et al*. (1991). Apparent total tract digestibility of DM, OM, CP, NDF and ADF, and the N-balance were calculated as described by Harris (1970).

On days 16 - 18 an *in sacco* assay was conducted whereby bags (5 × 7.5 cm; pore 50 ± 7 µ) that contained 3 g DM each of the experimental diets (Table 2) were placed in the rumen of each lamb at 08:00 and removed (in triplicate) at 3, 8, 24, 48 and 72 h. Before insertion into the rumen, three additional bags per sample were manually washed with water (39 °C) for 20 min, and solubility was calculated. *In sacco* disappearances of DM, OM and CP of diets were calculated using the values determined before and after ruminal incubation of bags. The analysis of ruminal DM, OM and CP kinetics was carried out using the model described by Ørskov & McDonald (1979):

$$P = a + b\,(1 - e^{-kt})$$

where *P* = denotes proportion (g/g DM) of the material disappearance (lost through the bag) at time *t*, *a* = ruminal soluble, readily disappearing fraction (g/g) at 0 h; *b* = insoluble, potentially disappearing fraction (g/g DM), *k* = disappearance constant for fraction *b*, and t = lag phase.

For the *in vitro* assay, rumen fluid was collected from two lambs fitted with ruminal cannulae and fed a total mixed ration (500 forage and 500 g/kg concentrate). A manual system was used to measure gas production through *in vitro* incubation at 39 °C, according to Theodorou *et al.* (1994). The incubations were conducted in glass flasks (125 mL), sealed with a butyl rubber stopper and a screwed plastic cap, containing 90 mL of a culture medium (Malafaia *et al.*, 1999), 10 mL of rumen inoculum and 500 mg of DM of experimental diets (Table 2). The samples were incubated in triplicate for each treatment and time. The gas pressure was obtained by manometric readings (0 to 1 kg/cm^2), while the volume was measured with a graduated syringe (10 mL). The determinations were done at 0, 1, 2, 3, 4, 5, 6, 7, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52, 56, 60, 64, 68, and 72 h after the addition in rumen inoculum. Immediately after adding rumen inoculum, an initial reading was taken and used to standardize the pressure and to discharge the gas volume in all flasks. To quantify the gas production derived from the culture medium and the rumen inoculum, three flasks were used as blanks. The pressure and volume values were registered and added to the values of the previous readings. Thus, the cumulative pressure and volume of the fermentation gases were obtained. The volume of gas corrected by the pressure related to the incubated DM was calculated according to Theodorou *et al.* (1994).

The DM, OM and CP residues of each incubation time were fitted to residue of the nonlinear regression model using the NLIN procedure of SAS (2002). Data were analysed as a 6 × 6 Latin *s*quare design, within a 3 x 2 factorial arrangement of treatments (i.e. N source: urea, PE, PL; energy source: BBP and MOL); main effects (source of N) and interaction (source of N x source of carbohydrate) of silages in diets, were analysed using the mixed option of SAS. LSMEANS of SAS were used to compare means. Thus, the model included lamb (random, 5 degrees freedom (df)), period (fixed, 5 df), treatment (fixed, 5 df), interaction treatment x period (25 df), and error (24 df).

The cumulative gas production profiles were evaluated using the logistic model as reported by Malafaia *et al.* (1999): $V(t) = VF/1 + \exp [2+4R\,(L - t)]$, where *V* represents the total gas produced from the digested fraction at time t, VF is equivalent to the maximum volume of gas production and its respective gas production rate R and the duration of the initial gas volume L. *In vitro* incubation times were used to fit non-linear regression models using the NLIN procedure (SAS, 2002). Data was analysed as a complete randomized design, within a 3 x 2 factorial arrangements of treatments described previously and using the GLM procedure of SAS (2002). If the interaction of N source with energy (E) source was significant ($P < 0.05$), the LSMEANS procedure was used to compare means. Differences were accepted at $P < 0.05$.

Table 2 Ingredients and chemical composition of diets

	Poultry litter		Pig excreta		Urea	
	MOL	**BBP**	**MOL**	**BBP**	**MOL**	**BBP**
Ingredients, g/kg DM						
Silage	400	400	400	400	400	400
Maize stover	108	146	120	150	130	147
Corn grain ground	397	359	330	308	369	332
Wheat middlings	40	40	40	40	36	40
Soybean meal, 44% CP	20	20	75	67	30	46
Fish meal	10	10	10	10	10	10
Vitamin x mineral premix [a]	25	25	25	25	25	25
Chemical composition, g/kg DM						
Dry matter	616	625	584	564	620	611
Crude protein (CP)	146	146	144	144	144	144
Ash	79	76	69	68	72	80
Neutral detergent fibre	306	373	317	355	416	418
Acid detergent fibre	152	190	160	185	233	216
Acid detergent lignin	43	44	30	40	45	46
ME, MJ/kg DM [b]	10	10	10	10	10	10
Calcium	12	11	12	11	8	7
Phosphorus	6	6	6	7	3	4

MOL: sugarcane molasses; BBP: bakery by-product; DM: dry matter.
[a] Content of vitamin/mineral premix/kg: 60 g phosphorus; 160 g calcium; 100 g sodium; 20 g potassium; 4 g sulphur; 2 g magnesium; 30 mg zinc; 0.6 mg copper; 1.8 mg iron; 2 mg manganese; 20 mg iodine; 6 mg cobalt; 12 mg selenium; 50 000 IU vitamin A; 10 000 IU vitamin D; 250 IU vitamin E.
[b] Metabolizable energy = apparent digestibility x 0.82 (McDonald *et al.*, 1988).

Results

Maize stover contained 929 g DM per kg and 341 g CP, 76 g ash, 739 g NDF, 521 g ADF and 108 g per kg of DM. Fresh PE contained 278 g DM per kg and 125 g CP, 126 g ash, 334 g NDF, 126 g ADF and 45 g ADL per kg of DM. Poultry litter contained (g/kg) 880 DM, 280 CP, 217 ash, 383 NDF, 147 ADF and 43 ADL. Urea had (g/kg) 971 DM and 443 N. Bakery by-product had (g/kg) 890 DM, 124 CP, 40 ash, 120 NDF, and 51 ADF. Sugarcane molasses had (g/kg) of MOL was 760 DM, 60 CP and 120 ash.

Some differences were found in the chemical composition of silages (Table 1). As expected, PL and urea silages had higher ash, NDF, ADF, and ADL than the other silages. Also, PL silage had higher CP and ash content than PE silage. The quality of the silages was good because of acceptable pH, texture and odour. Chemical composition of diets differed slightly; for example, the urea diets had higher fibre content than the others, but CP and ME levels were similar for all diets (Table 2).

Gas production traits and *in vitro* degradation of diets were affected by N source (Table 3), while only the fermentation rate, lag phase and fractional rate of gas production at T/2 were affected by energy source. Thus, potential gas production, fermentation rate and lag phase were higher for diets with PL and urea than diets containing PE silage. The fermentation rate, lag phase and fractional rate of gas production for diets with MOL were higher than diets with BBP in silage. On the other hand, the time at which half the asymptote was reached and the fractional rate of gas production at T/2 were longer for diets with BBP in the silage than with MOL. The DM, OM and NDF degradation, as well as ME of diets with PL, were similar to diets with PE in the silage. The lowest degradation values were for diets with urea compared with diets with PL and PE silage. The degradation of diets was similar for diets with MOL and BBP in silage. There were no interactions between the main factors.

Nutrient intake and rumen pH in lambs were affected by N source (Table 4). With the exception of CP intake, the DM, OM, NDF and ADF intakes were affected by energy (carbohydrate in silages) source. Thus, the intake of diets with PL silage was higher than with PE silage. The lowest feed intake was for lambs fed diets with urea compared with lambs fed diets with PL or PE silage. The intake of diets with BBP in silage

was higher than for diets with MOL. However, interactions suggest that DM, NDF and ADF intake in lambs fed BBP in silage was lower than in lambs fed MOL, but it was found only in lambs fed diets with PL and PE silages, and not in lambs fed diets with urea silage. Rumen pH values in lambs fed diets with PL were higher than in lambs fed diets with pig excreta silage.

Table 3 Gas production and *in vitro* rumen degradation of diets

	Poultry litter		Pig excreta		Urea		SEM
	MOL	BBP	MOL	BBP	MOL	BBP	
Gas production							
A, mL/g DM [N]	287	270	269	269	265	288	6.3
B, 1/ h [N, E]	0.07	0.06	0.06	0.05	0.07	0.05	0.004
L, h [N, E]	4.6	4.6	3.4	3.0	5.9	4.9	0.52
T/2, h [N]	10.0	11.8	12.9	11.4	11.9	14.5	1.45
µ at T/2, 1/h [N, E]	0.12	0.09	0.07	0.07	0.11	0.07	0.01
Degradation, g/kg							
Dry matter [N]	830	829	811	794	771	760	8.5
Organic matter [N]	851	848	835	814	783	792	7.4
NDF [N]	491	519	495	476	445	420	9.1

MOL: sugarcane molasses; BBP: bakery by-product; DM: dry matter; A: potential of gas production; B: fermentation rate; L: lag phase prior to start of gas production; T/2: time at which half the asymptote is reached; µ: fractional rate of gas production per hour at T/2; NDF: neutral detergent fibre.
[N] effect of N source (P <0.05); [E] effect of energy source (P <0.05); SEM: standard error of mean.

Table 4 Intake, ruminal pH, digestion and nitrogen balance in lambs fed diets with silages

	Poultry litter		Pig excreta		Urea		SEM
	MOL	BBP	MOL	BBP	MOL	BBP	
Intake, g/d							
Dry matter [N, E, NxE]	2043	1890	1866	1494	1727	1716	31.2
Organic matter [N, E]	1882	1746	1719	1392	1620	1579	28.8
Crude protein [N]	299	275	270	215	248	247	27.0
Neutral detergent fibre [N, E, NxE]	625	705	591	530	718	718	11.4
Acid detergent fibre [N, E, NxE]	311	359	298	276	402	371	15.9
Digestion, g/kg							
Dry matter	681	668	682	660	700	654	11.2
Organic matter	698	677	684	676	712	678	19.0
Crude protein	750	734	734	750	813	767	19.1
Neutral detergent fibre	454	541	469	484	607	520	21.1
Acid detergent fibre	429	517	454	477	587	497	22.8
N balance, g/d							
Intake [N]	48.4	44.5	43.8	35.0	40.0	40.2	2.24
Faeces [N]	11.3	12.5	12.2	8.9	10.9	9.3	1.39
Urine [N]	32.2	26.6	26.0	21.2	23.1	24.8	2.16
Retention	4.9	5.4	5.6	4.9	6.0	6.1	0.89
Rumen pH [N]	6.24	6.26	6.01	6.07	6.41	6.35	0.11

MOL: sugarcane molasses; BBP: bakery by-product; [N] effect of N source (P <0.05); [E] effect of energy source (P <0.05); [NxE] interaction of N source x E source (P <0.05); SEM: standard error of mean.

The highest pH values were found in lambs fed diets with urea silage. There were no interactions in rumen pH values.

The total tract digestion of diets was similar. The N balance trial indicated that N intake and N content in faeces and urine were affected only by N source. Lambs fed diets with poultry litter silage had higher N intakes and N excretion than lambs fed pig excreta silage. The lowest N intake and excretion values were found in lambs fed diets with pig excreta silages compared with lambs fed diets with poultry litter or urea silage when BBP was used as the carbohydrate source. However, the N retention in lambs fed experimental diets with the various types of silages was similar.

The potential disappearance and degradation rate of DM and OM were not affected by N or energy sources in silages, but solubility and potential disappearance of those fractions were affected by N source (Table 5). Also, total degradation CP of the diets was affected by N source in the silages. Thus, diets with pig excreta or urea silage had higher soluble fractions of DM and OM than diets with poultry litter silage. Total degradation of CP of diets with pig excreta or urea silage was higher than diets with poultry litter silage. Potential degradation of DM and OM was lower in diets with pig excreta and MOL silage, but was higher for CP.

Table 5 *In sacco* disappearance kinetics of diets (g/g)

	Poultry litter		Pig excreta		Urea		SEM
	MOL	BBP	MOL	BBP	MOL	BBP	
Dry matter [a]							
Soluble fraction [N]	0.180	0.204	0.233	0.181	0.193	0.222	0.018
Potential degradation [N]	0.650	0.629	0.606	0.640	0.618	0.607	0.018
Total degradation	0.830	0.833	0.839	0.821	0.811	0.829	0.020
Degradation rate (%/h)	0.011	0.010	0.011	0.011	0.010	0.009	0.002
Organic matter [a]							
Soluble fraction [N]	0.176	0.198	0.229	0.180	0.185	0.203	0.018
Potential degradation [N]	0.628	0.618	0.574	0.632	0.594	0.593	0.017
Total degradation	0.804	0.816	0.803	0.812	0.779	0.816	0.018
Degradation rate (%/h)	0.014	0.012	0.015	0.012	0.012	0.011	0.002
Crude protein [a]							
Soluble fraction	0.128	0.179	0.164	0.176	0.168	0.197	0.020
Potential degradation [N]	0.245	0.222	0.352	0.233	0.258	0.211	0.040
Total degradation [N]	0.373	0.401	0.516	0.409	0.426	0.408	0.034
Degradation rate (%/h)	0.013	0.014	0.014	0.013	0.013	0.009	0.004

MOL: sugarcane molasses; BBP: bakery by-product; [a] Lag phase (h) for dry matter and organic matter was not detected; lag phase of crude protein was for poultry litter + MOL, 1.8; poultry litter + BBP, 1.4; pig excreta + MOL, 1.8; pig excreta + BBP, 2.2; urea + MOL, 1.4; urea + BBP, 1.6; [N] Effect of N source ($P<0.05$); SEM: standard error of mean.

Discussions

The silage quality was acceptable and values are in agreement with our previous findings (Bórquez *et al*., 2010). Most of the results indicated that ensiling PL with MOL and adding it to diets offered a higher feeding value than ensiling PE or urea with MOL or BBP. This can be explained by differences in digestibility and then in feed intake. The addition of MOL to PL may enhance silage quality.

Parthasarathy & Pradhan (1982) studied the nutritive value of PL silage with wheat straw, bagasse or sawdust, and found that there was no effect on degradability of DM and CP when they fed livestock this silage. Al-Rokayana *et al*. (1998) studied silage made with sorghum straw, PL and MOL, including different levels in diets, in lambs, and found that digestibility of DM, OM and CP was higher than the control (without silage). This suggests that the soluble carbohydrates in MOL that were available to the bacteria were an adequate source of energy (Bórquez *et al*., 2009). Because both *in vitro* and *in sacco* assays indicated that diets with poultry litter silages had higher degradation than others, the higher feed intake in lambs fed diets with PL plus MOL silages could explain the absence of differences in total tract digestion of diets.

Ahmed & Talib (2008) evaluated the nutritive value of deep-stacked broiler litter in ruminant nutrition and found that the DM intake and palatability of the diet were not affected in goats and sheep. Mthiyane *et al*. (2001) reported that the degradability of DM was greater with PL and sugarcane stem silage at 48 h fermentation than the control without silage. In effect, with cattle manure silages, Sarwar *et al*. (2006) and Borquez *et al*. (2009) found significant increases of feed intake of the diets, without any effect on total tract digestion. According to these researchers, the increment in feed intake might be because of an improvement in DM and OM digestibility, as was found in our *in vitro* and *in sacco* assays. A likely reason for the MOL effect on cell wall digestibility is the difference in DMI (Weiss & Wyatt, 2004). This suggests that non-structural carbohydrates of MOL had important effects on ruminal fermentation, such as those found with non-structural carbohydrate supplementation (AlZahal *et al*., 2007). Although PL silage showed the highest nutritional value, there is a dearth of information on pig excreta silage, though acceptable values were reported when it was added to diets for ruminants (Bhattacharya & Taylor, 1975).

When BBP was used in PE silage, the lag time (L, h) was lower, which could be because of the type of fibre of pig waste and better nutrient conditions for microorganisms provided by BBP. The digestion of the experimental diets containing PE was similar to that reported by Bhattacharya & Taylor (1975), who suggested that ensiling PE may increase animal acceptability and help in pathogen control (Arndt *et al*., 1979). Chaudhry *et al*. (1996) made silage with PL and MOL and included this silage in diets for lambs. They found that digestibility of DM and CP increased. Unfortunately, we did not study silage pathogens, but the methodology that was used to ensile pig excreta was similar to that of Borquez *et al*. (2009; 2010), in which pH of cattle manure silages was lower than 4.2. This suggests that undesirable faecal microorganisms (coliforms, salmonella, shigella, proteus), yeasts and moulds would be eliminated, a finding that has been reported for animal excreta silages (Cornman *et al*., 1981). Iñiguez-Cobarrubias *et al*. (1990) studied silage of PE with wheat straw, included at different levels. They found that CPD (crude protein digestibility) was higher in diets with 44% PE silage as opposed to 22%; and after seven days of fermentation, coliforms were eliminated. Because in our investigation there was no effect in N retention between treatments, this could mean that the silages studied were equally effective as N sources for growing lambs. Rude & Rankins (1993) made silage with PL and corn forage, Johnson grass, sorghum and Bermuda grass, and found higher N retention and digestibility of DM, OM, and NDF when mixing corn forage and PL. Jakhmola *et al*. (1984) studied cattle waste mixed with green maize and wheat bhoosa enriched with urea and MOL prior to ensiling (wastelage). They found that urea adversely affected wastage characteristics, while MOL had a beneficial effect on the fermentation process. Moreover, digestibility of DM, OM, cell content, hemicelluloses and soluble ash decreased with increasing levels of wastelage in the diet, but the N retention balance was reduced.

Several safety concerns are associated with the use of animal manure as a feed ingredient. There is the potential risk of residues of microbial pathogens, drugs and other chemicals, which may harm livestock or transfer volatile residues in animal products to humans. Each country must therefore enact a law regulating the use of manure as a feed ingredient for animals, especially for young and lactating ruminants.

Conclusion

Diets with silages made from maize stover, poultry litter (as N source) and sugarcane molasses (as energy source) had higher feeding values than diets containing silages fortified with pig excreta or urea (as N source) and bakery by-products (as energy source) for lambs. Ensiling poultry litter or pig excreta with sugarcane molasses or bakery by-products and adding them to diets could reduce feed costs and environmental effects. Results indicated that adding these animal excreta to blended rations has been satisfactory for lambs, without apparent harmful effects, but further studies should be performed with a larger number of experimental units in order to support information for sheep producers.

Acknowledgement

We acknowledge the Universidad Autónoma del Estado de México and the National Council of Science and Technology (CONACYT) for the economic support to the project 2238/2006 and the opportunity to carry out master's science studies.

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