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Effect of corn stover silages inoculated with effective microorganisms (EM®) on digestibility of sheep

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INTRODUCTION

- The annual availability of corn stover (**CS**) is approximately 25.5 and 75 million tons in Mexico and USA respectively.
- The CS contains > 46% of ADF, 70% NDF and low digestibility (less than 55%), the availability of nutrients and energy is very low.
- The sugar cane molasse (**SCM**) and acid milk whey (**AMW**) are agroindustrial by-products sources of carbohydrates widely used in animal feeding.
- The effective microorganisms (**EM®**) is a mixture of *Lactobacillus spp., Actinomycetes, Rhodopseudomona palustris* and *Saccharomyces cerevisiae* which have shown the capacity of degrade organic matter and in a previous study we observed increase ($P < 0.05$, 11%) in the *in vitro* dry matter degradation of CS adding 1mL/kg of EM®.
- We hypothesized that inoculation with EM in the silage process of corn stover could improve the *in vivo* digestibility and ruminal fermentation in sheep

OBJECTIVE

Evaluate the effect of corn stover silages, with two sources of energy (cane molasses or milk whey) and EM (1effective microorganisms, 1 mL/kg DM), on the digestibility of nutrients and rumen fermentation.

MATERIAL AND METHODS

- Treatments: Silages were made in plastic containers (150kg), 30 days of fermentation (Table 1 shown the composition). ME® (EM México), was adding at 1 ml/kg feed (dry matter).
- Animals: Six male sheep with canula in the rumen were used in a 6 x 6 Latin square design. Each period had 11d for adaptation to the diet followed by 5d for sample collection. Were taken samples of feces and ruminal content and feed for analysis.
- The sheep were housed in a metabolic cages and feed twice a day with a diet consisted of concentrate (55% DM) and corn stover or corn stover silage (45% DM).
- Feed and feces were analyzed to determinate DM, OM, CP, NDF, ADF, GE. Ruminal content was analyzed to VFA, N-NH3, pH and methane (stoichiometry).
- The results were analyzed with PROC MIXED procedures of SAS.

Table 1. Composition of the silages

Identification[a]	Corn Stover (CS)(%)	Urea (%)	Acid milk whey (%)	Suggar cane molasses (SCM) (%)	Effective Microorganims (EM®)* (mL/kg)
CS-AMW	88	3	15	0	0
CS-SCM	88	3	0	15	0
SIL-AMW	88	3	15	0	0
SIL-SCM	88	3	0	15	0
SIL-AMW-EM	88	3	15	0	150
SIL-SCM-EM	88	3	0	15	150

[a]**CS-AMW**=Corn stover with acid milk whey, **CS-SCM**= Corn stover with sugar cane molasses, **SIL-AMW**= Corn stover silage with acid milk whey, **SIL-SCM**= Corn stover silage with sugar cane molasses, **SIL-AMW-EM**=Corn stover silage with acid milk whey and effective microorganisms and **SIL-SCM-EM**=Corn stover silage with sugar cane molasses and effective microorganisms.
*Dose of Effective Microorganisms at 1 mL/Kg mix feed

Table 2. Composition of the diets of corn stover silages with sugar cane molasses or acid milk whey, urea and EM® used in the *in vivo* test on cannulated sheeps.

Components	Treatments* CS-AMW	CS-SCM	SIL-AMW	SIL-SCM	SIL-AMW-EM	SIL-SCM-EM	SEM
Dry matter, %	28.33	28.33	28.17	31.5	29.33	27.83	0.45
Organic matter, %	85.79	86.52	87.69	86.75	87.01	84.48	0.26
Crude protein, %	11.45[ab]	**9.53[b]**	12.49[ab]	11.77[ab]	**14.31[a]**	**13.54[a]**	0.38
Gross energy, Mcal/kgDM	4.02	3.99	3.96	4	3.95	3.97	0.02
Acid detergent fiber, %	44.01	40.42	42.01	41.91	42.31	40.26	0.67
Neutro detergent fiber, %	67.33	63.90	63.65	62.43	63.58	60.99	0.87

*Treatments: (Table 1)
[a,b] Different letters superscripts in the same row are different ($P < 0.05$)
SEM= Standard error of the mean

Table 3. Volatile fatty acids concentration, ammoniacal nitrogen, CH_4 and pH of the ruminal liquor of the treated sheeps.

Ruminal liquor	Treatments[a] CS-AMW	CS-SCM	SIL-AMW	SIL-SCM	SIL-AMW-EM	SIL-SCM-EM	SEM
Total VFA, mol/mL[i]	**125.47**	**124.01**	112.79	109.97	101.94	103.67	3.25
Acetic, (%)[bj]	**67.80**	66.73	**65.85**	66.25	65.25	66.82	0.365
Propionic, (%)	21.63	23.32	23.18	22.4	24.2	22.25	0.414
Isobutiric, (%)[ck]	0.32	0.23	**0.35**	0.32	0.32	**0.35**	0.013
Butiric, (%)[c]	7.55	**7.78**	8.3	**8.8**	7.65	8.28	0.190
Isovaleric, (%)[dj]	1.53	**1.13**	1.45	**1.45**	1.52	1.53	0.042
Valeric, (%)[e]	1.2	1.0	1.0	1.0	1.0	1.0	0.052
A:P ratio	3.14	2.97	2.86	2.98	2.73	3.02	0.062
N-NH3,[ehi]	**5.82**	6.21	**13.98**	7.08	9.13	**16.55**	1.36
pH[fgj]	5.90	5.70	**6.03**	**5.73**	**5.88**	**5.95**	0.034
*CH_4, g/day	445.87	436.89	432.79	442.29	419.55	442.92	4.44

[z]Treatments: (Table 1)
[b] CS-AMW VS SIL-AMW ($P < 0.10$)
[c] CS-CM VS SIL-CM ($P < 0.10$)
[d] CS-CM VS SIL-CM ($P < 0.05$)
[e] CS-AMW VS SIL-AMW ($P < 0.05$)
[f] SIL-AMW VS SIL-AMW-EM ($P < 0.10$)
[g] SIL-CM VS SIL-CM-EM ($P < 0.05$)
[h] SIL-CM VS SIL-CM-EM ($P < 0.01$)
[i] CS-AMW AND CS-CM VS SIL-AMW AND SIL-CM AND SIL-AMW-EM AND SIL-CM-EM ($P < 0.01$)
[j] CS-AMW AND CS-CM VS SIL-AMW AND SIL-CM AND SIL-AMW-EM AND SIL-CM-EM ($P < 0.10$)
[k] CS-AMW AND CS-CM VS SIL-AMW AND SIL-CM AND SIL-AMW-EM AND SIL-CM-EM ($P < 0.05$)
* Methane was estimated using stoichiometry

Table 4. Effect of EM® in corn stover silages with molasses or acid milk whey and urea on the digestibility of cannulated sheeps.

Variable	Treatments[a] CS-AMW	CS-SCM	SIL-AMW	SIL-SCM	SIL-AMW-EM	SIL-SCM-EM	SEM
	6	6	6	6	6	6	
Intake, g/day							
DM	1,098	1,103	1,120	1,168	1,126	1,090	
OM	1,046	1,052	1,070	1,116	1,072	1,033	
NDF	394.33	382.83	383.83	395.50	386.00	364.67	
ADF	254.17	239.83	248.83	262.17	250.83	237.50	
N	17.3	16.2	18.6	19	20	18.8	
GE	4.81	4.81	4.89	5.11	4.90	4.75	
Excretion, g/day							
DM[ac]	**298.83**	281.67	257.17	290.50	**297.33**	287.83	13.19
OM[ac]	**264.17**	249.83	230.17	259.33	**264.50**	253.83	12.12
NDF	179.67	169.67	160.83	178.00	178.67	163.83	8.64
ADF	108.50	109.17	98.33	110.50	109.17	103.33	5.32
N	5.66	5.50	5.16	5.83	5.83	5.66	0.44
GE[c]	1.24	1.17	1.09	1.23	1.25	1.19	0.057
Total digestibility on tract, %							
DM[b]	**72.78**	74.23	**77.03**	75.02	73.83	73.45	0.92
OM[c]	**74.80**	76.02	**78.53**	76.69	75.62	75.32	0.87
NDF	54.24	55.13	58.26	54.20	54.14	54.00	1.96
ADF	56.97	53.66	60.66	57.10	56.96	54.66	2.00
N	67.34	64.82	71.80	68.18	71.21	69.93	1.30
DE, Mcal/Kg[dh]	3.06	**3.15**	3.20	**3.32**	3.19	3.28	0.47
DE, %	74.38	75.43	77.71	75.81	74.82	74.69	0.91

[a]Tretments: (Table 1)
[b]CS-AMW VS SIL-AMW ($P < 0.05$)
[c]CS-AMW VS SIL-AMW ($P < 0.10$)
[d]CS-CM VS SIL-CM ($P < 0.10$)
[e]SIL-AMW VS SIL-AMW-EM ($P < 0.05$)
[f]SIL-AMW VS SIL-AMW-EM ($P < 0.10$)
[g]SIL-CM VS SIL-CM-EM ($P < 0.05$)
[h]CS-AMW AND CS-CM VS SIL-AMW AND SIL-CM AND SIL-AMW-EM AND SIL-CM-EM ($P < 0.10$)

RESULTS

- The inoculation of corn stover silages with EM increased ($P < 0.05$) the content of CP in both sources of carbohydrates respect the corn stover without silage with molasses (Table 2).
- The use of the silages with EM and molasses increased ($P < 0.05$) the concentration of N-NH3 and rumen pH (Table 3) but no effect was observed for digestibility (Table 4).
- The silage with acid milk whey improved (5.8%, $P < 0.05$) the OM digestion compared with corn stover without silage.

CONCLUSIONS

- The use of Effective microorganisms (EM) improve the CP content in CSS with AMW or SCM
- The use of EM in combination with SCM increased the amoniacal nitrogen content and decreased the pH with AMW
- A diet with 45% corn stover silage with EM was not sufficient to improve in vivo digestibility of nutrients in sheep.

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