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EFFECT OF MICROBIOLOGICAL TREATMENT ON THE NUTRITIVE VALUE OF CORN SILAGE

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ABSTRACT

The current study aimed to investigate the effect of microbiological treatment on improving the nutritive value of corn silage as animal feed. Dried whole corn plants were prepared and two ground silos (0.5 ton each) were used for ensiling whole corn silage and inoculated by bacterial inoculant (containing *Lactobacillus plantarum* and *Entrococcus faecium*) at the recommended rate of 1/2g bacterial inoculants/liter of water/ton of fresh whole corn silage. The ensiling period lasted for 50 days. The criteria of response were determined by: the quality of treated corn silage, chemical characteristics and performance of rams, nutrients digestibility and nitrogen balance. Results for treated and untreated silage, respectively, showed that the silage had pH 3.71 and 3.69, Total Volatile Fatty Acids (TVFA) were 2.48 and 1.98 mmol/100ml, and NH_3-N values were 6.1% and 6.41% (on dry matter basis). The values of organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE), nitrogen free extract (NFE) and ash content on dry matter basis, however, were very close in the two rations. There were no significant differences between the two rations for the dry matter (DM). The value of CF digestibility was not significantly different from that in treated corn silage, while ration contents of treated corn silage were significantly higher in OM, CP, NFE and EE digestibility than the untreated corn silage. Recorded values for total digestible nutrients (TDN) and starch value (SV) of rations of treated corn silage were significantly higher than those of untreated corn silage being 52.64 and 63.37 vs. 43.53 and 56.09%, respectively. The digestible crude protein (DCP) values were (7.43%) for ration of treated corn silage by 5.96% for the ration of untreated corn silage.

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INTRODUCTION

In Egypt, corn stalks, at 3.6 million tons/year, are the major available source of lignocellulosic wastes, which can be collected from commercial research farms. Corn silage is a safe feed and the most popular with feeders, that is often called the "king of roughages" for animal rations. Moreover, it works well for starting cattle and lambs as feed, the corn plant can also be handled mechanically at convenient time of the year and over a short period of time. Well-made corn silage is a very palatable product with a moderate value of a digestible protein and particularly for the amount of energy contents. On a dry matter (DM) basis, corn silage usually has 8.9% crude protein, 65% to 75% TDN **(Kellems and Church, 2001)**. Feeding with high quality silage can possibly increase animal performance, reduce feeding costs and, ultimately, results in an increased return in time and money invested in forage production.

Van Saun (2000) indicated that the silage quality can greatly influence animal's productivity; the poorer silage quality, the longer it remains in the ruminant digestive tract, decreasing animal productivity. Moreover, ensiling process destroys the germination power of weeds. Animal organic wastes can be ensiled with green forage. The process of ensiling kills pathogenic bacteria, fungi and parasites if present in animal wastes. The process is less dependent on the weather. Silage furnishes high quality succulent feed for any season of the year at a low expense and the possibility for keeping more animals on a certain area of land.

Bacterial inoculants are the most widely and fastest growing class of silage additives today. Most contain live cultures of mainly lactic acid bacteria of the genera *Lactobacillus,* and *Streptococcus,* in addition to *Pediococcus.* These bacteria ferment sugar (glucose and fructose) to lactic acid. The increase in lactic acid causes the pH of the silage to drop rapidly; stabilizing the forage once pH gets near 4.0 is achieved. **Wittenberg et al (1983)** and **Gordon (1989)** indicated that few silage inoculants have been shown to hasten the fermentation process, resulting in less nutrient loss, improved digestibility, less protein breakdown and silage with higher feed quality.

The aim of the present study was evaluating the effect of bacterial treatment of *Lactobacillus plantarum* and *Entrococcus faecium* on the digestibility and feeding values of whole corn silage.

MATERIALS AND METHODS

Experiments of the current investigation were carried out at the Regional Center for Feed and Food (RCFF) of Agricultural Research Center (ARC) and at Faculty of Agriculture, Ain Shams University, Egypt. Corn plants were obtained from the experimental farm of Agricultural Research Center (ARC), Giza, to study the effect of microbiological treatment for improving nutritive value of corn silage.

Preparation of corn silage

Whole corn plants (at medium dough stage) were directly chopped into 2-3 cm pieces with forage chopping harvester machine. The ensiling process started immediately after chopping where moisture content at the ensilage process was approximately 70%. The silage stocks were comprised by a tractor and tightly sealed by plastic sheets then hardly covered by 20 cm soil and rice straw boles to guarantee anaerobic conditions for good lactic acid fermentation. Two ground silos (0.5 ton each) were used for the experiment, one was untreated whole corn silage prepared without any additives and the second was composed of whole corn silage inoculated with *Lactobacillus plantarum* and dried *Entrococcus faecium* (1132 N63), obtained from Pioneer Company (Japan). Inoculation was conducted at the recommended rate of 1/2g bacterial cells/ liter water/ ton of fresh whole corn silage. The ensiling lasted for 50 days, and then samples were taken to test quality. After the ensiling period, the whole corn silages were available for feeding animals in digestible trials.

Determination of silage quality

Silage pH was determined using digital pH meter. Ammonia nitrogen was determined using saturated solution of magnesium oxide and distillation was performed according to method of **A.O.A.C. (1990).** Total VFAs were determined according to **Warner (1994)**.

Metabolism trials

To determine nutrient digestibility and nutritive value of the experimental rations, two digestible trials were conducted with three rams/group, with average weight of 73.5 Kg for each ram. The formulation of the experimental rations is shown in **Table (1)**. Each trial continued for 31 days, which 21 days were considered as preliminary period followed by 10 days as a collection period. Samples of feces were collected, mixed and then dried at 60°C for 48 hours. Dried feces were ground and stored for complete chemical analysis.

Table 1. Formulation of experimental rations fed in corn silage trials

Ingredients	Control	Tested silage
Concentrated feed mixture	500g	500g
Untreated corn silage	2000g	0
Treated corn silage	0	2000g

Chemical analysis

Chemical analysis of samples of the experimental rations and feces included determination of dry matter, crude protein, crude fiber, ether extract

and ash; all were performed according to the methods of **A.O.A.C. (1990)**. Urine was collected daily from each ram during the collection period in plastic container containing sulfuric acid (10%) to prevent losses of ammonia-N. Daily urine volume was measured and 10% of the volume was taken in glass bottles and stored in refrigerator for nitrogen determination.

Statistical analysis

Statistical analysis was done using **SAS program (1996)**.

RESULTS AND DISCUSSION

Table (2) shows chemical composition of treated silages and untreated. Records illustrate that treated silage was slightly higher than treated one in terms of DM, OM, CP, EF and NFE, whereas it was lower in CF and ASH. These observations were similar to those obtained by **Yacout (2001) and El-Saadany et al (2001)**.

Table 2. Chemical analysis of ingredients of rations used in metabolism trials

Parameter	Concentrated ration	Untreated corn silage	Treated corn silage
DM	90.66	32.48	33.24
OM	90.31	91.27	92.87
CP	15.67	7.73	8.60
CF	13.40	28.87	25.35
EE	2.64	1.74	2.21
ASH	9.69	8.73	7.13
NFE	58.61	52.92	56.71

DM: dry matter, OM: organic matter, CP: crude protein, CF: crude fiber, EE: ether extract, NFE: nitrogen free extract

Silage quality

Results of silage quality determination **(Table 3)** showed that pH and NH_3-N values did not significantly differ after treatment, while TVFA slightly decreased. These results were in disagreement with those obtained by **Yacout (2001)** and **El-Saadany et al (2001)**. Generally, good quality silage should have pH between 3.8 and 4.20 **(McDonald et al 1995 and EL-Shennawy 2003)**, but the TVFA's values were 2.48 mmol/100ml in treated corn silage compared with untreated corn silage (1.98m mol/100ml). Chemical composition of the experimental rations used during the whole experimental period is presented in **Table (4)**.

Table 3. Effect of microbial inoculation on corn silage quality at the end of ensilage period

Parameter	Untreated corn silage	Treated corn silage
pH	3.71	3.69
NH_3-N (as % of DM)	6.10	6.41
Total VFA's (mmol/100ml)	2.48	1.98

Table 4. Chemical composition of the experimental rations used during the whole experimental period (% on DM basis)

Parameter	Untreated corn silage	Treated corn silage
DM	56.92	57.01
OM	89.23	91.10
CP	10.77	8.90
CF	10.40	11.32
EE	23.41	19.71
ASH	1.75	2.25
NFE	53.67	57.82

Digestibility coefficient

Results concerning nutrient digestibility coefficients are presented in **Table (5)**. The results indicated that there was a significant difference between the two rations concerning DM, OM, CP, EE and NFE digestibility in treated silage corn ration compared to untreated corn silage ration, the same result was obtained by **El-Shennawy (2003)**. The average digestion coefficients of DM using different animal species and different varsities of corn silage ranged between 52.3 and 66.6% (**Block et al 1982 and Etman et al 1994**). **Ferret et al (1997)** found that OM digestibility of different corn hybrid silages by sheep ranged from 59.2% to 75.7%. The digestibility of CF of corn silage by different animal species ranged between 56.7% and 70.6 % (**Etman et al 1994 and El-Sayes et al 1997**). The

digestion coefficients of corn silage ranged between 74.96 and 80.62 % for EE (**Mahmoud et al 1992 and Gaafar, 2001**) and ranged between 59.58 and 75.2% for NFE (**Leahy et al 1981 and Gaafar, 2001**).

Table 5. Effect of bacterial inoculants *1132 N631* on digestibility Coefficients of corn silage at the end of ensilage period (% on DM)

Digestibility coefficients	Untreated corn silage ration	Treated corn silage ration
DMD	62.48 [b]	70.14 [a]
OMD	60.98 [b]	66.88 [a]
CPD	57.26 [b]	65.65 [a]
CFD	54.30 [a]	55.98 [a]
EED	76.06 [b]	87.13 [a]
NFED	64.13 [b]	70.04 [a]

Different superscripts (a, b) indicate significant difference (p<0.05).

Nutritive value

The nutritive value obtained for the different rations (on DM basis) in terms of total digestible nutrients (TDN %), starch value (SV) and digestible crude protein (DCP %) are presented in **Table (6)**. These values were significantly higher in treated corn silage ration than in control ration. Starch value of treated corn silage rations reached 52.64% compared with untreated corn silage (control) which was 43.53%. Moreover, the TDN value increased in treated corn silage to 63.37% where in untreated corn silage ration was 56.09%. These results were in agreement with those obtained by **Mahmoud et al (1992)**. Also, the DCP increased in treated corn silage rations to 7.43% compared with untreated corn silage rations (5.96%). However, **El-Sayes et al (1997)** and **Mohamed et al (1999**) mentioned that TDN was higher and DCP was lower in the rations contained treated corn silage than the untreated corn silage. It could be concluded that the quality of corn silage can be improved when treated with effective fermentative bacterial species. Corn silage usually has 65 - 75 % TDN (**Church, 1991**). Average DCP values of corn silage ranged between 4.40 and 7.87 % as reported by **El-Sayes et al (1997) and Etman et al (1994)**.

Table 6. Nutritive values (% on DM basis) of silage untreated with bacterial inoculants 1132 N 631 at the end of ensilage period

Nutrient value	Untreated corn silage ration	Treated corn silage ration
SV	43.53 [b]	52.64 [a]
TDN	56.09 [b]	63.37 [a]
DCP	5.96 [b]	7.43 [a]

Different superscripts (a, b) indicate significant difference (p<0.05).

Nitrogen balance

It was clear that nitrogen intake values recorded for animals fed on treated corn silage ration was significantly (p< 0.05) higher than those fed on untreated corn silage ration **(Table 7)**. Nitrogen balance (g/h/d) was positive in treated corn silage ration and untreated corn silage rations indicating that the animals were in normal nitrogen metabolism status, a condition necessary for accurate evaluation of the tested rations. Similar results have been reported by **El-Kady et al (1999), Abd El-Rahman (1996) and El-Shennawy, (2003**). They mentioned that feeding sheep or goats with either treated silage or untreated silage improved retained nitrogen. Concerning nitrogen retained (%) from nitrogen intake, it could be noticed that values recorded for sheep given treated corn silage ration were higher than those recorded for animals given the untreated ration.

Table 7. Nitrogen utilization with rams fed on the experimental rations

Items	Untreated corn silage ration	Treated corn silage ration
Nitrogen intake (g/h/day)	17.74 [b]	19.24 [a]
Nitrogen extraction (g/h/day):		
Fecal- N	7.56 [a]	6.6 [b]
Urinary-N	4.72 [a]	4.7 [a]
Digested-N	10.18 [b]	12.46 [a]
Nitrogen retention (g/h/day)	5.46 [b]	7.94 [a]
% of N-intake	30.78 [b]	41.27 [a]
% of N-digested	53.63 [b]	63.72 [a]

Different superscripts (a, b) indicate significant difference (p<0.05).

Generally, rams fed on treated silage tended to perform better than those fed on untreated silage and have the lowest feed cost /kg gain (LE). From the foregoing results, it could be concluded that preserving amount of corn plant as silage treated with lactic acid bacteria has a beneficial effect in offering an appropriate ruminal condition, enhancing animal performance and reduced the feed cost of kg gain and participate in feeding animal and minimize such problems of disposal pollution. These results introduce an effective technique towards making best use of residues which is applicable on medium sized farms to upgrade lignocelluloses agricultural wastes in such a way that can be used by small holders as fodder for ruminants. More research is needed for making silage from other kinds of residues and on other species and breeds of animals.

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