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THE CHARACTERISTICS AND FEEDING VALUE OF ENSILED CATTLE WASTE-STRAW MIXTURES FOR LAMBS

(With 5 Tables)

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الخصائص والقيمة الغذائية لسيلاج مخاليط الروث والتبن للأغنام

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تم تحضير سيلاج معملى من مخلفات الحيوان وبعض الأتبان لتقدير الفترة والنسبة بين الروث والاتبان المختلفة اللازمة للحصول على التخمر المناسب لعمل السيلاج. وقد تم جمع الروث والبول (المخلفات) من ماشية غذيت على قش أرز حتى الشبع مع اضافة أعلاف غير تقليدية تتكون من ذرة وردة قمح وكسب قطن غير مقشور ورجيع الكون بكميات تتناسب مع انتاجها من اللبن كما تم خلط المخلفات مع كل من تبن القمح وقش الأرز وتبن العدس وكانت نسبة الخلط هى صفر و٢٥ ، ٥٠ و٧٥% من المادة الجافة. فترة عمل السيلاج كانت ٤ ، ٥ ، ٦ ، ٧ أسابيع. وقد أوضحت النتائج بعد ٧ أسابيع أن درجة الأس الهيدروجينى وصلت الى مستوى ثابت وكذلك وجد أنه بزيادة نسبة المخلفات لم تتغير درجة الاس الهيدروجينى تغير كبيراً. ولكن ارتفع معامل هضم كل من البروتين الخام والمادة الجافة معمليا بزيادة مدة تحضير السيلاج ونسبة المخلفات. وقد اختفت جميع الميكروبات والسالمونيلا بعد أربعة أسابيع. كما أجريت تجربة للهضم وتجربة للنمو لتقدير معاملات هضم المركبات الغذائية وكفاءة النمو لحملان مغذاه على علائق تحتوى على سلاج المخلفات المكون من ٥٥ ، ٣٠ ، ١٠ ، ٥% من قش الأرز والمخلفات والبرسيم والمولاس على الترتيب. وتم تكوين ثلاث علائق كالتالى (١) عليقة المقارنة (٢) عليقة تحتوى على ٢ر١٣% سيلاج المخلفات (٣) عليقة تحتوى على ٣ر٢٧% سيلاج المخلفات (من المادة الجافة) لتغذية عدد تسعة حملان فى عمر عام تم استخدامها فى تجارب الهضم و١٢ ذكر و١٢ أنثى من الأغنام عمر ٨ شهور فى تجربة النمو. وأوضحت النتائج وجود تأثير منحنى فى معاملات الهضم عند زيادة نسبة سيلاج المخلفات من صفر الى ٣ر٢٧% فى كل العناصر الغذائية. وكان معامل هضم البروتين الخام أكبر بحوالى ٧٦ر١ ، ٣ر مره فى العلائق المحتوية على ٢ر١٣ ، ٣ر٢٧% سيلاج عنه فى عليقة المقارنة. كان معدل الزيادة اليومية لكل من الذكور والاناث مرتفعاً فى العليقة المحتوية على ٢ر١٣% سيلاج مخلفات عن التى تحتوى على ٣ر٢٧% وكانت الأخيرة أعلى من عليقة المقارنة. وكان متوسط الزيادة اليومية فى الذكور أعلى منه فى الاناث (مستوى معنوية أقل من ٥%). كان الفرق فى المأكول اليومى غير معنوياً ولكنه كان أعلى رقمياً فى الإناث عنه فى الذكور. وكانت التكاليف النسبية لانتاج كيلوجرام نمو أقل

بحوالى ٢٧% فى الذكور المغذاء على علائق محتوية على سيلاج المخلفات بينما كانت فى الإناث أقل بحوالى ٥ر٣٣ ، ٣٠% فى العلائق المحتوية على ٢ر١٣ ، ٣ر٢٧% سيلاج مخلفات على الترتيب. مما سبق يمكن أن نخلص الى امكانية استخدام مخلفات الأبقار بعملها سيلاج مع مواد العلف الخشنة وتغذيتها للأغنام دون حدوث مضاعفات أو أمراض.

SUMMARY

Small silo study was conducted to determine the ensiling time and the proportion of cattle wastes to different straws necessary for optimum fermentation. The milking cow wastes were ensiled with wheat, rice and lentil straws. The proportions of waste to straw in the silage were 25, 50 and 75% on dry matter (DM) basis. The duration of ensiling was 4, 5, 6 and 7 weeks. Results indicated that after 7 weeks of ensiling, the pH value reached to a constant level. Also, with increasing the waste proportion the change in the pH values were narrow. In vitro CP and DM digestibilities increased with increasing time of ensiling and proportion of waste. All total and fecal coliforms, and salmonella were disappeared in all mixtures after 4 weeks of ensiling. Digestibility and growth studies were carried out to determine digestibility and growth performance of lambs fed diets containing waste silage prepared from 55, 30, 10 and 5% of rice straw, cattle waste, berseem and molasses, respectively. Three diet treatments (1) control diet A, (2) 13.2% waste diet B and (3) 27.3% waste diet C in DM basis were prepared for digestibility and growth studies. Nine of one year old, Ossimi rams and twenty four, 8 months old, lamb (12 females and 12 males) were used in digestibility and growth studies respectively. Qudratic effects of digestibility were noticed when waste silage was increased from 0 to 27.3% in almost all nutrients. Crude protein digestibilities in diets B and C were about 1.76 and 0.3 times that of diet A respectively. In both males and females the average daily gain was remarkably higher in diet B than diet C which was also higher than the control. The average DG was significantly higher in males than females ($P<.05$). Differences in DFI was not significant but it was numerically higher in females than males. The relative feeding cost for producing one kg of DG was about 27% lower for males in both diets B and C than diet A, while it was 33.5 and 30% lower in diets B and C respectively, for females, than diet A. It could be concluded that cattle waste can be ensiled with different roughages and fed to lambs without adverse effects.

Key Words: *Waste silage-Lambs, Digestiblity, Growth.*

INTRODUCTION

Recently in many countries, previously popular rumen by-pass protein sources from red meat offal renders such as blood meal and meat and bone meal can no longer be used as feeds for ruminants because of the threat of bovine spongiform encephalopathy (BSE) or mad cow disease (Vazquez-Anon 1998). Also in Egypt, because of the shortage of available feedstuffs, there has been interest in finding alternative sources of feed for ruminants. Two primary areas of interest are the recycling of animal waste and the use of crop residues as feed sources. Smith and Wheeler (1979) indicated that although animal waste is a good feed resources, it is not economically utilized in ruminant diets. Approximately 50% of the animal waste output is produced in confinement and is collectable (Heichel, 1976). Animal waste can be an environmental pollutant because it can be a media for fly larvae, cause serious odors besides it may be a source for dust (Helmer, 1980). As a feed, the waste may has some disadvantages such as, variablility in composition and its containing undesirable contaminants of organic or inorganic origin. Smith (1981) indicated that the evaluation of by-products or waste for ruminants is in principle no different from evaluation of other feedstuffs.

The ensiling of cattle feces and urine (waste) with a roughage, such as hay or straw, has been studied as an economical and efficient way of processing cattle waste. Bandel and Antony (1969) ensiled a mixture of 57 parts of cattle waste and 43 parts of grass hay (wet basis) they named the resulting product "Wastelage". Cornman et al. (1981) indicated that in vitro dry matter digestibility increased ($P<.05$) linearly with increasing level of cattle waste (feces and urine). The wastelage was found to have no; palatability problems (Harpster et al., 1978 and Lamm et al. 1979); differences in its effect on animal production compared with the traditional diet (Bandel and Anthony 1969, Anthony 1971, Rafiq et al., 1994) and pathogenic organisms (Knight et al., 1977; Newton et al., 1977). Yadav and Pradhan (1989) indicted that microbiological screening showed that the sun-dried animal waste was safe as a feed, and feeding to cattle produced no harmful effects. In the USA Smith and Wheeler (1979) estimated the value of cattle waste as a fertilizer at 23$ / metric ton and as an energy source for finishing cattle gaining 1.1 Kg/day at 86 to 94$/ metric ton. Fermentation of silage made from cattle waste and roughage is very fast (Newton et al. 1977). Ensiling process has been

effective in destroying potential pathogenic organisms in cattle waste (Knight et al. 1977, Ahmed et al. 1992).

In the present study two experiments were performed, the first one was to test the effect of waste proportion and ensiling period on the silage characteristics and in vitro digestibility, while the second experiment was performed on lambs to measure digestibility of diets containing the silage and growth performance of the lambs fed the tested mixtures.

MATERIALS and METHODS

I- Ensiling characteristic and in vitro digestibility experiment:

In this experiment a milking cow waste was ensiled with three kinds of straw; wheat, rice and lentil; for 4 different periods; 4, 5, 6, and 7 weeks. The straws were chopped into small pices, in order to be throughly mixed with the waste, then mixed with the waste at different ratios; 75, 50 and 25%; expressed on dry matter basis. The mixture (straw and waste) was then pressed in plastic jars, each of 5 kg capacity, sealed with a glow and then kept for the required length of ensiling period. Eight jars were prepared for each straw waste mixture, two for each of the four ensiling periods, and with a total of 24 for each kind of straw.

Microbiological examination:

For the microbiological examination 25g wet samples were taken from the waste and from the jars each at the end of its respective ensiling period, where every sample was mixed with 225 ml of sterile distilled water, in a sterile blender jar. The homogenates were filtered through four layers of sterile cheese cloth (Cornman et al., 1981). The extracts were immediately subjected to quantitative testes for total fecal coliforms (Millipore Corp., 1973), total qualitative testes for salmonella (Lewis, 1964) and electrometrically pH determinatioin.

Chemical analysis:

The rest of the jar-ensiled mixtures each was oven-dried at 60°C for 48 h, finely ground, then kept for chemical analysis, the same as that for the initial ingredients waste and straws. The analysis included dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE) and ash followed as that of AOAC (1980) procedure.

In vitro digestibility:

For the determination of DM and CP digestibilities using the in vitro pepsin-HCl AOAC (1980) procedure, triplicate samples were taken from each silage mixture. For the digestibility correction pure casein was digested the same as the silage samples and the digestion coefficient of its DM and CP is considered.

II- Feeding experiment:

For testing the value of the silage for animals two trails were performed, one for measuring the silage digestibility and the other for measuring the lamb growth efficiency when they were fed the silage.

Diets:

Silage was prepared by mixing 55% rice straw, 30% cattle waste (collected at milking times through 3 days and kept covered with plastic sheets till mixing), 10% berseem (to help the anaerobic medium), and 5% molasses (to accelerate the fermentation processes). The mixing proportions were calculated on a dry matter basis and ensiling was done in a bunker of a capacity of 3 tons for 6 weeks.

The wastelage was fed as a replacement proportion of the basal diet which contained 30% rice straw and 70% commonly used concentrate mixture (Contains corn, wheat bran and undecortecated cottonseed cake). Several proportions (10, 20, 30, 40 and 50%) were firstly tested for its acceptability where the lambs refused diets containing more than 30%. As a result of this pilot test two mixture were prepared of about 15 and 30% wastelage and compared with the basal diet as the control.

Molasses was added to all diets to improve their taste at 10% level, hence the proportion of all ingredients was changed as shown in Table 4.

Animals:

For determining the digestibility three healthy Ossimi rams one-year old were used in each digestibility trial, following the usual procedures using metabolic cages. They were fed for a preliminary period of 15 days and a collection one of 7 days. Total fecal was collected and sampled daily and oven dried. Samples of faces and diets were each throughly mixed, ground and kept for chemical analysis.

For the growth trial twenty four 8 months-old lambs (12 females and 12 males), divided into 3 equal groups, were used. The animals were kept for 90 days and weighed at the beginning then every other week.

Diets were offered two times daily and the average daily feed consumption was determined.

Statistical analysis:

Data of the preparatory study were analyzed as a 3x3x4 factorial study (Sokal and Rohlf, 1981). The statistical model was

$Y_{ijkl} = U + (S)_i + (R)_j + (T)_k + (SR)_{ij} + (ST)_{ik} + (RT)_{jk} + (SRT)_{ijk} + E_{ijkl}$

where

U = grand mean

S_i = is the straw effects i= 1, 2, 3.

R_j = is the ratio effects j =, 25, 50 and 75%

T_k = is the time effects k= 4, 5, 6 and 7 weeks.

$(SR)_{ij}$,$(ST)_{ik}$, and $(RT)_{jk}$ are the first order interaction effects in the subgroups represented by the indicated combinations of the ith group of straw, the jth group of ratio and kth group of incubation time.

$(SRT)_{ijk}$ is the second-order interaction effect in the subgroups representing the ith, jth, and kth group factors straws, ratios and time of incubation resp.

E_{ijkl} = is the error term of the lth item in subgroup ijk.

Data from the digestibility and growth study were analyzed for significance by least squares analysis of variance. Significant differences among treatment means were tested using the multiple range test of Duncan (1955).

RSULTS and DISCUSSION

The composition of the wastes and straws prior to ensiling are presented in Table 1. Animal wastes are characterized by low DM, high CP, EE and ash contents. This may be because the wastes contain urine mixed with fecal material also it may be contaminated with some ash during daily collections. Within the straws lentil straw was the highest in CP content and the lowest in ash.

Table 2 showed the effect of both the ensiling time as well as the percentage of wastes on the pH value of silage. The results indicated that after 6 weeks of ensiling the pH value reached to almost constant value (4.4 to 4.9). Also, with increasing the ratio of wastes the change in the pH value was very narrow about 0.3 pH unit when the waste increased from 25 to 75%. The pH values were the same as those of Harpster et al. (1975) and Moore and Anthony (1970) but lower than that of Lamm et al. (1979).

Table 3 shows that the interaction among treatments on the in vitro CP and DM digestibilities was not found. In vitro crude protein digestibility increased (P<.05) with increasing time of incubation up to 7 weeks with all straws. The changes in the in vitro crude protein digestibility were high between weeks 4 and 5 then reduced to the lowest value between weeks 6 and 7 in all mixtures except that for lentil straw where the highest increase was noticed between weeks 6 and 7. Also the highest digestibility was found at 75% of the waste mixture with all straws. The same order was noticed with DM in vitro digestibility except for wheat straw where there were numerical differences only among the waste levels in DM digestibility. The same results were found by Cornman et al. (1981) who indicated that in vitro dry matter digestibility increased (P<.05) linearly with increasing level of cattle waste (feces and urine).

Total and fecal coliform counts were greater than 10^6/g. After 4 weeks of ensiling, no coliforms or salmonella were detected. The achieved results observed throughout the study are in harmony with the work of other researchers (McCaskey and Anthony, 1979, Cornman et al., 1981).

Feedin experiments:

The feed ingredients, for the three tested diets and their chemical composition as well as the determined digestion coefficients of nutrients are shown in Table 4. The level of wastelage was kept at about 30% and not more because of the animal refusal for higher percentages. On the contrary Lamm et al. (1979) found no platability problems when they fed the wastelage to the lambs. However, the results agreed with that of the same author in the absence of digestive disturbances. The CF content of the diets contained wastlage was reduced significantly (P<.05) than the control one because the low CF of the wastlage. The digestibilities of CP, EE, CF, NFE, OM and DM increased because of the replacement of 13% of the basal diet by wastelage to 1.76, 1.45, 1.33, 1.16, 1.28 and 1.34 times that of the control, in respective order, while the replacement of 27% increased the digestibility to 1.32, 1.23, 1.29, 1.11, 1.18 and 1.15 respectively. These results agreed with conclusion of Rafiq et al. (1994).

Results in table 5 indicated that body weight gain was numerically higher with diets contained the wastelage especially that containing the low percentage. This points that there is no adverse effect on growth performance for wastelage feeding, a fact which can be confirmed by

CAST (1978) with cows, Radwan (1994) with rabbits and Lamm et al. (1979) with calves. Also, Anthony (1967) and Bandel and Anthony (1969) have reported the feasibility of feeding cattle wastes as wastelage. The daily gain was significantly higher ($P<.05$) in male than female. Part of this differences, may be due to the differences in the average initial body weight which was higher ($P<.05$) in male than female lambs. Also, the differences in feed intake were not significant ($P>.05$) but they were higher in female than male lambs. The feed conversion index was higher in female than in male lambs in the three diets.

Table 5 showed that addition of the wastelage to the animal diets decreased the total feed cost in relation to body gain by about 12 and 24% respectively. The reduction in the feed price required to produce kg of gain was about 27% for male and 33.5 and 30% for female on diets B and C respectively. These differences in relative feed cost as a combination of feed cost and daily gain. Smith and Wheeler (1979) indicated that utilizing of excreta products as feed ingredients in balanced diets for several classes of ruminants is economical than its utilization as sources for fertilizer or methane production.

From the previous studies and the obtained results, it could be concluded that animal waste can be ensiled with different sources of roughages to improve their feeding value and digestibility. This conclusion is confirmed by the work of Fontenot et al. (1983) and Sreedhar et al. (1993) who indicated that feeding animal waste had not effect on carcass grade or tastes of meat nor composition or flavor of milk. Also, McCaskey and Anthony (1979) indicated that animal wastes have been used successfully in animal feeding program for several years without significant problems related to animal health. From the economical point of view Smith and Wheeler (1979) and Fontenot and Jurubescu (1980) indicated that the economical value of excreta produced as feed ingredients in balanced diets for several classes of ruminants is three to ten times greater than their value as plant nutrient sources. They also added productivity (growth) of ruminants fed diets containing excreta products was equal to that of ruminants fed control diets containing only traditional feed ingredients, a matter which show the nutritional feasibility of using these products as a part of the diet for ruminants.

Table 1: Chemical composition of wastes and straws expressed on DM basis.

Item	DM	CP	EE	CF	NFE	Ash
Wste	18.6	14.6	4.6	26.6	34.1	20.1
Wheat straw	90.7	3.6	1.8	32.1	49.5	13.0
Rice straw	95.0	2.9	1.4	31.8	47.9	16.0
Lentil straw	92.0	6.4	2.2	33.5	46.1	11.8

Table 2: Average pH values in the different waste straw mixtures ensiled for different periods.

Time	wheat straw			rice straw			lentil straw		
	25%	50%	75%	25%	50%	75%	25%	50%	75%
0 wk	5.7^{a}	5.5^{a}	5.4^{a}	5.6^{a}	5.4^{ab}	5.2^{a}	5.6	5.5	5.4^{a}
4 wk	5.2^{ab}	5.3^{ab}	5.3^{a}	5.5^{a}	5.6^{a}	5.2^{a}	5.3	5.4	5.0^{ab}
5 wk	4.4^{b}	4.2^{b}	4.0^{b}	4.9^{ab}	4.7^{ab}	4.8^{ab}	5.0	4.6	4.1^{b}
6 wk	4.0^{b}	4.3^{b}	4.2^{b}	4.3^{b}	4.6^{b}	4.0^{b}	4.9	4.6	4.2^{b}
7 wk	4.6^{b}	4.4^{b}	4.1^{b}	4.3^{b}	4.1^{b}	4.1^{b}	4.9	4.8	4.3^{ab}
SE	0.3	0.4	0.3	0.3	0.3	0.3	0.4	0.3	0.4

ab: means within column with unlike superscripts differ (P<.05) significantly.

Table 3: In vitro CP and DM digestibility of the different kinds of silage.

Wk	Wheat straw				Rice straw				Lentil straw			
	25	50	75	Av.	25	50	75	Av.	25	50	75	Av.
						CP digestibility						
0	35	39	38	37.4^{c}	30	36	40	35.4^{c}	40	46	50	45.4^{c}
4	40	45	49	44.7^{b}	39	39	45	41.0^{c}	48	56	60	54.7^{b}
5	46	49	54	49.7^{ab}	45	46	50	47.0^{b}	50	56	63	56.3^{b}
6	49	50	56	51.6^{a}	50	47	56	51.0^{ab}	52	58	63	57.7^{b}
7	52	53	60	55.0^{a}	52	53	59	54.7^{a}	59	62	67	62.7^{a}
Av.	44.4^{b}	47.3^{ab}	51.4^{a}	47.7	43.2^{b}	44.2^{b}	50.0^{a}	45.8	49.8^{c}	55.6^{b}	60.6^{a}	55.4
SEM				2.1				1.9				1.6
						DM Digestibility						
0	36	39	39	38.0^{c}	32	35	43	36.7^{d}	43	49	51	47.7^{c}
4	41	46	52	46.3^{b}	39	43	46	42.7^{c}	48	55	57	53.4^{b}
5	48	51	56	51.8^{ab}	47	48	52	49.0^{b}	52	56	61	56.4^{b}
6	51	53	57	53.7^{a}	51	50	57	52.8^{ab}	52	59	63	58.0^{b}
7	55	56	61	57.3^{a}	55	55	62	57.4^{a}	60	63	68	63.7^{a}
Av.	46.2	49.0	53.0	49.4	44.8^{b}	46.2^{b}	52.0^{a}	47.7	51.0^{b}	56.4^{ab}	60^{a}	55.9
SEM				2.3				1.8				1.7

abcd: means within column and row with unlike superscripts differ (P<.05) significantly.

Table 4: Feeding value of diets containing cattle waste.

Item	Diets %		
	Control	B	C
Basal diet*	90.9	77.7	63.6
Cattle waste silage	-	13.2	27.3
Molasses	9.1	9.1	9.1
Chemical composition %			
Dry matter	93.5	92.75	93.5
Crude protein (CP)	9.3	10.08	10.45
Ether extract (EE)	1.65	1.75	1.25
Crude fiber (CF)	17.75[a]	13.25[b]	11.25[c]
Nitrogen extract (NFE)	53.50	56.45	59.55
Ash	11.50	10.50	11.00
Digestion coefficient %			
CPD	38.40[c]	67.70[a]	50.50[b]
EED	45.60[c]	66.20[a]	56.00[b]
CFD	38.00[b]	50.40[a]	48.90[a]
NFED	72.40[c]	84.30[a]	80.70[b]
OMD	60.50[c]	77.20[a]	71.10[b]
DMD	55.10[c]	74.00[a]	63.40[b]

a,b,c, means within raws with unlike superscripts differ (P<.05).

* Basal diet contained 30% rice straw and 10% commonly used concentrate mixture (Contain corn, wheat bran and undecortecated cottonseed cake).

Table 5: Growth performance of lambs fed diets containing fecal silage for 90 days.

Items	Control A		Diet B		Diet C	
	Males	Females	Males	Females	Males	Females
A- Performance						
Initial BW kg	26.8	19.9	26.7	19.8	27.8	20.5
Final BW kg	31.6	23.4	32.0	24.5	32.5	24.4
B.W. gain kg	4.2	3.5	5.3	4.7	4.7	3.9
Daily gain g	46.7	38.9	58.5	52.2	52.2	43.30
Feed intake g/day	829	884	867	897	904	906
Feed conversion	17.76	22.7	14.0	17.2	17	20.9
B- Economical evaluation						
Feed price/ton	250		220		190.0	
Total feed consumed	74.61	79.56	78.03	80.73	81.36	81.54
Total feed cost LE	18.65	19.89	17.17	17.76	15.46	15.49
Feed cost/kg gain	4.44	5.68	3.24	3.78	3.29	3.97
Relative feed cost* %	100	100	73.0	66.5	74.1	69.9

* Relative feed cost = $\frac{\text{Feed cost/kg gain of tested diet}}{\text{Feed cost/kg gain of control}} \times 100$

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