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Ensiling of mulberry foliage (*Morus alba*) and the nutritive value of mulberry foliage silage for goats in central Vietnam

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Abstract

The first experiment was conducted to evaluate the effect of different additives (molasses or rice bran) on quality of silage made from mulberry (*Morus alba*) foliage. The second experiment was designed as a Latin square (5 x 5) with 5 growing goats with a mean live weight of 17.3 kg to determine effects of mulberry foliage silage on feed intake, digestibility, and nitrogen retention. The treatments were: (MS 0) natural grass *ad libitum* (basal diet), (MS 250) basal diet plus 250g/day mulberry foliage silage, (MS 500) basal diet plus 500 g/day mulberry foliage silage; (MS 750) basal diet plus 750 g/day mulberry foliage silage and (MS adlib.) mulberry foliage silage ad libitum.

The results from the first experiment showed that the mulberry foliage silage had a high protein and ash content and that the best quality was with 5% of molasses. The pH value and the ratio between N-NH_3 and total N were lower in the silages with 5% of molasses. The results from the second experiment showed that mulberry foliage silage was very palatable for goats. The DM intake increased from 2.70 to 3.41 kg DM per 100 kg live weight as the proportion of mulberry silage increased from 0 to 40% of the diet DM. When only the mulberry silage was fed the intake was 3.02 kg DM/100 kg live weight. DM and OM digestibility coefficients did not differ between diets; however, there was a curvilinear (R^2=0.94) increase in N retention as the offer level of mulberry silage increased. The retention of N on the 100% mulberry silage diet (5.2 g/day) was almost 3 times as high as on the grass hay diet.

Key words: Biomass, composition, digestibility, goats, mulberry, *Morus alba*, nitrogen retention, shrubs, silage

Introduction

Mulberry is a traditional feed for silk worm all over the world. It is reported to have a high edible biomass yield of 12 to 15 tonnes DM/ha/year, and that with a cutting interval of about 9 to10 weeks, the leaves have a high protein content (18 to 25% in DM), and high *in vivo* DM digestibility (75 to 85%). It thus has a high potential as a protein-rich forage supplement for ruminant production (Nguyen Xuan Ba et al 2003; Nguyen Xuan Ba et al. 2004). Mulberry plants grow very well in the spring and autumn in Central Vietnam and there is often a surplus of biomass in these periods. In order that mulberry forage could be used as a protein supplement for ruminants throughout the year; appropriate methods of conservation of mulberry should be considered.

Objectives

These were to:

- identify an appropriate additive for ensiling of mulberry foliages
- determine the nutritive value of mulberry silage for growing goats.

Materials and methods

Location and feeds

The experiments were conducted from April to December 2003 in Hue University of Agriculture and Forestry. The native mulberry foliages were collected in different locations in central Vietnam. Natural grass was cut around Hue City.

Experiments 1: Effect of different additives on silage quality

Experimental design and procedures

The mulberry foliages were harvested after a regrowth period of 2.5 months. They were chopped into small pieces (2 to 3cm length) and wilted under sunshine. Rice bran 5% (w/w) (RB) and molasses 5% (M) were used as additives in making the silage. 54 laboratory silos were used according to a 3*6 factorial arrangement with 2 additives (RB and M) and a control (without additive) (C) and 6 ensiling periods. There were 3 replicates per treatment. The laboratory silos were made from PVC plastic tube with a volume of 2000 cm^3. The contents of each silo weighed approximately 1500 g. The silos were kept at room temperature, from July to September 2003. The samples were taken at 0, 7, 14, 21, 28 and 56 days after ensiling.

The silos were weighed every week to determine losses during the ensiling period.

Experiment 2: Effect of mulberry silage levels in the diets on feed intake, digestibility, nitrogen retention and N-NH3 content in the rumen fluid of goats

Experimental design and animals

Five local growing goats with average body weight of 17.3 kg were used to study the total tract digestibility and nitrogen utilization of the diets. The experiment was designed as a 5 x 5 Latin square arrangement. Each period lasted 16 days, in which 10 days were for adaptation, 5 days for data collection and day 16 for taking the sample of rumen fluid. The animal diets were natural grass hay (basal diet) (NG 0), basal diet plus 250 g/day mulberry silage (MS 250), basal diet plus 500 g/day mulberry silage (MS 500), basal diet plus 750 g/day mulberry silage (MS 750) and mulberry silage ad libitum (MS ad lib.). Water and salt were freely available for all animals. Feeding was 4 times per day at 8, 11, 14 and 17 o'clock. The animals were kept in digestibility cages in order to collect the separate samples of faeces and urine

Sample collection

Faeces were collected every 2 hours and put in polyethylene bags and stored at 4 ^{o}C. At the end of each period the total faeces were mixed and a sub-sample (about 10%) was then dried at 60 ^{o}C for chemical analysis. Urine was collected with prior addition nd added 20% of H_2SO_4 (10%) to avoid nitrogen loss and stored at -20^{0}c. At the end of period the samples were mixed well and took the sub samples about 50 ml for nitrogen analysis. Rumen fluid was taken by stomach tube 4 hours after feeding on day 16. At each time, about 20 ml of rumen fluid were obtained. 10% of solution of 20 % H_2SO_4 was added to halt the fermentation.

Measurements and chemical analysis

Feed offered and refused, and output of faeces and urine, were recorded daily during the last 5 days of each period. Samples of feed offered and refusals were taken daily and analyzed for DM and N. Total N of feed, faeces and urine and N-NH_3 of feed and rumen fluid were measured by the Kjeldahl procedure as outlined by the AOAC (1990). The ash content of feed and faeces was determined following the AOAC (1990) recommendations. Organic matter was assumed to be the result of subtracting the percentage of ash from 100. pH was determined by glass electrode measurements in a digital pH meter.

Biometrical analysis

The data were analyzed according to the analysis of variance technique using the general linear model (GLM) procedure in the software of MINITAB version 13 The mathematical model used was:

$Y_{i\,jk} = M + P_i + A_j + T_{(i\,j),K} + E_{i\,jk}$

Where:
$Y_{i\,jk}$: Independent variable (in take, apparent digestibility....)

M: Overall mean
P_i: Effect of period

$A_{j:}$: Effect of goats

T_k: Effect of treatments

$E_{i\,jk}$: Effect of random error

Results and discussion

Experiments 1: Effect of different additives on mulberry foliage silage quality

There were no differences among the additives in the effects on DM losses during the ensiling period (Table 1).

Table 1: The loss in weight of the silos throughout the ensiling period (%)

	Days				
	7	**14**	**21**	**28**	**56**
No additive	1.00	1.50	1.50	1.99	2.25
Molasses	1.20	1.68	1.68	2.17	2.17
Rice bran	1.02	1.27	1.52	2.03	2.28
SEM	0.13	0.20	0.32	0.34	0.30
Prob.	0.54	0.44	0.91	0.93	0.96

The DM content of the silages was highest with rice bran as additive and lowest with no additive (Table 2; Figure 1). The DM content tended to fall slightly with increase in ensiling duration; this effect was significant in the case of the rice bran additive.

Table 2: Effect of ensiling period on the dry matter content in ensiled mulberry foliages (%)

	Days							
	0	**7**	**14**	**21**	**28**	**56**	**SEM**	**Prob.**
No additive	44.9	44.6	44.3	45.2	44.2	43.4	0.45	0.15
Molasses	46.7	46.6	46.0	46.7	44.5	46.8	0.55	0.086
Rice bran	48.5	48.2	48.2	47.4	46.6	46.9	0.22	0.001
SEM	0.423	0.383	0.355	0.224	0.618	0.456		
Prob.	0.003	0.002	0.001	0.001	0.067	0.003		

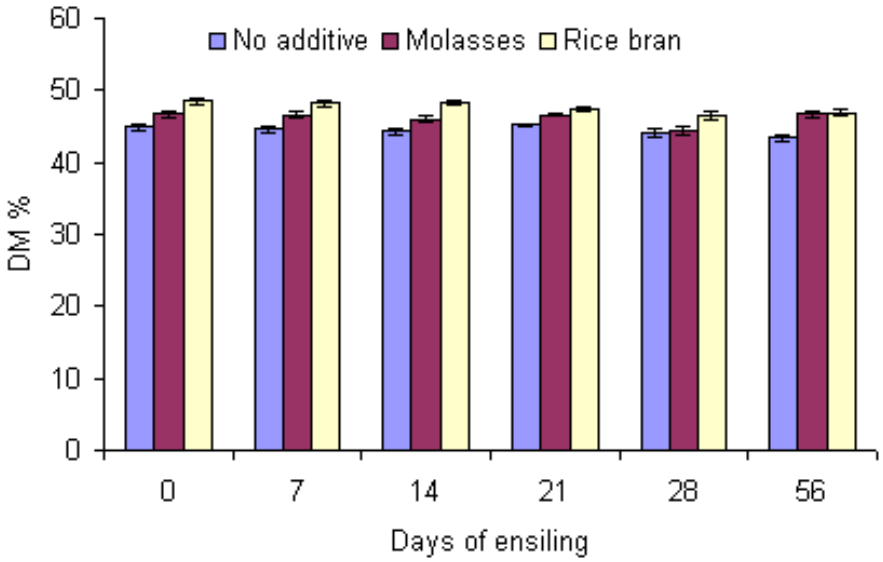

Figure 1: Effect of ensiling period on the dry matter content in ensiled mulberry foliages

The pH of the silages decreased after 7 days but with no further changes up to 56 days (Table 3; Figure 2). Silages withy molasses had the lowest pH while the control silages without additive tended to have the highest pH. In general the pH values of the ensiled materials were in the range of 5.0 to 5.5 which is higher than traditional silages made from grass or maize (McDonald et al 19).

Table 3: Effect of ensiling period and additives on the pH of ensiled mulberry foliage

	Days						SEM	P
	0	**7**	**14**	**21**	**28**	**56**		
No additive	6.93	5.82	5.32	5.51	5.48	5.58	0.018	0.0001
Molasses	6.94	5.38	5.04	5.29	5.34	5.27	0.028	0.0001
Rice bran	6.92	5.75	5.28	5.47	5.48	5.47	0.014	0.0001
SEM	0.014	0.02	0.022	0.035	0.011	0.016		
Prob.	0.435	0.001	0.001	0.01	0.001	0.001		

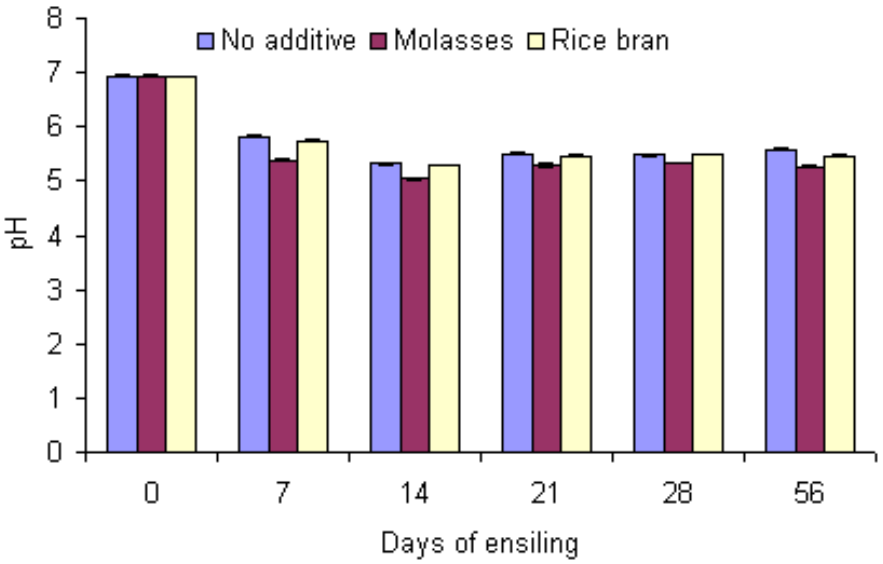

Figure 2: Effect of ensiling period and additives on the pH in ensiled mulberry foliage

The total N content in the silages tended to increase with ensiling time (Table 4), because there was some loss of volatile substances during the ensiling process (Table 1). The ammonia content of total N increased from about 9% in the fresh foliage to about 11% after ensiling (Table 5; Figure 3). This value tended to be lower in the silage made with molasses. The increase in

ammonia-N is indicative of some breakdown of the protein, which would be facilitated by the relative high pH (5.0 to 5.6).

Table 4: Effect of ensiling period and additives on the N content (as % in DM) of ensiled mulberry foliage

	Days						SEM	P
	0	7	14	21	28	56		
No additive	3.17	3.23	3.28	3.43	3.56	3.37	0.05	0.001
Molasses	3.01	3.20	3.21	3.29	3.50	3.31	0.38	0.001
Rice bran	2.99	3.19	3.19	3.38	3.52	3.46	0.28	0.001
SEM	0.47	0.33	0.02	0.04	0.02	0.06		
Prob.	0.07	0.72	0.02	0.14	0.30	0.24		

Table 5: Effect of ensiling period and additives on the NH3-N as % of total N of ensiled mulberry foliage

	Days						SE	Prob.
	0	7	14	21	28	56		
No additive	9.3	10.6	11.0	10.6	10.9	11.9	0.267	0.001
Molasses	9.3	10.5	10.6	10.6	10.6	10.1	0.25	0.014
Rice bran	8.5	10.8	10.9	10.6	11.0	11.2	0.121	0.001
SE	0.26	0.20	0.11	0.15	0.22	0.33		
Prob.	0.13	0.50	0.09	0.90	0.48	0.03		

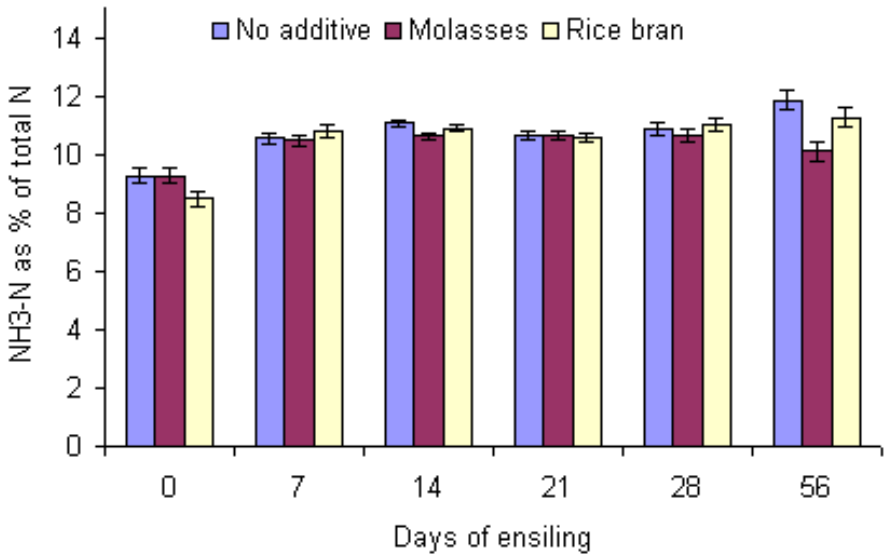

Figure 3: Effect of ensiling period and additives on the NH3-N as % of total N of ensiled mulberry foliage

The ash content of the silages increased slightly with increasing duration of ensiling, as a result of the loss of organic matter (Table 1).

Table 6: Effect of ensiling period and additives on the NH3-N as % of total N of ensiled mulberry foliage

	Days						SEM	Prob.
	0	7	14	21	28	56		
No additive	13.1	14.3	14.3	14.7	14.7	14.8	0.105	0.0001
Molasses	13.2	14.0	14.3	14.4	14.5	14.7	0.091	0.0001
Rice bran	13.3	13.6	14.3	14.6	14.8	14.8	0.159	0.0001
SEM	0.14	0.17	0.035	0.164	0.087	0.068		
Prob.	0.68	0.11	0.81	0.57	0.21	0.34		

Experiment 2: Effect of mulberry silage supplements levels in the diets on feed intake, digestibility, and nitrogen retention and rumen fluid pH of goats

The crude protein was twice as high and the fibre twice as low in the mulberry silage compared with the grass hay (Table 7).

Table 7: Chemical compositions of feeds (% in DM except for dry matter which is % as fed)

	DM	CP	OM	CF
Grass hay	84.9	8.95	92.0	33.6
Mulberry foliages silage	32.3	18.0	82.9	18.0

DM intake increased linearly as the proportion of mulberry silage in the diet increased up to 40% of the diet DM (Table 8; Figure 4). However, when only mulberry silage was fed the intake (3.02% of live weight) decreased by 13%. A higher voluntary intake of 3.91% of live weight was reported by Theng Kouch et al (2003) for goats of similar live weight fed only fresh mulberry foliage.

Table 8: Mean values for effect of offer level of mulberry silage (MS) on the content of crude protein in the diet and on feed intake by goats

	MS 0	MS 250	MS 500	MS 750	Only MS .	SE	Prob.
MS in diet DM (%)	0	16.2	28.4	39.9	100	0.97	0.001
CP in DM (%)	8.95	10.4	11.5	12.6	18.0	0.09	0.001
DM intake (% LW	2.70a	2.82 a	3.16 ab	3.41 b	3.02 ab	0.11	0.004

ab Means within rows without common letter are different at P<0.05

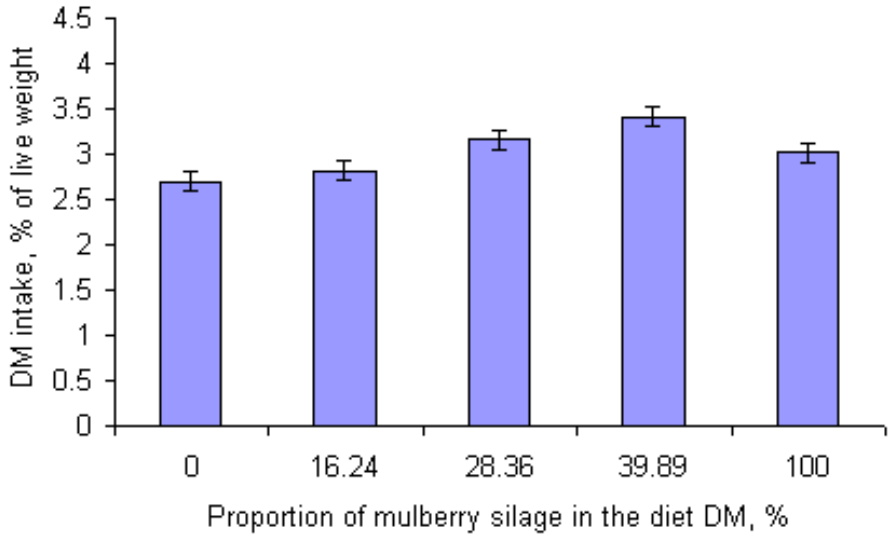

Figure 4: Mean values for effect of offer level of mulberry silage on the feed intake by goats

Digestibility coefficients for DM and OM did not appear to be affected by increasing levels of mulberry silage as replacement for the grass hay (Table 9). However, the values for the 100% mulberry silage diet (63%) were lower than was reported (76.1%) by Theng Kouch et al (2003). It is unlikely that ensiling of the mulberry foliage was the causative factor for this difference. Digestibility of crude protein increased with level of mulberry silage, probably because with increasing level of dietary crude protein, the metabolic faecal N becomes a smaller proportion of total faecal N.

Table 9: Mean values for effect of offer level of mulberry silage on the digestibility (%) of DM, OM and CP by goats

	MS 0	MS 250	MS 500	MS 750	Only MS	SE	Prob.
DM	59.4	57.2	57.7	59.1	58.0	2.27	0.955
OM	63.1	60.1	62.2	64.2	63.1	1.85	0.606
CP	49.1a	49.7 a	58.5 b	60.3 b	62.9a	1.68	0.001

ab Means within rows without common letter are different at P<0.05

There was a curvilinear increase in N retention (Figure 5) as the offer level of mulberry silage increased. The retention of N on the 100% mulberry silage diet (5.2 g/day) was almost 3 times as high as on the grass hay diet (Table 10). It is interesting to note that the 30% increase in N retention on the 100% compared with the 40% mulberry silage diet was achieved even though digestible DM intake was 13% less on the 100% mulberry silage diet.. The goats in the study of Theng Kouch et al (2003) had a N retention of 8.4 g/day when fed only fresh mulberry foliage.

Table 10: Mean values for effect of offer level of mulberry silage on rumen ammonia and N balance in goats

	MS 0	MS 250	MS 500	MS 750	Only MS	SE	Prob.
Rumen N-NH3, mg/ litre	156	184	195	223	225	16.6	0.062
N balance, g/day							
Intake	7.13	8.36	10.5	12.3	16.4	0.355	0.001
Faeces	3.60	4.13	4.34	4.87	6.04	0.224	0.001
Urine	1.65	2.15	2.96	3.35	5.17	0.22	0.001
Retention	1.87a	2.08a	3.19ab	4.06bc	5.20c	0.327	0.001

ab Means within rows without common letter are different at P<0.05

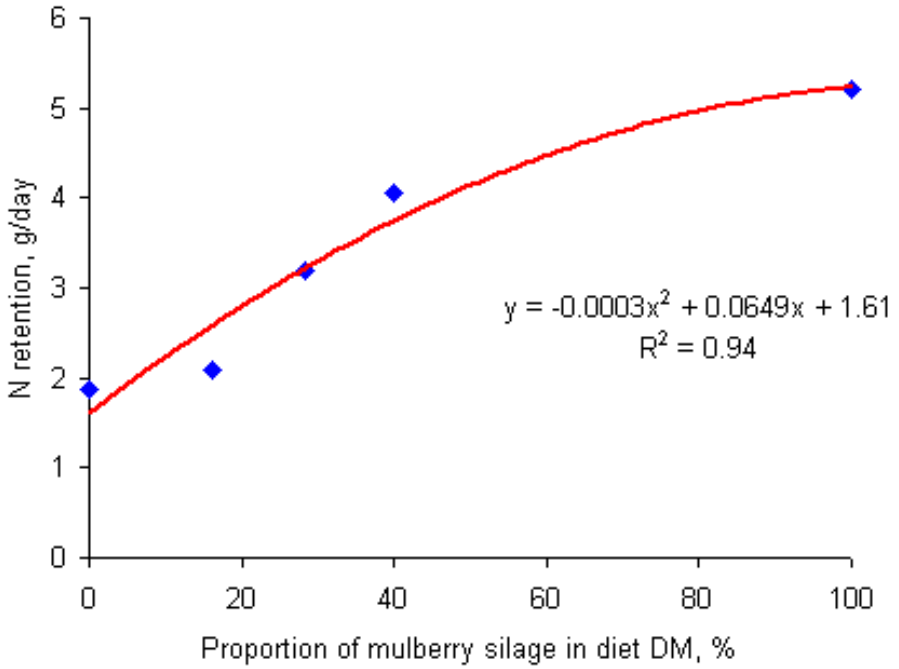

Figure 5: Effect of level of mulberry silage replacing grass hay on N retention in goats

Conclusions

- Mulberry foliage can be ensiled satisfactorily without the need for additives such as molasses or rice bran.
- Goats fed a basal diet of native grass hay responded with increased voluntary intake as the offer level of mulberry silage increased up to 40% of the diet DM. Intake decreased when mulberry silage was the only component of the diet.
- There were no differences in DM digestibility for diets in which the level of mulberry silage varied from zero to 100% replacing grass hay.
- There was a curvilinear increase in N retention with increasing level of mulberry silage.

References

AOAC 1990 Association of Official Analytical Chemists, Official methods of Analysis, 15th edn. Vol. 1. AOAC. Washington, DC.

Nguyen Xuan Ba and Le Duc Ngoan 2003 Evaluation of some unconventional trees/plants as ruminant feeds in Central Vietnam. *In: Proceedings of Final National Seminar-Workshop on Sustainable Livestock Production on Local Feed Resources (Editors: Reg Preston and Brian Ogle). HUAF-SAREC, Hue City, 25 – 28 March, 2003.* Retrieved , from http://www.mekarn.org/sarec03/bahue.htm

Nguyen Xuan Ba, Vu Duy Giang and Le Duc Ngoan 2004 The use of mulberry foliage for ruminants Science & Technology journal of Agriculture & rural development Vol. 5,

Theng Kouch, T R Preston and J Ly 2003: Studies on utilization of trees and shrubs as the sole feedstuff by growing goats; foliage preferences and nutrient utilization; *Livestock Research for Rural Development (15) 7* Retrieved , from http://www.cipav.org.co/lrrd/lrrd15/7/kouc157.htm

Vu Duy Giang 2001 *Morus alba* - The high quality feed resources for animals. Scientific news papers Vol. 30 (1387), pp. 10.(http://www.FAO.org/DOCREP/005/x9895E/)

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