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In sacco Dry Matter and NDF Degradability of Grass Silage Harvested at Three Stages of Maturity

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Abstract. The objective of this experiment was to study the effects of grass maturity at harvest on the nutritive value of grass silage in relation to chemical composition and *in sacco* degradability of dry matter (DM) and neutral detergent fiber (NDF). Grass sward was harvested at transition phase (P1), early reproductive phase (P2) and late reproductive (P3) growth stage of orhardgrass (*Dactylis glomerata* L.) as a dominant grass (70% over other grasses). Four fistulated Charolais sheep were used to measure silage DM and NDF degradability characteristics over 0, 3, 6, 12, 24, 48 and 72 h of *in sacco* incubation. As the crop matured, the NDF and acid detergent fiber (ADF) concentration decreased significantly ($P<0.05$). The DM degradability and the effective degradability significantly decreased ($P<0.05$) with increasing grass maturity at harvest. The effective degradability (ED) of DM and NDF was calculated considering a rumen passage rate of 4% $hour^{-1}$ and the following values were found: 62.6, 51.2, 50.7 for DM and 46.9, 39.3, 38.0 for NDF, respectively. It was concluded that decreased *in sacco* DM and NDF degradability was a result of lower nutritive value of grass silage harvested at advanced grass maturity.

Keywords: grass silage, *Dactylis glomerata*, in sacco degradability, sheep

INTRODUCTION

Grass silage is the most important form of conserved forage for the nutrition of ruminants in many regions of Europe (Dawson *et al.*, 2002). It varies greatly in terms of chemical and biological composition due to the impact of factors such as the maturity stage at harvesting, sward botanical composition, fertilization level, climate and ensiling techniques upon the fermentation process in the silo and on nutritive value (Knežević *et al.*, 2007). Climate conditions in the continental part of Croatia in late April/early May are unfavourable for the production of high quality GS. Besides, the widely grown grass in Croatia, orchardgrass (*Dactylis glomerata* L.), may turn from vegetative to generative growth in a couple of days, which greatly influences its quality (Fowler *et al.*, 2003). For grass in general, the substantial decrease in the feeding value that accompanies advanced maturity is due to chemical and physical changes in the plants. The proportion of cell walls increases in the plant material and the increased lignin content is correlated with reduced forage intake and digestibility of the cell wall material (Jung, 1989). Mowing at the earlier maturity stage increases the number of cuts in the season and directly affects the chemical composition and the forage nutritional value (Gruber *et al.*, 1999). Minson (1990) investigated the impact of the number of cuts on the crude protein (CP) and NDF concentration. The author has found a higher proportion of CP by 90 g kg^{-1} DM and a lower proportion of NDF by 197 g kg^{-1} DM at 4 compared to 2 grass cutting per year. However, frequent mowing increases the ash concentration in the forage because the young grass easily contaminates with the soil and the leaves contain more minerals than the stem (Minson, 1990).

The present study was carried out under the hypothesis that P1cut silage would have increased DM and NDF degradability in comparison with the P2 and P3 silage. The objective of the experiment was to examine the effects grass silage maturity at harvest on silage *in sacco* DM and NDF degradability.

MATERIALS AND METHODS

The grass silage was made from a semi-permanent, predominately orchardgrass meadow harvested on 18 May, 25 May and 06 June in 2002 (transition phase, early reproductive phase and late reproductive phase growth stages of orchardgrass respectively) for silages designated P1, P2 and P3, respectively. Botanical composition was determined from 30 forage samples by manual separation of sward components (grasses, clovers, forbs). The sward contained 80.6% orchardgrass (*Dactylis glomerata* L.), 13.7% legumes out of which 11.2% white clover (*Trifolium repens* L.) and 2.5% red clover (*Trifolium pratense* L.), 2.3% other grasses and 3.4% forbs on a DM basis. Herbage for silage was cut with a disc mower and wilted for 8 h in the field before harvesting with a round baler. The grass silages were analysed for dry matter (DM), nitrogen (N) that was expressed as crude protein (CP) (total N x 6.25) g kg^{-1} DM, neutral detergent fiber (NDF), acid detergent fiber (ADF) and organic matter (OM).

Silage degradability characteristics were determined using four Charolais fistulated sheep, 4 year old, of approximately 60 kg of live weight, to measure degradability over 0, 3, 6, 12, 24, 48 and 72 h. The animals were fed a ration of meadow hay and pellet concentrate for sheep in a ratio of 75:25 (DM basis), which was calculated to provide maintenance. The bag size was 10 cm x 20 cm with a pore size 50±15µm (ANCOM Technology Corp., USA). All silage samples were dried and milled trough a 1.5 mm sieve. After withdrawing the bags from the rumen, they were put into icy water, washed in a washing machine for 15 min using cold water and then kept in a freezer. After all the bags had been taken from the rumen, they were dried for 2 days at a temperature of 60°C. The value of degradability at time 0 was obtained by washing two bags in a washing machine for 1 h using cold water. For each bag, the residue was analyzed for DM.

The degradability at each time interval was calculated by taking the mean value obtained from the eight bags. The disappearance values were fitted to the equation $p=a+b(1-e^{-ct})$ using the NEWAY 5.0 software (Ørskov and McDonald, 1979). The effective degradability (ED) of DM and NDF in each grass silage was then estimated by the following equation: $ED(\%)=a+bc/\ c+k$, were k is the outflow rate from the rumen assumed to be 0.04 h^{-1}. Data were analysed with the GLM procedures of SAS (1999).

RESULTS AND DISCUSSION

Advanced grass maturity at harvest was evidenced by a linear increase in cell-wall carbohydrate as ADF and by a linear decrease in the CP content ($P<0.05$) in grass silage as shown in Tab.1. Higher CP concentration and lower NDF and ADF concentrations in the P1 silage compared to the P2 and P3 silage can be explained by a higher leaf to stem ratio in the sward (Jung, 1989). The CP content of the three silages used in this experiment (90-120 g kg^{-1} DM) corresponds well with the results reported by Vranić *et al*. (2005) (77-167 g kg^{-1} DM) in a survey carried out on 19 family farms in Croatia in 2004.

Tab. 1

Chemical composition of grass silages (g kg^{-1} DM unless otherwise stated)

Item	Stage of grass maturity at harvest			LSD $_{5\%}$
	P1	P2	P3	
Dry matter (g kg^{-1} fresh weight)	396[a]	408[a]	463[b]	37,97
Crude protein	120[a]	98[b]	90[c]	3,88
Neutral detergent fibre	677[a]	672[a]	705[b]	32,43
Acid detergent fibre	372[a]	423[b]	429[b]	10,92

Note: Values within the same row with different superscripts differ significantly (P<0.05).
P1, transition phase of orhardgrass; P2, early reproductive phase of orhardgrass; P3, late reproductive growth stage of orhardgrass

The mean *in sacco* DM degradability at each time interval is given in Fig. 1.and Fig. 2. The release of DM from feeds during 3 to 72 h of incubation in the rumen indicates differences in degradation between the forages as well as differences in the final maximum release after 72 h of incubation. Differences were the greatest between the P1 and the P3 silages, as expected. Characteristics of the DM and NDF degradation of the silages are given in Tab. 2. The P2 and the P3 silages had a significantly lower (P<0.05) soluble component than the P1 cut silage. That indicates that P1 silage may be rich in soluble compounds. The insoluble but fermentable component slowly degraded fraction and its rate of fermentation in the P1 and the P2 silages was significantly higher than in the P3 silage (P<0.05), suggesting lower degradability of NDF in the latter feed. There was a significant (P<0.05) difference between all feedstuffs in the ED_{DM4}, with the highest ED_{DM4} in the P1 and the lowest ED_{DM4} in the P3 silage. This study and that of Long *et al*. (1999) support the view that the herbage maturity stage at harvest is one of the main factors affecting the nutritive value of forages. The results are in agreement with that reported by Long *et al*. (1999) that *in sacco* DM degradability varies from 621-778 g kg^{-1}DM after 48h of incubation. The advanced grass maturity at harvest led to decreased degradation of silage DM as determined using the polyester bag procedure in the rumen (Vanhatalo *et al*., 1996).

Tab. 2

Dry matter and neutral detergent fibre degradability of grass silages

Item	Stage of grass maturity at harvest				Stage of grass maturity at harvest			
	P1	P2	P3	LSD $_{5\%}$	P1	P2	P3	LSD $_{5\%}$
DM degradability					NDF degradability			
a (g/kg DM)	34.8[a]	28.9[c]	30.7[b]	1,27	27,2[a]	24,3[b]	21,9[c]	1,47
b (g/kg DM)	49.9[a]	43.9[b]	39.9[c]	1,58	51,8[a]	45,1[b]	41,8[c]	1,70
c (f/h)	0.067	0.055	0.055	NS	0,058	0,047	0,050	NS
ED_{DM4}	62.6[a]	51.2[b]	50.7[b]	1,36	46,9[a]	39,3[b]	38,0[b]	2,72

Note: P1, transition phase of orhardgrass; P2, early reproductive phase of orhardgrass; P3, late reproductive growth stage of orhardgrass; a = Rapidly degraded fraction (%); b = Slowly degraded fraction (%) and c = Rate of degradation (fraction/h) are constants in the exponential equation ($p=a+b(1-e^{-ct})$); ED (%), effective degradability (out flow rate: 4% h); DM, dry matter; NDF, neutral detergent fibre
Values within the same row with different superscripts differ significantly (P<0.05).

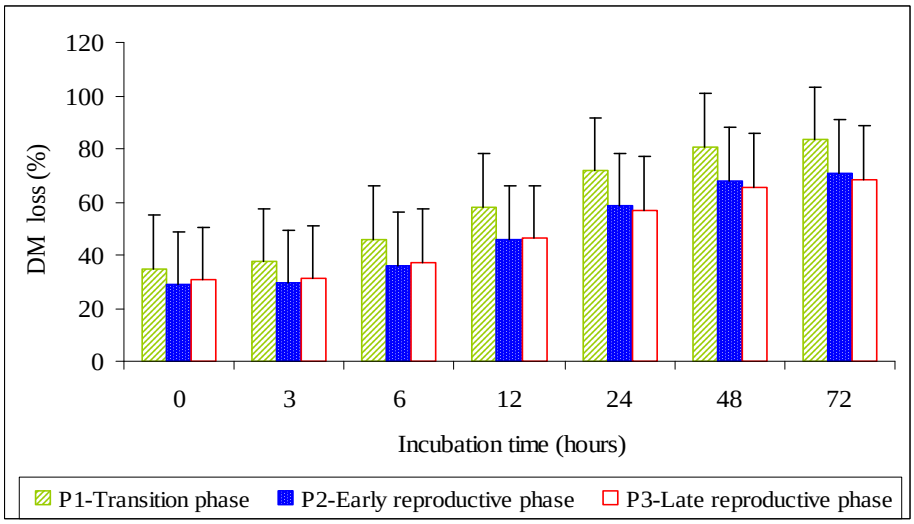

Fig. 1. Dry matter loss of P1, P2 and P3 grass silage incubated *in sacco* for different periods of time.

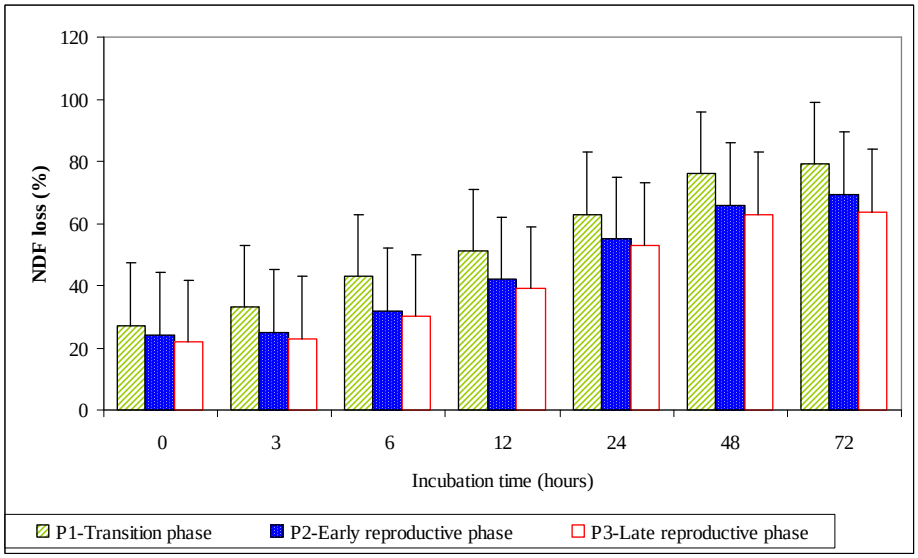

Fig. 2. NDF loss of P1, P2 and P3 grass silage incubated *in sacco* for different periods of time.

CONCLUSIONS

In conclusion, the results of this work demonstrate that the increasing maturity of grass ensiled had evident effects on the silage chemical composition, DM and NDF degradability. Early harvest ensured higher DM and NDF degradability of silages, which is necessary when a high production level is to be achieved with forage-based diets.

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