MACERATED ALFALFA FORAGE FOR BEEF AND DAIRY CATTLE

(Batang Hijauan Pakan Alfalfa (*Medicago sativa)* yang Dipress dan Dipecah untuk Sapi Pedaging dan Perah)

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ABSTRAK

Sejumlah penelitian telah dilakukan untuk menyelidiki faedah pemecahan batang alfalfa pada saat dipanen di daerah Prairi terhadap lama pengeringan, sifat-sifat nutrisi pada saat disimpan dan nilai nutrisi pakan. Alfalfa pada awal pertumbuhan bunga dipanen menggunakan salah satu dari dua mesin : mesin convensional (CONV) atau dengan mesin pemecah batang yang mempunyai empat tingkat pemecahan (LIGHT : ringan, LIGHT+ : agak berat, SEVERE : berat dan SEVERE+ : sangat berat). Selama pengeringan, perlakukan LIGHT+ s.d. SEVERE+ mencapai kadar Bahan Kering (BK) 45% dan 80% dalam waktu masing-masing hanya sekitar 2 jam dan 9-11 jam, dibanding CONV, yang mencapai kadar BK tersebut berturut-turut dalam waktu 6 dan 54 jam. Padet sapi pedaging mengonsumsi BK silase 13% lebih banyak dan memperoleh pertambahan bobot badan harian 22.7% lebih berat ($P<0.05$) jika batang alfalfa dipecah pada saat dipanen (SEVERE), dibanding tidak (CONV), pada awal pertumbuhan selama 21 hari. Sapi perah Holstein betina awal laktasi yang diberi ransum yang mengandung silase dan hay dari alfalfa yang batangnya dipecah pada saat dipanen memproduksi susu dengan kandungan gizi yang sama dibanding batang. Namun demikian, kelompok sapi yang diberi ransum yang mengandung alfalfa yang terpecah batangnya memberikan bobot hidup yang lebih berat dan nilai kondisi tubuh yang lebih baik ($P<0.05$) pada saat akhir penelitian laktasi selama 14 minggu.

Key words: Alfalfa, maceration, wilting time, silage, hay, dairy, beef.

INTRODUCTION

Conventional harvest with mowing equipment utilizing rollers or erimpers and leaving alfalfa in wide swaths on the field requires 3-4 d of wilting to reach 80% DM content in good weather conditions under eastern Canada/Maritime environments (Savoie *et al.*, 1984). A long wilting period will results in quality loss primarily due to leaching and prolonged plant respiration Savoie and Beauregard (1991) or undesirable microbial growth (Dawson *et al.*, 1950). Attempts to shorten wilting time can be achieved by conditioning the alfalfa during mowing or subsequent windrow handling operations, the reduction being from 20 to 60% depending on procedure used and crop conditions (Klinner 1975; Rotz and Sprott 1984).

Longitudinal splitting and crushing of the stems by running cut plant materials through a series of serrated steel rollers rotating at different speeds (maceration) has been inves tigated as a means of reducing wilting time required for alfalfa. Shinners *et al.* (1987) found that alfalfa dried to 80% DM content in 6 h or less using a field mower-macerator prototype. Very severe maceration has increased drying rate by

500% under laboratory conditions (Sundberg and Lundvall 1991, cited by Savoie *et al.*, 1994), ad by 100% under field conditions (Savoie *et al.*, 1993). Although maceration can reduce wilting time, concern has been raised about leaching of plant soluble if cut alfalfa is exposed to precipitation (Savoie *et al.*, 1993) or leaf and fine material shattering, which may result in DM loss (Savoie *et al.*, 1994).

Hong *et al.* (1988a) revealed that DM intake increased in sheep and goats fed macerated alfalfa forage compared to those fed conventionally-conditioned alfalfa, and milk yield and milk protein concentration increased in goats fed macerated compared to conventionally-conditioned alfalfa. Petit *et al.* (1994) found an increase in DM intake when either macerated timothy or alfalfa forages were fed to lambs.

The objective of this study was to know if maceration of alfalfa:

1. Can reduce wilting time of alfalfa to reach 45% and 80% DM concentration.
2. May not affect the nutrient content of alfalfa forage.
3. Can increase LAB population in alfalfa forage.
4. Can improve forage quality and animal (beef and dairy) performances.

METHODS

1. Field trial

A 2-ha, uniform stands of early-bloom alfalfa were cut into 10, 100-m swaths, using either a New Holland 116 hay bin conventional mower-conditioner (CONV swaths) or a prototype mower macerator built by the Prairie Agriculture Machinery Institute with 4 degrees of macerations (LIGHT, LIGHT+, SEVERE, and SEVERE+ swaths for each maceration level). A quarter in each swaths length was sprinkled with water to simulate precipitation, either in d-0 (day of cutting) or d-1 (one day post-cutting). Samples to measure wilting time were taken 3 times daily at 8:00 am, 12:00 am and 16:00pm; beginning from d-0 until the 80% DM has been achieved. Three grab sample for each swath per time of sampling were taken using plastic bags, which were immediately cooled for subsequent drying in laboratory. Samples for nutrient analyses were collected using part of forage materials from samples for DM measurements. Samples for LAB counts were collected aseptically.

Complete Randomized Design (Steel and Torrie, 1981) was used for this trial. Variables measured included time to reach 45% and 80% DM concentrations, post-wilting nutrients (CP, NDF, ADF, soluble carbohydrates) concentrations and LAB population.

2. Growing beef cattle trial

Thirty-four weaned Simmen tal-cross calves (272.0±4.9 kgs BW), 17 males and 17 females, were assigned to three forage treatments (CONV silage, macerated silage, and

hay of various harvest methods). The animals were placed randomly into 17 pens (1 male and one female in each pen). Six pens were assigned to CONV silage; another 6 pens to macerated silage and the last 5 pens were assigned to hay. Before data collection, animals were injected with vitamin A solution and adapted to pens and forage ration for 2 weeks. Fifty grams of mineral mix were fed at the time of daily feeding (at 8:30 pm). Cobaltiodezed salt lick and drinking water were available ad-lib. Weighing of feed and feeding were conducted on weekly basis. Weighing of animals was conducted at the initial day of feeding treatment, at week 3, week 6, and at the final day of treatment.

Complete Randomized Design was used for this trial. Variables measured included DM intake, ADG, and feed to body weight ratio (feed efficiency).

3. Dairy cattle lactation trial

Thirty three animals including 14 primiparous and 19 multiparous Holstein cows were assigned to one of two dietary treatments, either conventionally-conditioned hay and alfalfa silage or macerated alfalfa hay and silage as part of total mixed rations (TMR). Feeding of the silage and hay treatments started two weeks prior to calving. Data collection was initiated on the second week after calving and continued for 14 weeks. Long hays were fed separately at 2 kg/head/d and the TMRs were fed once a day. The feed was formulated to contain 1.73 Mcal NE_L/kg DM, with other nutrient parameters meeting production parameters for a 625 kg cow producing 40 L milk/d at 3.60% fat (NRC, 1989).

Animal body weight (BW) and body condition score (BCS) were determined at the time data collection was initiated and every four weeks thereafter until animals went off test. Milk yield was monitored daily and milk composition over a 24-h period was assessed on a weekly basis. Feed offered and rejected (weigh backs) were weighed daily with the amount of feed offered targeted to allow a minimum weigh back of 2 kg.

The data were analyzed as a split-plot design with harvest treatment and parity as the main-plot (2 x 2 factorial) using cow within harvest and parity as the error term, and week of lactation as the sub-plot, using general linear model (GLM) procedures of SAS (1986). Variables that were measured including milk yield and composition, ADG and BCS.

RESULTS AND DISCUSSION

1. Field trial

The CONV treament not exposed to precipitation achieved 45% DM content, a level that is considered favorable for ensiling, at 6.5 h post-mowing (61.4% shorter in average, $P< 0.05$). A 53.4-h wilting

time was required for CONV alfalfa to achieve 80% DM content, the minimum acceptable level for storage as hay. Maceration of alfalfa shorten the wilting time dramatically to only 9-19 h post-mowing when the forages were not exposed to precipitation (83.3-78.9%). Oztekin and Ozcan (1997) wilted macerated alfalfa to 80% DM content in 5-6 h. Macerated, pressed alfalfa under laboratory condition achieved that macerated and matted alfalfa wilted 200-300% faster under laboratory condition. The differences in the degree of shortening of wilting time among the studens may have been due to differences in swath or windrow density (savoie and Beauregred, 1991), or by differences in wilting environment (climatic or weather) conditions.

The macerated alfalfa in our study contained lower crude protein (CP) content ($P<0.05$, Table 1), relative to CONV alfalfa. The concentrations of NDF and ADF for post-wilted mecerated alfalfa, on the other hand, were increased by SEVERE and SEVERE+ macerations. Lower concentration of CP and higher comcentrations of NDF and ADF for the macerated alfalfa could have been due to higher leaf and young stem materials being shattered with meceration, relative to CONV alfalfa. Similar results with ours were observed by Hong *et al.* (1988), and Petit *et al.* (1992). Lactic acid-producing bacteria (LAB0 population tended to be increased by maceration at 0 h and 24 h wilting $P = 0.10$ and $P = 0.08$, respectively, Table 2).

Table 1. Effect of Maceration On Post-Wilting Nutrient Content (kg/g DM) of Alfalfa

	Maceration treatment					
	CONV	LIGHT	LIGHT+	SEVERE	SEVERE+	SE
CP	200.80^{a}	195.50^{ab}	182.70^{ab}	185.10^{ab}	180.70^{b}	4.40
NDF	335.70^{b}	359.90^{b}	364.50^{ab}	396.60^{a}	397.70^{a}	7.70
ADF	273.50^{b}	276.90^{b}	282.00^{ab}	310.70^{a}	315.70^{a}	7.90
Sol. Sugars	117.10	121.10	122.90	127.50	124.00	2.80

Table 2. Effect of Maceration on Lactic Acid Bacteria (LAB) Count (log_{10} of CFU/g DM) in Alfalfa during The First 24-h of Wilting

	Maceration treatment				
	CONV	LIGHT+	SEVERE	SEVERE+	SE
LAB, 0 h	3.01	3.61	4.23	4.09	0.24
LAB, 3 h	3.13	4.24	4.35	4.24	0.23
LAB, 24 h	3.51	4.59	5.06	4.51	0.28

2. Growing beef cattle trial

At the initial 21 d of data collection, daily DM intake (DMI) by calves was about 0.2 kg higher ($P<0.05$) in the group of calves fed the macerated relative to CONV alfalfa silage. This, in turn, resulted in higher ADG for the given calves (Table 3). Higher DMI for calves fed the macerated forage may be due to softer materials of the macerated alfalfa, which can be more densely compacted when settled in the rumen, or may be due to either lower retention time or higher digestibility of the macerated forage relative to the CONV forage. The positive impact of maceration on gains was not apparent at the final day of growing trial (Table 4). The growing trial started in the Fall with temperature of-5.4 $\pm 7.6^0$ C during the first 3 weeks, Oct. 24 th to Nov. 13 th, 1995, and ended in the Winter from December 5th 1995 to January 9th, 1996, with temperature of -17.4 ± 6.6 ^{0} C. Differences in the environmental temperature might have altered the patten of feed choise, or the physical characters of the forege. We found that the chopped silages used in the experiment were freezing at the time of winter-feeding. Also, during the cold weather, animals tend to eat more relative to those in warmer conditions (Delfino and Mathison, 1991), which could have been caused by greater energy intake required to balance body energy lost as heat from the body, and to maintain body temperature in the colder environments. Cooler temperatures possibly increase forage passage rate in the rumen, resulting in greater intake. The greater appetite of animals during winter may have negated the ability of nervous system to make choises for the feed, resulting in no differences in DMI between treatments.

Table 3. Effect of Maceration of Alfalfa on Growing Beef Cattle Performance at The Initial 21 of Feeding

	Maceration Treatment			
	CONV silage	SEVERE silage	Hay	SE
DMI, kg/d	7.00^b	7.90^a	7.10^b	0.10
DMI, %BW	2.50^b	2.80^a	2.50^b	0.00
ADG, kg/d	0.90^b	1.10^a	1.10^a	0.10
Feed conv, ratio, kg feed/kg gain	8.10	7.70	6.50	0.50

Table 4. Effect of Maceration of Alfalfa on Growing Beef Cattle Performance at The Final Day (Day 78) of Feeding

	Maceration Treatment			
	CONV silage	SEVERE silage	Hay	SE
DMI, kg/d	8.50	9.10	8.8	0.20
DMI, %BW	2.80	2.90	2.8	0.10
ADG, kg/d	0.90	1.00	1.0	0.10
Feed conv, ratio, kg feed/kg gain	9.60	9.10	9.0	0.40

3. Dairy Cattle Trial

Dry matter intake was similar between groups of cattle fed the two kinds of forages. Similar results were observed by Hong *et al.* (1988) for lactating goats fed alfalfa, and by chiquette *et al.* (1994) for steers fed timothy hay. Other studies (Petit *et al.* 1994, Hong at al. 1988) found the tendency of greater intake in animals fed macerated relative to conventially conditioned alfalfa. Differences in severity of macerations or ration formulation (feed ingredients) among the studies, may, in part, affect differences of results in DMI between the two conditioning treatments. Milk yield and milk composition in our study were similar between the two treatments (Table 5). Although DMI and milk yield were similar between treatments, animals fed the TMR containing conventionally harvested alfalfa (Table 6). These result suggest that the TMRs containing macerated alfalfa gained more weight ($P< 0.05$) than those fed the TMR containing macerated alfalfa were more efficently used for BW gain relative to that of the control diet. Koegel *et al.* (1992) cited the findings of Mertens and Hintz, tahta growing sheep gained more weight when they were fed macerated alfalfa silage ($P< 0.06$). The higher BW gain for the cows fed the TMRs containing macerated alfalfa was followed by greater BCS of the given cows.

Table 5. Milk Yield and Composition For Dairy Cows Fed TMR Containing Either CONV or Macerated Alfalfa during 14-Week Early Lactation Trial

	Maceration Treatment		
	CONV	SEVERE	SE
Yiled, kg/d	38.80	38.50	8.80
Butterfat, %	2.78	2.84	2.80
Protein, %	3.04	3.09	1.00
Solid non Fat, %	8.62	8.76	9.00

Table 6. Body Weight (BW) and Body Condition Score (BCS) For Cows Fed Tmrs Containing Either CONV or Macerated Alfalfa during 14-Week Early Lactation Trial

	Maceration Treatment		
	CONV	SEVERE	SE
DMI, kg/d	21.70	21.40	0.50
DMI, %BW	3.45	3.45	0.11
BW change, kg/d	0.17^{b}	1.40^{a}	0.07
Final BW, kg	619.60^{b}	641.50^{a}	10.07
BCS, unit	2.80	2.94	0.05

CONCLUSION

3. Maceration of alfalfa resulted in shorter wilting time to reach either 45% or 80% DM.
4. Maceration of alfalfa during defoliation, although may cause a decrease in CP at the time of mowing, possibly improves silage quality by increasing LAB bacterium population.
5. Growing beef calves fed macerated alfalfa silage in a certain (favorable) environmental condition eat more feed and gained more weight relative to those fed conventionally conditioned alfalfa.
6. Early lactating cows fed TMRs containing macerated forage gain more weight and tend to have better BCS.

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