



The Impact of Alfalfa Hay Particle Size on the Utilization of Soy Hull by Early Lactating Dairy Cows

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ABSTRACT

The purpose of this study was to evaluate the effect of alfalfa hay (AH) particle size (PS) and replacement of soybean hull (SH) in the diet on the performance of early lactating dairy cows. Eight lactating Holstein cows averaging 590 ± 33 kg of body weight and 47 ± 13 days in milk in replicated 4×4 Latin square design were assigned to a 2×2 factorial arrangement of treatments: PS of AH (fine vs. coarse) combined with SH (zero or substituted as 50% of AH). Physically effective fiber (peNDF) and physically effective factor (pef) contents of the diets were increased by increasing the PS of AH and the inclusion of SH in the diets ($P < 0.01$). Intake of peNDF was increased by increasing the PS of AH ($P = 0.08$) and SH inclusion ($P < 0.01$) in the diets. Apparent digestibility of organic matter decreased as fine AH ($P < 0.05$) was added to the diets, but coarse particles of AH increased ($P < 0.05$) and SH tended to decreased fiber digestion ($P = 0.06$) of diets. Milk production was increased by feeding diets containing SH ($P = 0.04$) but was not affected by AH particle size. Addition of SH reduced milk fat content ($P < 0.01$) but coarse particle of AH increased milk fat content ($P < 0.03$). Cows fed coarse AH tended to spend more time chewing ($P = 0.08$). Coarse particles of AH increased total chewing activity ($P < 0.05$) and also tended to increased eating activity ($P = 0.09$). When chewing activity was expressed based on NDF intake, ruminating time and total chewing time tended to be increased by coarse AH ($P < 0.1$). Interestingly when chewing activity was reported based on peNDF intake, the SH inclusion in the diets decreased eating time ($P < 0.02$), total chewing time ($P < 0.03$) and decreased trend for ruminating time ($P = 0.08$). The inclusion of SH in the diets decreased fecal pH value ($P < 0.05$). Coarse particles of AH in the diets containing SH resulted in increasing of fecal cumulative DM > 4 mm, 0.43 mm and 0.3 mm. In conclusion although supplementation of diets contained SH with coarse AH to some extent interacted with SH and improved milk fat yield and chewing activity, this interaction resulted in decrease of eating and total chewing activities, decreased in fecal pH and probably passing more DM to lower tract.

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1. Introduction

Soybean hull (SH) is currently considered as a suitable replacement of the forages especially for early lactating dairy

cows. Soy hulls may include up to 42% of the diet dry matter in lactating dairy cows as a replacement for forages (Weidner and Grant, 1994b). Low replacement of SH for forage (14.5% of diet DM) in the diets of early lactating dairy cows showed higher dry matter intake, higher milk production and retained more energy in dairy cows received diets containing SH compared to control group (Miron et al., 2010).

Due to the fact that SH fiber is highly digestible, it is not a good source of effective fiber. It has been reported that substitution of AH with SH resulted in reduced milk fat content, rumination

Abbreviations: peNDF, physically effective fiber; pef, physically effective factor; PSPS, Penn State Particle Separator; NFF, non forage fiber; AH, alfalfa hay; PS, particle size; SH, soy hull; NDF, neutral detergent fiber.

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process (Weidner and Grant, 1994b) and reduced ruminal mat consistency (Weidner and Grant, 1994a). NRC (2001) considers that the averages of the NDF value of non forage fibers sources (NFFS) are 50% of the NDF value of forages. This means that using SH as a replacement for forages can compromise the effectiveness of fiber in the diets. However, the addition of long hay to diets that contained SH can interact with SH to increase milk fat, decrease the passage rate of the byproduct, increase rumination activity, and increase ruminal extent of digestion (Weidner and Grant, 1994a, 1994b). As long as effective fiber is adequate in a ration, SH can be an important source of both energy and fiber in rations for high producing early lactating dairy cows. Generally utilization of hay with long particle size (PS) in ruminant diets increases the physically effective NDF (peNDF) contents (Teimouri Yansari et al., 2004; Yang and Beauchemin, 2005), resulted in increasing chewing activity, rumen pH (Beauchemin et al., 2003), as well as improving total tract nutrient digestibility (Yang and Beauchemin, 2005).

Previous studies have focused on SH as a replacement for forage or grain, however very little research has investigated the effect of particle size or peNDF content of diets on the utilization of SH by dairy cows. Weidner and Grant (1994b) demonstrated that replaced SH for AH up to 25% or 42% of diet DM and showed that arithmetic and geometric means of diet particles were decreased. Calculating of peNDF based on the tabular values of DM > 1.18 and NDF of the diets in this study reveals that inclusion of SH decreased peNDF contents of control diet from 21.0% to 16.5% in SH containing diets and also reduced total chewing activity by 30%. In another study Slater et al. (2000) showed the replacement of a portion of alfalfa silage and corn silage with SH and cotton seed hull decreased the mean PS of diets fed to dairy cows and decreased chewing activity. Therefore the main objectives of the present study was to evaluate the impact of PS of AH on the utilization of SH, nutrients intake and digestion, milk production and composition, chewing activity and fecal PS distribution of early lactating dairy cows.

2. Material and methods

2.1. Animals, diets and treatments

Eight lactating Holstein cows with the initial average body weight of 590 ± 33 kg and 47 ± 13 days in milk (DIM) were housed in individual tie stalls and milked three times daily at 0600, 1400 and 2200 h. Cows were fed a TMR twice daily at 0800 and 1600 h for ad-libitum consumption. The experimental design was a replicated 4×4 Latin square with four periods and a 2×2 factorial arrangement of treatments: alfalfa hay PS (fine vs. coarse) combined with SH content (zero or substituted as 50% of AH). The diet was formulated according to NRC (2001) recommendation to supply adequate metabolizable energy and protein for a 650 kg cow producing 45 kg/d of milk (Table 1). The basal diet contained 60% barley and maize based concentrate and 40% forage. In the basal diet 63% and in diets containing SH 47% of diet NDF was from the forage. Differences in average PS and the pef of the diets were created by changing of AH and SH substitution for AH. Alfalfa hay was chopped by using a small chopper fitted with 5 mm and 20 mm sieves (theatrical PS) to obtain hay with fine and coarse PS. Each

Table 1

Ingredients and chemical composition of the total mixed diets (DM basis).

Ingredients, %	Diets			
	AH		AH + SH	
	fine	coarse	fine	coarse
Alfalfa hay	20.01	20.01	10	10
Soy hull	-	-	10	10
Corn silage	20.01	20.01	20	20
Barley grain	14.01	14.01	13.99	13.99
Corn grain	14.01	14.01	13.99	13.99
Soybean meal	18.99	18.99	17.52	17.52
Sugar beet pulp	4.99	4.99	6.52	6.52
Wheat bran	4.99	4.99	4.98	4.98
Protected fat ¹	2.00	2.00	2.00	2.00
Calcium carbonate	0.30	0.30	0.30	0.30
Salt	0.19	0.19	0.19	0.19
Vitamin and mineral premix	0.50	0.50	0.50	0.50
Chemical, % of DM				
DM	59.56	60.56	59.02	59.78
OM	92.65	92.65	92.50	92.50
CP	17.10	17.10	17.10	17.10
NDF	31.30	31.30	32.30	32.30
NDF from forage	19.80	19.80	15.30	15.30
NEL ² , Mcal/kg	1.53	1.53	1.57	1.57

AH: alfalfa hay, SH: soy hull, SE: standard error of means.

1. Energizer RP-10. IFFCO, Malaysia SDN. BHD. Company No 485777-W. PLO 406-Jalan Emas, 81700 Pasir Gudang, Johor Malaysia. 2. Estimated based on NRC (2001).

experimental period consisted of a 14 d adaptation and 5 d data collection including measurement of diets PS distribution, feed intake, milk production, nutrient digestibility and fecal particles distribution.

2.2. Feed intake and milk production

Feed intake and milk production of the experimental cows was recorded daily during the last 5 days of each period. Feed and ort were sampled daily and mixed weekly for DM determination and ground through 2 mm screen (Retsch Cutting Mill Retschmule) for subsequent analysis. Dry mater of samples was determined by oven drying at 55 °C for 48 h. All samples were analyzed in duplicate for kjeldahl nitrogen (by using of kjeltel auto 1300), ether extract, and OM (AOAC, 1998). Neutral detergent fiber (NDF) was determined according to Van Soest et al. (1991) without amylase application. Composite three milking daily were collected twice in last five days of each period (days 16 and 19) and analyzed for fat, protein, lactose and solid not fat (SNF) content using infrared analyzer (Milk Analyzer™, Astori, Italy).

2.3. Particle size distribution, chewing activity, rumen sampling and digestion

The Penn State Particle Separator (PSPS) was used to measure PS distribution of fiber sources (i.e. SH, AH and maize silage) and the diets as described by Kononoff et al. (2003). Physically effective NDF was estimated by multiplying the NDF concentration on each sieve (19.0, 8.0 and 1.18 mm) by the amount of DM retained on the same sieves (Yang and Beauchemin, 2006). Percent of DM retained on each sieve,

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