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Effects of a potato pulp silage supplement on the composition of milk fatty acids when fed to grazing dairy cows

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ABSTRACT

This study was completed to determine the effects of potato pulp silage (PPS) as a diet supplement on the composition of milk fatty acids in grazing dairy cows in comparison to a barley grain supplement. Eight late lactation Holstein dairy cows were fed grazing based diets supplemented with 150 g/kg of PPS ('PPS') as a substitute for barley ('barley'), and grazed on 4.3 ha swards, mainly containing orchard grass, for 56 days. Total dry matter (DM) and pasture DM intake and milk yields, as well as milk composition, did not differ between treatments. The linolenic acid intake did not differ (329 g/day *vs.* 323 g/day DM). The *trans*11C18:1vaccenic acid (VA) concentration in blood was higher in cows fed PPS (2.4 g/100 g FA) compared to those fed barley (1.9 g/100 g FA). There were no differences between treatments in the *cis*9*trans*11conjugated linoleic acid (CLA) concentration in blood. The short-chain and medium-chain fatty acids in milk also did not differ between treatments. The VA concentration in milk was increased in cows fed PPS (2.32 g/100 g FA) compared to those fed barley (1.84 g/100 g FA), and CLA was higher in cows fed PPS (1.25 g/100 g FA) than those fed barley (0.95 g/100 g FA). Milk CLA concentration was positively correlated to blood VA concentration. Results suggest that an increase

Abbreviations: CLA, conjugated linoleic acid; FA, fatty acid; VA, *trans*11C18:1vaccenic acid; c, *cis*; t, *trans*; C18:2, linoleic acid; C18:3, linolenic acid; BH, biohydrogenation; PPS, potato pulp silage; DM, dry matter; PPS, potato pulp silage; DIM, days in milk; BW, body weight; MY, milk yield; TMR, total mixed ration.

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in milk CLA concentration is related to an increase of the VA concentration in blood by Δ^9-desaturase in mammary glands in the PPS fed compared to barley fed groups.

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1. Introduction

In recent years there has been extensive research on potential benefits of consumption of conjugated linoleic acid (CLA) on human health. CLA is a mixture of positional and geometric isomers of linoleic acid with conjugated double bonds, which are unique components of ruminant lipids that have beneficial effects on human health. They include anti-carcinogenic, anti-oxidative and anti-atherogenic effects, as well as stimulation of the immune system (Pariza, 1999). The major dietary source of CLA from ruminant dairy products is the isomer *cis*9(c9)*trans*11(t11) octadecadienoic acid in milk fat (Erin et al., 2006). This isomer is produced by two pathways, one of which is in the rumen, as an intermediate during biohydrogenation (BH) of linoleic acid (C18:2) by bacteria, and the other is during rumen BH of linolenic acid (C18:3) in which *trans*11C18:1vaccenic acid (VA) is formed, thereafter c9t11CLA is formed in the mammary gland by desaturation of Δ^9-desaturase from VA (Bauman et al., 2000). The major portion of c9t11CLA, that is 0.64–0.80 of milk fat is produced in the mammary glands by Δ^9-desaturase from VA (Griinari et al., 2000; Kay et al., 2004).

Increasing dry matter (DM) intake of supplemental feeds, and decreasing pasture DM intake, resulted in a decrease in the CLA content of milk (Bargo et al., 2006a). Bargo et al. (2006b) also reported that the CLA content in milk was lower in cows fed supplements under the same grazing conditions because of the high intake of C18:3 from pasture, which is biohydrogenated to VA, and transported to the mammary gland. However, Kolver and Muller (1998) reported that cows fed pasture-based diet had lower body condition score and body weight (BW) than cows fed total mixed rations because the pasture contained a high crude protein (CP) and low carbohydrate content which resulted in a poor protein/energy balance, with the result being a reduction in DM intake. Starch based concentrates improved the protein/energy balance, rumen fermentation and increased rumen microbial protein synthesis (Bargo et al., 2003). Therefore, supplements that contain fermentable carbohydrates are required under grazing condition.

Another method of increasing the CLA content of milk fat is to change rumen conditions and decrease BH from unsaturated fatty acids to C18:0, and increase VA flow to duodenum when cows are grazing. The rumen bacteria that biohydrogenate unsaturated fatty acids to VA include *Butyrivibrio fibrisolvens*, which is very sensitive to acidic condition. The highest production of VA and CLA by BH occurs when rumen pH is above 6.0 (Martin and Jenkins, 2002). Moreover, Monteils et al. (2002) reported that ruminal pH is more variable for supplemented wheat grain than potato starch in grass silage-based diets. Okine et al. (2005) reported that high quality potato pulp silage (PPS) had a lower pH, and higher lactic acid content, when made from fresh starch extracted potato pulp without additives. As the nutritional value of PPS was similar to beet pulp, it could be a useful feed for ruminants. There was no difference in milk production between grazing lactating dairy cows supplemented with either PPS or corn grain (Hanada et al., 2005). Nocek and Tamminga (1991) reported that passage of starch to the duodenum decreased when barley grain was used as a substitute to corn grain in the diet, because corn starch was less degraded than barley starch in the rumen. Since barley starch is degraded faster than PPS by rumen microorganism, it might have an effect on the ruminal environment and microbial population relative to formation of VA and CLA, and so influence the fatty acids composition of the cow's milk fat.

The aim of this study was to investigate effects of a PPS supplement in comparison to a barley grain supplement on the fatty acid profile of milk fat, and CLA, when fed to lactating grazing dairy cows.

2. Materials and methods

2.1. Experimental design

This study was completed at the Field Center of Animal Science and Agriculture of the Obihiro University of Agriculture and Veterinary Medicine, Hokkaido (Japan), from August 2006 to October

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