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Effects of feeding lasalocid on fatty acid profile of holstein dairy cows

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Abstract

This study was conducted to investigate the efficacy of Lasalocid on milk fatty acid profile in Holstein dairy cows. For this study 12 cows with initial weight 625 ± 48 kg were allocated to control group and Lasalocid group, with 6 replication in each group using completely randomized design (CRD). The experiment was accomplished during 21 days including pre trial period (14d) and feedlot period (7d). Diet was given twice daily to each group. The conjugated linoleic acid content of diets with Lasalocid was higher than other and there were significant differences ($P < 0.05$).

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Introduction

The rumen is inhabited by bacteria, protozoa and fungi, but bacteria play a dominant role in all facets of ruminal fermentation (Hungate, 1966). Gram-positive bacteria produce more ammonia, hydrogen, and lactate than Gram-negative species, and compounds that inhibit Gram-positive ruminal bacteria have increased feed efficiency (Russell and Strobel, 1989). In the 1970's, the Food and Drug Administration approved Lasalocid as a feed additive for beef cattle, and this antibiotic is primarily effective against Gram-positive bacteria (Russell and Strobel, 1989). When Lasalocid (an ionophore) reaches the cell membrane, there is an electro-neutral exchange of protons for monovalent cations, intracellular potassium declines, sodium accumulates, and the cells are de-energized.

The carboxylic ionophores, lasalocid and monensin, are widely used in growing and finishing beef cattle diets to increase feed efficiency and(or) weight gain. Ionophores function by forming lipid-soluble complexes with certain cations and facilitating their transport across cell membranes (Pressman and Fahim, 1982).

Lasalocid, an ionophore similar to monensin, has been used to improve weight gain and feed efficiency of ruminants (Bergen and Bates, 1984; Van Nevel and Demeyer, 1988). Part of the ionophore effect is a result of decreased methane and increased propionate in ruminal fermentation (Bergen and Bates, 1984; Russell and Strobel, 1989). Propionate is converted to glucose after absorption, and thus is an important glucogenic precursor for ruminants (Wiltrout and Satter, 1972). Glucogenic amino acids are also precursors for glucose. Therefore, increasing propionate could potentially spare glucogenic amino acids.

Conjugated linoleic acid (CLA) is a term representing a mixture of positional and geometric isomers of octadecadienoic acid with a conjugated double bond system. Conjugated linoleic acid has been shown to possess a number of health benefits based on biomedical studies across a variety of animal models. These include anticarcinogenic, anti-atherogenic, anti-obesity, anti-diabetic and immune system enhancement (McGuire, 2000, Belury, 2002). Conjugated linoleic acid originates from either incomplete biohydrogenation of linoleic or linolenic acid to stearic acid in the rumen (Fellner *et al.,* 1995) or from endogenous synthesis in the mammary gland or adipose tissue. Endogenously, cis-9, trans-11 CLA (the primary isomer found in milk) is synthesized from trans vaccenic acid, another intermediate of ruminal biohydrogenation, via Δ9-desaturase in tissues (Corl *et al.,* 2001). The CLA content of milk and meat is affected by several factors including the animals breed, age, and diet.

Ionophores disrupt ruminal biohydrogenation similar to unsaturated fat supplements. Higher concentrations of linoleic acid, trans C18:1, and CLA were maintained in continuous cultures of ruminal bacteria following infusion of monensin, nigericin, or tetronasin (Fellner *et al.,* 1997). Feeding monensin had similar effects on enhancing linoleic acid and trans FA in milk of lactating cows, and also caused a reduction in milk fat percentage (Sauer *et al.,* 1998). According to Van Nevel and Demeyer (1995), ionophores and other antimicrobials act primarily to inhibit lipolysis, thus reducing the formation of a free carboxyl group that is a requirement for subsequent hydrogenation of double bonds. This study investigated the effects of Lasalocid on milk fatty acid profile in Holstein dairy cows.

Materials and methods

Animals and feeding

Twelve lactating Holstein dairy cows (625 ± 48 kg of BW) housed in a tie-stall facility at the Parsabad Moghan, were used in the study. The cows were milked in their stalls twice daily at 0800 and 1800 h. All cows were fed an identical TMR (Table 1) formulated to meet or exceed nutrient requirements (NRC, 2001). Experimental period was 28 days, includes 7 day adaptation period, 14 days before and 7 days sampling period. During the sampling period, samples were taken from milk of dairy cows. And obtained samples transported to the laboratory to determination of fatty acid profile and CLA.

Calculations and statistical analysis

Data were analyzed as a completely randomized design using a general linear model (GLM) procedure of SAS (1999), with Duncan's multiple range test used for the comparison of means.

Results and discussion

The results of the fatty acid profile of milk were shown in Table 2. Fatty acids used in this study, including fatty acids, 10, 12, 13, 16, 18 carbons and conjugated linoleic acid (CLA), respectively. The obtained data showed that the untreated ration (without Lasalocid) have higher C13 and C18 profiles ($P<0.05$). Whereas Lasalocid treating showed highest CLA composition ($P< 0.05$).

Short- and medium-chain fatty acids arise almost exclusively from the de novo synthesis using circulating acetate and butyrate originating from the rumen, whereas long-chain fatty acids are derived from the uptake of circulating lipids. Palmitic acid (C16:0) originates from both the de novo synthesis and uptake from circulating lipids (Mansbridge and Blake, 1997). In the current study, lower concentrations of short-chain fatty acids in milk fat might, in part, be due to a reduction in ruminal production and supply of acetate and butyrate, as reported previously (Van der Werf *et al.,* 1998; Martineau *et al.,* 2007). The increased proportion of trans-10, cis-12 CLA with Lasalocid supplementation might also have been involved in decreasing the de novo synthesis of the short-chain fatty acids in mammary gland (Baumgard *et al.,* 2000). It is generally accepted that ionophores, such as Lasalocid, are partially effective in inhibiting the biohydrogenation of linoleic acid, thus reducing the rate of stearic acid production (Fellner *et al.,* 1997).

Fatty acids in milk arise from two sources; uptake from circulation and the de novo synthesis within the mammary epithelial cells (Neville and Picciano, 1997).

Table 1. Ingredients and chemical composition (DM basis) of the basal diet.

Alfalfa	20
Corn silage	17
Barley	29
Cotton seed meal	6
Soybean meal	13
Wheat bran	6
Fish meal	3.5
Fat	2.5
Mineral and vitamin mixture	1.5
Salt	0.5
$CaCO_3$	1
NEL	1.58
CP	18

Table 2. The fatty acids in milk.

Ration	Fatty acids (grams per 100 grams of fatty acids)					
	C_{10}	C_{12}	C_{13}	C_{16}	C_{18}	CLA
without Lasalocid	1.52	2.6	5.73[a]	16.29[b]	14.27[a]	1.07[b]
with Lasalocid	1.44	2.61	3.81[b]	18.79[a]	13.54[b]	1.23[a]
SEM	0.0311	0.0434	0.0727	0.0736	0.0883	0.0115

Increasing dietary concentrations of unsaturated fatty acids decreases milk C14:0 and C16:0 levels (Palmquist *et al.,* 1993). Increasing specific unsaturated fatty acids such as conjugated linoleic acid (CLA), linoleic acid (C18:2) and linolenic acid (C18:3) in milk would increase consumer interest and acceptance of milk due to the health benefits associated with these fatty acids (Ramaswamy *et al.,* 2001). The fatty acid content of the lactating cow diet affects the type and the proportion of the fatty acids in the milk fat (Grummer, 1991). Conjugated linoleic acid is an intermediate product of biohydrogenation of linoleic acid by the rumen bacterium, Butyrivibrio fibrosolvens (Harfoot and Hazelwood, 1988).

Conclusion

Lasalocid increased the ratio of unsaturated to saturated fatty acids in milk fat. Therefore, Lasalocid can be considered as an effective inhibitor of biohydrogenation of unsaturated fatty acids in the rumen, and consequently as a tool for increasing the supply of unsaturated fatty acids to the mammary gland for milk fat synthesis, thus enhancing the nutritional properties of the milk in terms of human health.

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