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Effect of dietary fat quality on $C_{18:1}$ fatty acids and conjugated linoleic acid production: An *in vitro* rumen fermentation study

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Abstract

Samples of three diets, previously tested with lactating dairy cows, were incubated *in vitro* with rumen fluid with the aim of monitoring the concentration of *cis* and *trans* $C_{18:1}$ fatty acids and of the isomers of conjugated linoleic acid with fermentation time.

The three diets had a common forage basis (lucerne hay and maize silage), but different fat sources in the concentrate (basically made up of maize meal and soybean meal). The control diet (diet C) had no fat added and the other two diets were supplemented either with a calcium salt of olive oil (diet O) or with extruded full fat soybean (diet S). The fatty acid pattern in the fermentation vessels was affected by the kind of dietary fat in the samples, both in terms of concentration and of fermentation times (12, 24, 36, 48 h).

Oleic acid (OA), elaidic acid and conjugated linoleic acid (CLA) isomers were particularly looked at. OA was not completely saturated to stearic acid, but isomerized to other acids of the $C_{18:1}$ family as well. Vaccenic acid was increased with all the three diets, especially with diet O after 36 h. CLA resulted increased with diet S only ($P<0.05$), with significant differences between isomers. The saponification of olive oil appeared to be a partial protection against rumen biohydrogenation. The possibility of

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affecting the concentration of intermediate acids of the biohydrogenation pathways by dietary means was confirmed.

Keywords: Artificial rumen; Biohydrogenation; Fatty acids; Conjugated linoleic acid

1. Introduction

The fate of dietary unsaturated fatty acids (UFA) in the rumen is biohydrogenation. Rumen microbes play an essential role in the production of intermediate UFA metabolites like CLA isomers or vaccenic acid (VA, $C_{18:1}$ *trans* 11), which are then transferred to the mammary gland and to other tissues (Jenkins, 1993). In fact, milk and meat of ruminants are richer in CLA than those of not ruminant animals. Hence, there must be a strong correlation between rumen microbial metabolism and CLA released in the end products (Chin et al., 1992). Actually, CLA is a pool of geometrical and positional isomers of linoleic acid (LA) with two conjugated double bonds located from carbon 7 and carbon 13 (Bessa et al., 2000). The biologically most active CLA isomer is rumenic acid (RA), the *cis* 9 *trans* 11 isomer, synthesized in the rumen by isomerization of LA and by Δ^9 desaturation of VA in the mammary gland (Griinari and Bauman, 1999; Kramer et al., 1999). RA is accounted for about 90% of total CLA in milk fat from cows fed current diets (Bauman and Griinari, 2001). In the literature there are many references about the influence of the diet on CLA content in milk fat as the consequence of different profiles of *trans* C18:1 and CLA produced during rumen fermentation. Since some CLA and *trans* C18:1 isomers affect mammary gland lipid metabolism (Bauman and Griinari, 2001), the studies on rumen biohydrogenation processes may be used to better know the feeding conditions that lead to different CLA and *trans* C18:1 fatty acids patterns.

Also the kind of unsaturated lipid supplements could affect the processes of biohydrogenation and, consequently, the final products. It is well known that LA leads to accumulation of CLA and *trans* C18:1 in the rumen, but recently oleic acid (OA) also has been proposed as a rumen precursor of *trans* C18:1 isomers. Selner and Schultz (1980) observed an increase of $C_{18:1}$ *trans* acids in milk fat from cows fed diets rich in OA and Mosley et al. (2002) showed that it could be attributed to the isomerization of OA in the rumen.

In vitro rumen fermentors, as the one used in the present work may be looked at as reliable laboratory tools to study the metabolic pathways of rumen microbes, with reference to the different quality of diets (Beam et al., 2000). The quality and quantity of some metabolic intermediate acids which are formed in the rumen, such as RA or *trans* isomers are critical and consistent with yield and quality of milk fat and meat fat.

In a previous trial, three diets formulated for dairy cows and supplemented with different fats of vegetable origin were compared (Secchiari et al., 2003). Two of these diets showed interesting results because they promoted CLA isomers and improved the polyunsaturated fatty acid (PUFA) profile of milk while meeting the cows requirements.

Aim of present work was monitoring the evolution of concentration of C18:1 fatty acids and CLA isomers during *in vitro* rumen fermentation of samples of these diets in order to