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Influence of different dietary forages on the fatty acid composition of rumen digesta as well as ruminant meat and milk☆

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Abstract

We review literature on effects of dietary forages on milk and tissue fatty acid composition of cattle and sheep, with particular emphasis on changes induced by leguminous and biodiverse forages *versus* intensive ryegrass. Differences are discussed in relation to changes in rumen or duodenal digesta to explain the origin of the differences as, in most cases, increased omega-3 PUFA (*i.e.*, linolenic acid and/or long chain omega-3 PUFA) in milk and intramuscular fat due to feeding of red or white clover and botanically diverse forages could not be attributed to increased dietary supply of linolenic acid (C18:3 n-3). Hence, increased forestomach outflow of C18:3 n-3 has been suggested to originate from reduced rumen lipolysis, with literature providing some evidence for the role of polyphenoloxidase, which is particular active in red clover, to inhibit rumen lipolysis. Increased proportions of CLA c9t11 in milk and intramuscular fat of ruminants fed botanically diverse forages have been associated with increased forestomach outflow of vaccenic acid (C18:1 t11), which is the

Abbreviations: CLA, conjugated linoleic acid; FA, fatty acids; IM, intramuscular; PPO, polyphenol oxidase; PUFA, polyunsaturated fatty acids

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main precursor of endogenous CLA c9t11 production. Despite the lack of direct evidence, some plant secondary metabolites, present in herbs of botanically diverse forages, are suggested to be potential modifiers of rumen biohydrogenation based on their effects on rumen methanogenesis.

Keywords: Biohydrogenation; Botanically diverse forages; Fatty acids; Plant metabolites

1. Introduction

Feeding forages to ruminants increases the n-3 polyunsaturated fatty acid (PUFA) content in milk and meat (Dewhurst et al., 2003c, 2006) as they are natural rich sources of C18:3 n-3. In this respect, it is not surprising that milk from organic farming systems, characterized by high dietary forage proportions, have higher proportions of PUFA and particularly n-3 fatty acids (FA), *versus* 'conventional' milk (Ellis et al., 2006; Fievez and Vlaeminck, 2006). Moreover, clover, which has the potential to improve the milk FA profile in terms of human nutritional recommendations (*e.g.*, Dewhurst et al., 2003b), is extensively fed in these systems. Other studies have suggest animal products from systems using more botanically diverse forages to have a healthier FA profile for humans, with a higher PUFA content (*e.g.*, Collomb et al., 2002a; Ådnøy et al., 2005; Dewhurst et al., 2006) *versus* grass based systems. However, a review of these studies aiming at quantifying and describing the general trends is lacking. In this review, all known studies are integrated in an overall statistical analysis to describe these general trends. We further aimed to discuss inter-experiment differences relative to differences in the botanical composition of the forages. Finally, literature reporting rumen and/or duodenal digesta is used to explain differences observed in the milk and meat FA profile, and to speculate on the origin of the observed changes.

2. Effect of botanical composition of dietary forage on milk fatty acid profile

2.1. Data and statistical analysis

In order to quantitatively describe overall trends in dairy cattle studies on effects of type and diversity of forages on milk FA profile, three data sets were created, being: (1) studies reporting red clover *versus* ryegrass based diets; (2) studies reporting white *versus* red clover forages; (3) studies reporting botanically diverse *versus* grass based diets. Four studies described effects of feeding red clover *versus* ryegrass silages (Dewhurst et al., 2003b; Al-Mabruk et al., 2004; Van Dorland, 2006; Vanhatalo et al., 2006). From these four studies, only those reporting individual FA were used for statistical analysis (Table 1). Three studies compared the milk FA profile of dairy cattle fed red and white clover forages (Dewhurst et al., 2003b; Steinshamn et al., 2006; Van Dorland, 2006), and eight studies reported effects of feeding botanically diverse forages on the milk FA profile (Bugaud et al., 2001; Collomb et al., 2002a,b; Ferlay et al., 2006; Innocente et al., 2002; Kraft et al., 2003; Leiber et al., 2005; Lourenço et al., 2005b; Žan et al., 2006). From these eight studies, only five were retained for statistical analysis (Table 1) based to the criteria of: milk