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Response of lactating dairy ruminant to different profiles of dietary calcium soaps of fatty acids

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ABSTRACT

Nutrition has a significant effect on reproduction and lactation in Ruminant. Supply of require nutrient of dairy cows and ewes in early lactation is the main challenges that will be considered, since in most cases the animals facing negative energy balance after calving and the beginning of the period of lactation. Negative energy balance may sometimes result in reduced livestock production and metabolic diseases and thus negatively affected the growth of lambs and calves. The use of energy-rich diets, especially during the rearing period lactation can help to solve this problem. Studies showed that fat supplementation has positive effects on dairy cattle during a 120-day lactation period. Milk fat yield increased linearly during the nursing period, but not in the rest of lactation, with increased CSFA feeding. The absence of a positive response in milk fat yield during the milking period, even with high levels of CSFA in the diet, indicates a decrease in transfer of fat from CSFA to milk as lactation advanced, which is quantified by the lower relative milk fat yield response with high CSFA levels at the end of lactation.

Key words: Calcium**,** Fatty acids, Ruminant

INTRODUCTION

In most studies, the rations compositions and the animals characteristics (live weight and weight variation), only slightly indicated, do not make it possible to calculate the animals energy balance on a sufficient number of tests. A particular aspect of ruminant milk fat is the abundance of

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saturated fatty acids (SFA) arising from the ruminal bio hydrogenation of polyunsaturated fatty acids. One of the purposes of the incorporation of rumen resistant fat in the dairy animal diets is to handle the milk fatty acids profile in order to: (i) obtain a milk fatty acid composition that is more recommendable for human health by increasing the content of unsaturated fatty acids (UFA); (ii) make a product that better answers the technological, nutritional and organoleptic criteria (Ney, 1991; Schmidely and Sauvant, 2001). The CSFA, which is resistant to degradation in the rumen, represents an efficient means to modify the nature and the relative concentration of fatty acids of milk fat.

Calcium salt of fatty acids (CSFA)

Due to the high melting point of calcium salts and especial pH range for decomposition, are not affected from rumen. Because the CSFA at pH = 6.5-7 is neutral and will not be affected, so in sub-optimal rumen pH (pH = 6.5-6.8) (not 100%) through the rumen, finally in last part of abomasum and at the end of the beginning of the duodenum (beginning of the small intestine) with pH = 3.5 are fully opened and the fat cells are available for absorption.

BACKGROUND

There are numerous studies showing that it is possible to manipulate the fatty acid composition of milk by feeding protected unsaturated fats and oils. There is considerable interest in this work in relation to the production of milk with a higher unsaturated to saturated fat ratio to benefit human health. High yielding dairy cows during early lactation are often in negative balance because of insufficient feed intake to meet energy requirements. Under this condition animals have to draw upon their body reserves to support the milk production, often resulting in metabolic disorders and sub optimal milk yield (Kronfeld, 1982). Maximizing energy intake by increasing the energy density of the diet is a logical feeding strategy for early lactating cows. Excessive grain feeding increases energy density of the diet but rapid fermentation can lead to a suboptimal rumen environment and acidosis (Radostits et al., 2000) and decline in the concentration of milk fat. Fat supplementation also increases energy density of the diet, but high dietary fat can lead to a reduction in fiber digestion in the rumen and a decline in milk fat percentage, depending on the amount and type of fat fed (Palmquist and Jenkins, 1980). In order to counter affect these undesirable effects, dietary supplementation of fat as a salt of long chain fatty acids is a good alternative (Chalupa et al., 1984). Saturated and unsaturated long chain fatty acids have less effect on rumen fermentation when supplemented as calcium salt than as free fatty acids (Chalupa et al., 1985). Moreover, prevention of bio hydrogenation of polyunsaturated essential fatty acids in the rumen subsequently increases their absorption from the small intestine potentially increasing the supply of polyunsaturated fatty acids to the mammary gland. Such milk will be beneficial to those milk consumers who have heart problems (Maynard et al., 1979; Upritchard et al., 2005).

Origins of milk fatty acid

Shorter-chain fatty acids (C4:0 – C14:0 and half of the C16:0) in milk originate by de novo synthesis in the mammary gland from circulating acetate and b-hydroxybutyrate (Mansbridge and Blake, 1997). Acetate and butyrate are produced in the rumen during microbial fermentation of cellulose, hemicellulose and sugars, and butyrate is converted to b-hydroxybutyrate in the rumen wall. Longer-chain fatty acids (half of the C16:0 and C18 – C24) in milk are absorbed from the bloodstream. They originate mainly from dietary fatty acids that have undergone bio hydrogenation in the rumen to protect rumen microorganisms from the deleterious effects of Unsaturated fatty acids (Garnsworthy, 1997). Some longer-chain fatty acids (C16:0, C18:0 and C18:1) are synthesized in adipose tissue and appear in milk following body fat mobilization (Salter et al. 2002). A proportion of longer-chain saturated fatty acids, particularly C18:0 are converted to mono-unsaturated fatty acids by the Δ9-desaturase enzyme within the mammary gland (Jensen, 2002). This enzyme is also responsible for converting vaccenic acid (t11-C18:1) to conjugated linoleic acid (CLA; c9,t11-C18:2) (Bauman et al., 2001). The normal change in milk factors during lactation period in dairy cattle is show in Figure 1.

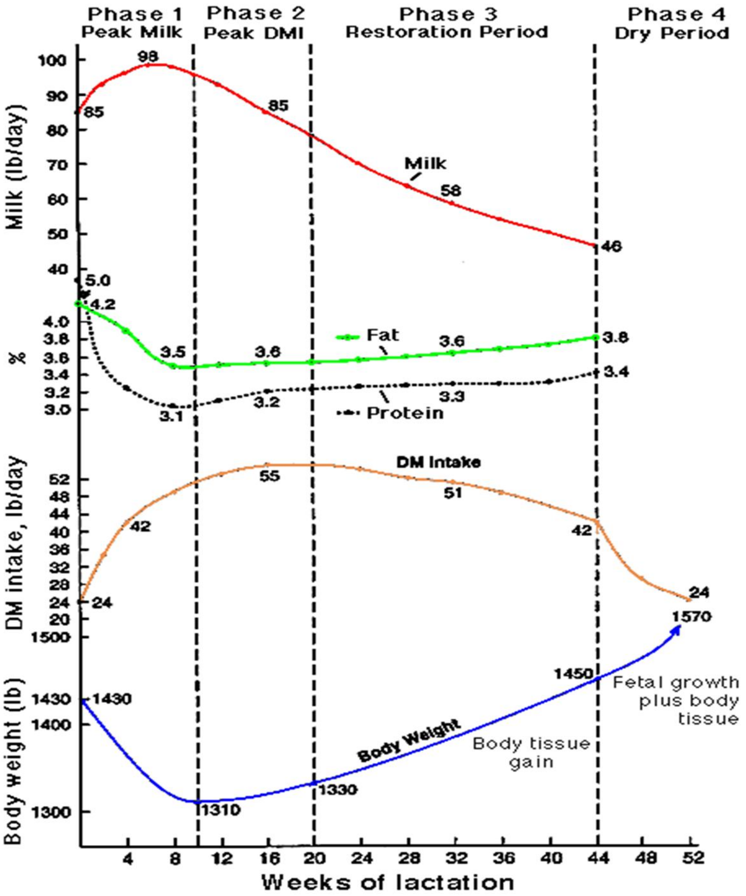

Fig1.variations of milk factors in dairy cattle during one lactation period

Dietary factors affecting milk fatty acids

In general, factors that influence volatile fatty acid concentrations in the rumen affect fatty acid synthesis in the mammary gland through the availability of precursors. Therefore, milk fat concentration varies directly with the forage to concentrate ratio or the fiber content of the diet (Sutton, 1985). However, it is also suggested that synthesis of short-chain fatty acids can be inhibited by diets with high proportions of starchy concentrates or long-chain fatty acids (Thomas and Martin, 1988; Beaulieu and Palmquist, 1995). High starch, low fiber diets result in milk with a low fat content, which has characteristic increases in trans fatty acids, especially t10-C18:1 and t10,c12 CLA (Griinari and Bauman, 2003). Relation between intake CSFA and fat yield response in dairy ewes show in figure 2.

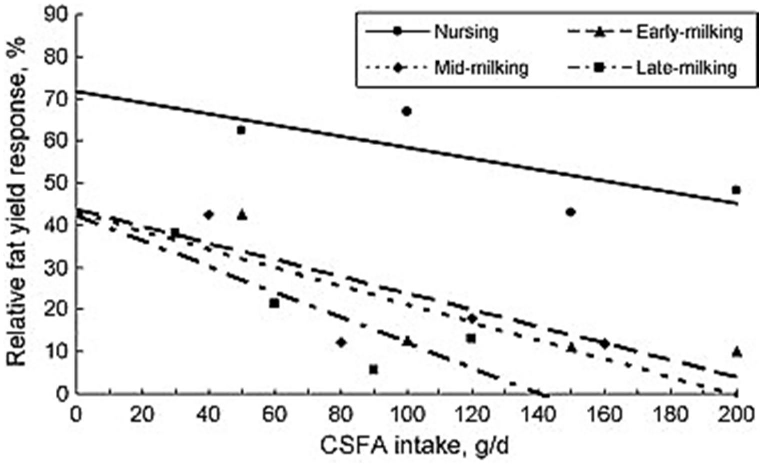

Fig2. Relation between intake CSFA and fat yield response in dairy ewes

Animal factors affecting milk fatty acids

Ruminant adipose tissue is rich in C16:0, C18:0 and C18:1, large proportions of which are synthesized de novo (Salter et al. 2002). The primary product of fatty acid synthesis is C16:0, which is synthesized from acetyl-coA by acetyl-coA carboxylase and fatty acid synthetize. In adipose tissue, but not mammary tissue, C16:0 may be further elongated by elongate to produce C18:0; mammary tissue lacks the elongate enzyme which catalysis this reaction. In both tissues, a double bond may then be inserted to form c9-C18:1. This last step is catalyzed by D9-desaturase, which appears to be rate limiting in the production of c9-C18:1 in adipose tissue (Ntambi, 1995)

CONCLUSIONS

Lactation curves, in yield and milk composition, are mainly conditioned by several factors including breed, stage of lactation, milking system and feeding in sheep (Flamant and Morand-Fehr, 1982; Treacher, 1983, 1989; Bocquier and Caja, 1993), as well as in other dairy ruminants.

Moreover it must be remembered that milk yield and milk composition (fat, protein, casein and serum proteins, but not lactose) are negatively correlated in sheep (Barillet and Flamant, 1977; Barillet and Boichard, 1987; Molina and Gallego, 1994; Fuertes et al., 1998), as in other dairy species, indicating the necessity to find an equilibrium between practices that will increase milk yield and will reduce its content. This appears in most cases as a result of an improved management, selection and nutrition. As a consequence, the financial income will result from both the unitary price of milk and its quality. Supplementing ration of lactating animals with protected fat enhanced the energy intake in early lactation which reduced the deleterious effect of acute NEB on lactation (Ganjkhanlou et al., 2009; Tyagi et al., 2010). Feeding of rumen protected fat and protein to lactating cows and buffaloes increased milk yield and milk composition (Chen et al., 2002; Garg et al., 2003; White et al., 2004; Thakur and Shelke, 2010; Mansoori et al., 2011). Formaldehyde treatment has proved to be an efficient and cheaper method for protecting highly degradable protein sources in rumen (Chaturvedi and Walli, 2001). It is now recognized that polyunsaturated fatty acids are essential for normal growth, and important for brain and vision development and immunity in infants; these fatty acids may also play a vital role in prevention and treatment of cardiovascular diseases in adults (Williams, 2000; Nordoy et al., 2001). In this direction many successful efforts have been made in the past to increase unsaturated fatty acids (USFA) and long chain fatty acids (LCFA) contents in milk fat by supplementing protected fat (Titi and Obeidat, 2008; Theurer et al., 2009; Mansoori et al., 2011). The supplementation of protected fat increased milk yield and proportion of USFA but decreased milk protein percentage (Canale et al., 1990; Chen et al., 2002; Lohrenz et al., 2010). However, nowadays the trend in the dairy industry is toward adoption of a pricing system based on both fat and protein contents of milk rather than milk fat content alone. Consequently, this pricing system has generated interest in understanding how milk composition can be modified through nutrition. Efforts have been made in the past to increase milk yield as well as milk protein content of dairy animals by supplementing ruminally protected amino acids (Bertrand et al., 1998; Robinson et al., 2010). It was hypothesized that supplementation of protected fat and protein during early lactation would improve yields of milk and milk components of dairy buffaloes and maintain persistence of the same after they were withdrawn. Objectives were to evaluate effects of protected fat and proteins supplement on milk production, composition, nutrient utilization and some blood constituents in Murrah buffaloes. Supplementation of protected fat and protein did not affect total DM intake of buffaloes in both the groups. Similar to the results obtained in the present study, Strusinska et al. (2006), Thakur and Shelke (2010) and Silvestre et al. (2011) did not observe any effect of supplementing rumen protected fat to cows and buffaloes on DM intake. Generally, digestibility of fat in ruminant diet is low due to high content of non-fatty material and the small proportion of true fat in the total diet, which causes endogenous secretions to be relatively high (Palmquist and Jenkins, 1980). However, added fat is more digestible than the lipid components of the basal diet or that additional fat dilutes endogenous lipid secretions resulting in a more accurate estimate of free lipid digestibility (Palmquist, 1991). The effects of fat supplementation on milk fat and fatty acids composition are influenced by the type and amount of dietary fat and its degree of inertness or protection in the rumen (Ashes et al., 1997). Use of supplemental fats increased milk fat content and yields but often decreased milk protein percentage (Canale et al., 1990; Chen et al., 2002; Lohrenz et al., 2010). Using Ca salts of fatty acids in the diet of dairy ewes, by analogy to dairy cows, has become more and more commonplace. Fats are added to diets of lactating ruminants to meet high energy demand during early lactation, increase fat content and change fatty acid composition of milk (Antongiovanni et al., 2002). Martini et al. (2004) stated that fat supplement to ruminants' affects milk yield and milk composition. Response in milk production to Ca salts has been variable (Gargouri et al., 2006). Earlier work showed that ewes fed supplemented diets produced more milk than the none supplemented ones (Perez Alba et al., 1997; Casals et al., 1999) while other studies showed no improvement in milk yield in diets containing different levels of fat (Dobarganes Garcia et al., 2004; Casals et al., 2006). Previous work has shown that the use of Ca salts in ewes' diet increased milk fat content with decreased milk protein content (Casals et al., 1999, 2006). Addition of fats to sheep diet increased milk content in long chain fatty acids and provided fatty acids which are directly available for milk fat synthesis (Dobarganes Garcia et al., 2004; Casals et al., 2006). Casals et al. (2006) reported that the available information on the effect of Ca salts of fatty acids, for dairy sheep under practical conditions, are very limited. Many of these products are available in the market and their effects vary depending on their FA composition. Therefore, the objective of this study was to evaluate the effect of feeding different levels of a Ca salt on milk yield and composition, and on growth rate of lambs of lactating Awassi ewes during their first 60 d of lactation.

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