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The need for fats in highly-productive ruminants

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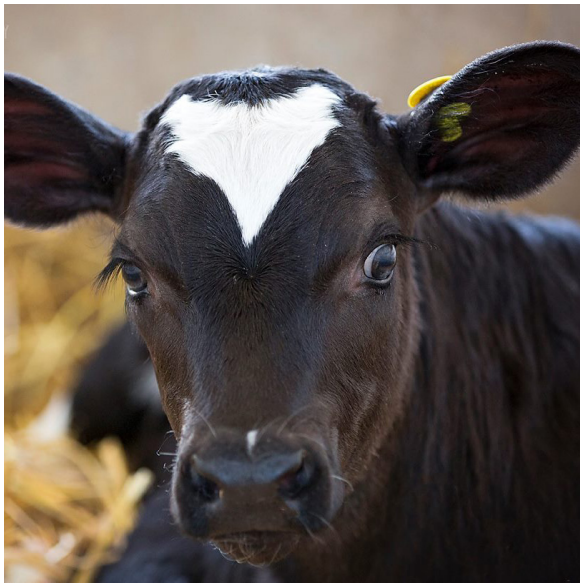
INTRODUCTION

The current high levels of production of dairy cows and the reduction in their reproductive performance require providing animals with high energetic diets while maintaining their health and welfare. This is even more remarkable during the transition period, since energy demands are even higher, and cows naturally have limitations on dry matter intake. In order to deal with this situation, the use of fat supplements is widespread, since they increase the energy density of the diet (fat contains 2.25 times the energy of carbohydrates, McDonald *et al.,* 2010) without jeopardizing rumen's health (unlike high energy diets based on carbohydrates)

In dairy cows, increasing the energy density of the diet is crucial during the transition period in order to achieve also acceptable reproductive outcomes, since when there is a reduction of 1.9 Mcal of daily Net Energy, ovulation is delayed one day. Accordingly, it has been observed that the addition of fat has resulted in increased levels of progesterone in blood and enhanced follicular development aspects that affect the maintenance of the embryo and its chances of survival (Lammoglia, 1997; van Knegsel, 2005). Due to this, fats should not be introduced into development programs just as mere suppliers of energy, but also as providers of essential polyunsaturated fatty acids (or precursors thereof) that play an essential role in reproduction



Regarding recommended values, rations of high producing animals should contain about 4-6% fat, in order to avoid problems such as reduction in dry matter intake and/or fiber digestibility (NRC, 2001)

CHOOSING THE MOST SUITABLE FAT IN RUMINANT DIETS: INTERACTIONS BETWEEN ANIMALS' NEEDS, HIGH PRODUCTION LEVELS, MARKET TRENDS, AND THE BIOHYDROGENATION PROCESS

However, not all fats are equal,every user needs to find what suits him best. In this sense, at least two technical criteria should be taken into account:

1. Chemical intrinsic quality (moisture content, peroxides, and dioxins, etc.)
2. Composition profile and nutritional value (gross energy content, percentage of triglyceride composition and essential fatty acids, etc.)

The energy value is one of the most important aspects to take into account. In ruminants, this does not only depend on its digestibility, but also upon its level of protection against ruminal biohydrogenation. To put it simply, it can be said that the part of the fatty acids present in the diet (particularly, the unsaturated ones) are different than those absorbed at the intestinal level; so that if one does not take into account the biohydrogenation process, it is not possible to predict productive results. Certain rumen microorganisms biohydrogenate unsaturated fatty acids, as they find them toxic (especially those with more than 20C)

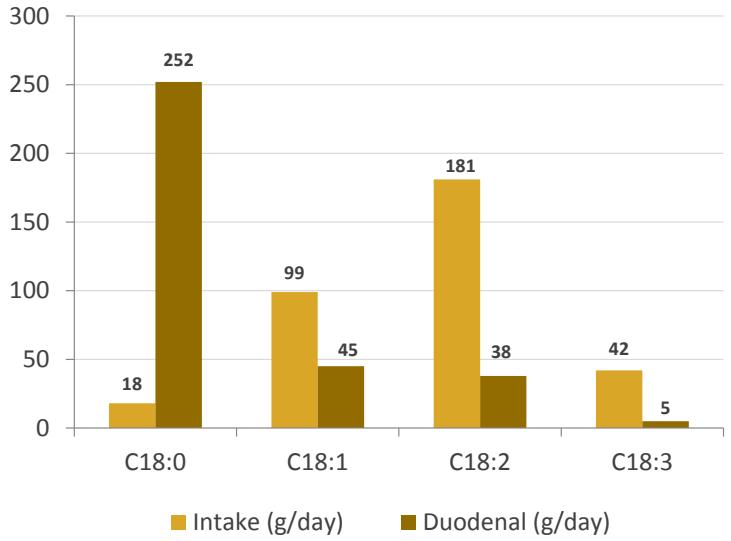


Figure 1. Fatty acids and dairy cows: ingested vs duodenal flow (own elaboration from Jenkins & Bridges, 2007)

To be precise, microbial enzymes saturate unsaturated fatty acids by adding hydrogen to the double bonds, continuing until the molecule becomes a saturated fatty acid, i.e. from C18:2 to C18:0 (Block *et al.*, 2005). This is reflected in the results of the study carried out by Staples *et al.* (1998), who observed that only around 10-25% of ingested unsaturated fatty acids are not modified and reach the small intestine. In line with these results, Doreau & Ferlay (1994) found that the hydrogenation rate of linoleic acid (C18:2) was 0.70-0.95 (0.80), and that of linolenic acid (C18:3) was 0.85-1.0 (mean 0.92)

Moreover, if these unsaturated fatty acids are given without being rumen-protected, they will lead to a reduction of both fibre digestion (reducing milk fat yield) and microbial protein synthesis (which is essential for milk production) (Solomon *et al.*, 2000). Moreover, rumen biohydrogenation produces some intermediates of which some of them (mainly trans-10, cis-12-CLA) act locally in the mammary gland, reducing the milk fat De Novo synthesis, and thus milk fat, up to 50% (Bauman & Griinari, 2003; Glasser *et al.*, 2008; Rico & Harvatine, 2013)

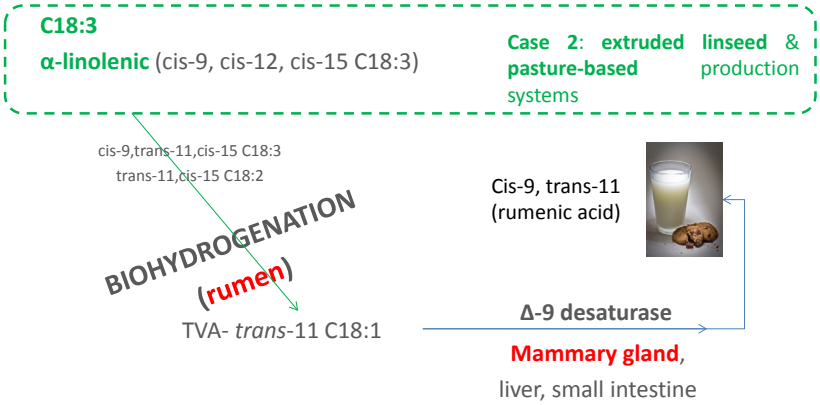


Figure 2. C18:3 modifications and transference into milk fat (own elaboration from Grinarii & Bauman, 1999; Mosley *et al.*, 2006; Kay *et al.*, 2007)

This last process is called "Milk Fat Depression" (MFD), and represents a challenge for the efficiency and profitability of modern dairies. Figure 3 shows schematically the relationship between the biohydrogenation process of C18:3 and MFD. Figure 4 shows how small quantities of trans-10, cis-12-CLA reduce milk fat percentage

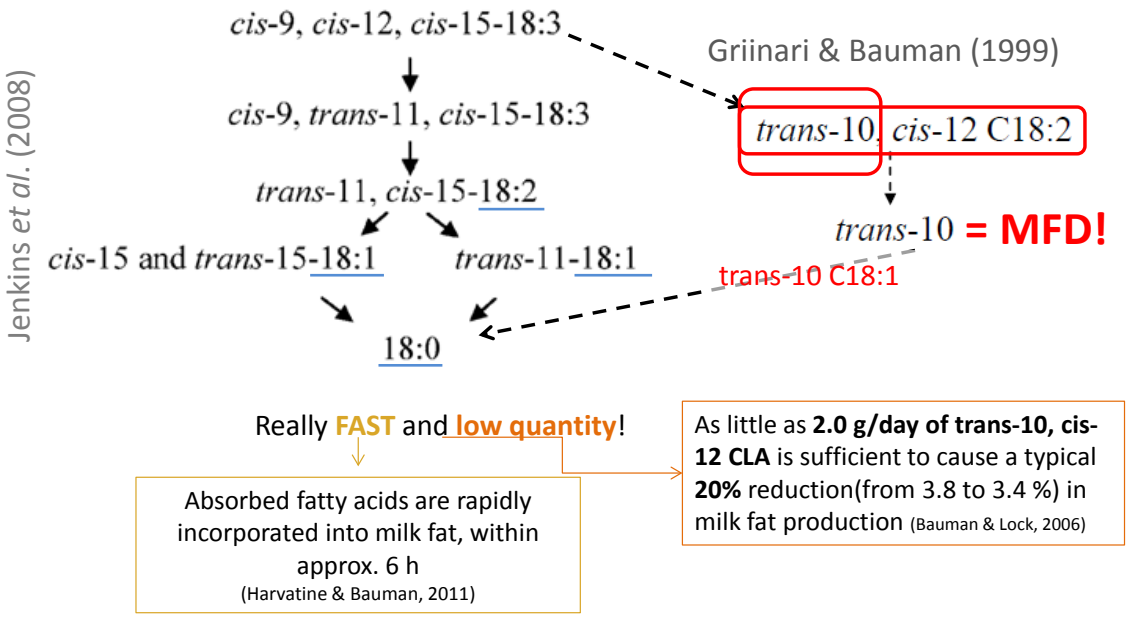


Figure 3. Relationsips between the biohydrogenation process of C18:3 and MFD

Thus, rumen biohydrogenation poses important implications. Firstly, it is known that reproductive performance is not only linked to the Energy Balance, but it is also greatly linked to the availability of specific fatty acids (unsaturated). Secondly, there is need to provide consumers with animal origin products whose fatty acid profile is healthier (i.e. having a higher content of Omega-3 fatty acids). Howecer, in order to avoid the biohydrogenation process, these fatty acids must be given in a rumen-protected chemical form. Thirdly, digestion and fat absorption is influenced by several factors, such as fat's composition and fatty acid profile. Thus, the inclusion of unsaturated fatty acids may increase the intestinal absorption of both the fat supplement and the whole diet (Glasser *et al.*, 2008; Loften *et al.*, 2014)

As a consequence, it is necessary to provide animals with the suitable amount of specific unsaturated fatty acids, and they must be protected against rumen biohydrogenation

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