Highly digestible fat sources for dairy cows

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Ruminants in intensive systems have to satisfy great energy requirements. The increased genetic potential for milk yield in modern dairy cows implies an increasing demand for sufficient energy supply together with limited capacity for feed intake.

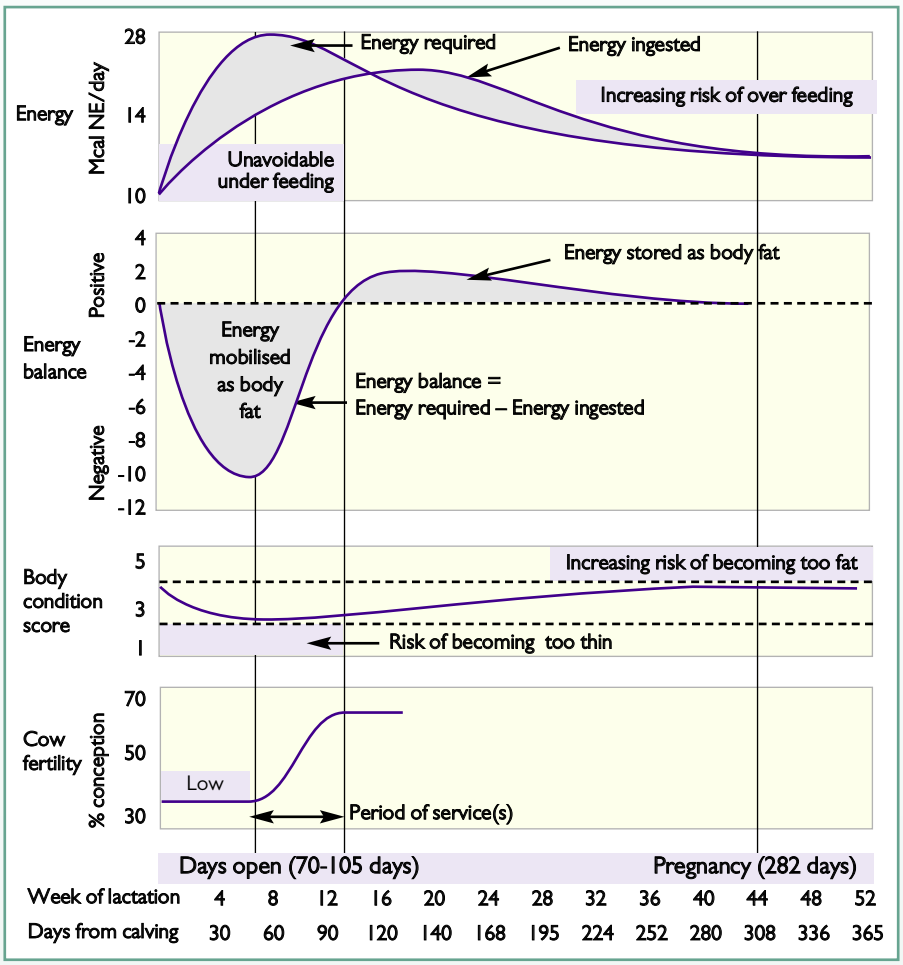
This means rations with low fill and either high content of easily fermentable carbohydrates or high density diets. In the first third of the lactation, when the cow milk yield is the highest, more energy is required.

A negative energy balance is likely to occur due to the limited capacity for feed intake as a result of the involution of the reproductive system (Fig. 1).

The most reliable strategy to deal with this negative energy balance is to increase the density of the diet with protected fats. Fats are 2.25 times more energetic than the starch coming from carbohydrates; furthermore, carbohydrate metabolism results in production of VFA (volatile fatty acids) and lactate; an increase in ruminal acidity and osmolality is likely to happen when acids and lactate (and glucose) accumulate.

In the first third of lactation the intake capacity is very low; milk production reaches the maximum and the cow is more receptive to service. Fertility can be diminished if the cow is too thin (Fig. 1).

Fig. 1. Energy intake, energy balance, body condition score and cow fertility during lactation (Michael A. Wattiaux Babcock institute, Wisconsin University).



Therefore, increasing the density of the diets in the three first months of lactation is essential.

When fats are added to the diet, they should be rumen inert so that they do not interfere with rumen microbiota; they have very little effect on rumen function. A fat is rumen inert when it is protected due to low pKa of the fat source given, lower than the pH in the rumen, and rumen protection due to high melting point of the fat fed.

Chemical characteristics

The digestibility of fatty acids depends on the chemical characteristics of the fat, the physical nature of the fat source or oilseed, characteristics of the dietary ingredients to which the fat is added and level of intake.

Some of the characteristics related to digestibility are:

- Chain length – the longer the chain the lower the digestibility.
- Esterification – whether fatty acids are attached to glycerol as triglycerides (esterified fatty acids), or are present as free fatty acids (FFA); free fatty acids are more easily absorbed.
- Insaturations – saturated fats are solid at body temperature (high melting point) therefore, less digestible. On the other hand, non-inert unsaturated fatty acids will be biohydrogenated in the rumen by microorganisms, but they are more digestible in the intestine.
- Inclusion rate – Palmquist (1991) and Bauchart (1993) stated that fat digestibility declined at high fat intakes; 3% is considered to be the optimum rate of inclusion to maximise digestibility.

The digestibility of the fat determines the absorption efficiency. Providing a source of energy, the incidence of both ketosis and the mobilisation of body reserves will be lower, thus, body condition score and fertility will be improved; and as a result open days will be reduced.

When fats are given as saturated fatty acids they will bypass the rumen as their melting point is over 50°C. When they reach the intestine the enzymes, of both abomasum and intestine, attack these com-

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Fat	DC	Inclusion	DE	NEl	UFL/kg	References
			Mcal/kg			
Calcium salt	100	3	7.8	6.4	3.7	Schauff et al. 1992a
Calcium salt	91.8	3	7.2	5.9	3.4	Schauff et al. 1992a
Calcium salt	83.5	5.6	6.5	5.4	3.1	Aldrich et al. 1997
Flaked HPFAD	65	5	6.0	4.9	2.8	Elliot et al. 1994
Prilled HPFAD	60.3	2.5	5.6	4.6	2.6	Elliot et al. 1995
Hydrogenated palm distillate	52.1	5.2	4.8	3.9	2.3	Elliot et al. 1996
Partially hydrogenated tallow	48.4	4	4.5	3.7	2.1	Drackley et al. 1993
Hydrogenated tallow	41.5	5.6	3.8	3.1	1.8	Elliot et al. 1994

Table 1. Estimated digestibility coefficient (DC), metabolic energy and net energy of calcium salts and hydrogenated fats at different intake levels (Drackley, 1999b). HPFAD = hydrogenated palm fatty acids distilled.

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pounds and they will be partially digested even though they would be still solid.

Fats can also be added as salts. Calcium salts of palm fatty acids (Ca-PFA) are inert at neutral pH (Ca-PFA have been tested to be stable at pH=5.5), so they will not be dissociated at normal rumen pH.

When they reach the abomasum they will be dissociated into calcium and fatty acids. These fatty acids will reach the intestine where they will be absorbed. The absorption is really high, therefore, the digestibility is too.

The fatty acid profile of the salt should have a melting point close to body temperature so that they can be absorbed.

Saturated fatty acids have high melting points, whereas, unsaturated fatty acids have lower ones.

A combination of mainly palmitic (C16:0), stearic (C18:0) and oleic (C18:1) acid have an optimal melting point (38°C). Digestibility values of different fat sources, obtained from a review are shown in Table 1. Different digestibility coefficients were obtained due to a change in the inclusion rate. When the fat intake is too high, digestibility will be diminished.

The highest digestibility was obtained for calcium salts of fatty acids, due to the higher absorption of these fatty acids in intestine, as already mentioned.

Optimise intake

So that a fat is rumen protected it should optimise intake, should not be lipolysed and biohydrogenated in the rumen, should not interfere with ruminal fibre digestion and finally will be highly digested and absorbed in the intestine.

Calcium salts of palm fatty acid distillate fulfil all the requirements mentioned above, since its chemical structure is inert at rumen pH and it is efficiently absorbed in the intestine. For instance, Weiss et al. (2004) obtained digestibility values for Ca-SFA that ranged between 87-93% depending on the inclusion rate. It has been scientifically proved that when Ca-SFA inclusion rate is about 3% the digestibility is approximately 93%.

Palm fatty acids distillate calcium salts have an optimal profile to enhance digestibility, having both saturated and unsaturated fatty acids.The fatty acid profile is half unsaturated that are more easily absorbed and which have been proved to have a positive effect on fertility. Many researchers have described effects of calcium salts on milk yield already; calcium salts are a reliable fat source for increasing milk production. ■