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Reducing problems in transition cows using protected choline

The onset of lactation is a critical period in high performing dairy cows. Good management during this transition period is crucial and nutritional adaptations can assist the process.

At the end of gestation and post-calving, every cow experiences a negative energy balance. As the energy demand of the nearly full-grown foetus and especially the initiation of lactation is so high, cows are not able to consume enough energy to fulfil this need. As a result, cows will use their body reserves and break down fat (and muscle) tissue as a source of energy. If the cow's dry matter intake during the calving period is impaired, the negative energy balance will be even more severe.

Fat metabolism in cows

When fat is mobilised from the adipose tissue (*Figure 1*), the original triglyceride structure is broken down into glycerine (glycerol) and fatty acids, or non-esterified fatty acids (NEFAs). NEFAs are transported through the blood to the liver, where they are metabolised further.

In a first pathway, NEFAs are oxidised in the mitochondria of the liver cells. This oxidation process creates energy for the liver cells. The capacity of the liver for complete oxidation of NEFAs is limited. If oxidation is not complete, ketones are formed (e.g. beta hydroxy butyrate or BHBA), which will appear in the blood.

A second possible pathway for NEFAs in the liver is the re-esterification to triglycerides. Re-esterified triglycerides can again be transported from the liver to the blood. For transport in the watery environment of the blood, these triglycerides must be packaged into very low-density lipoproteins (VLDL).

When the supply of NEFAs to the liver and the formation of triglycerides is high, synthesis of VLDL can be limited. In that case, triglycerides cannot be excreted but remain in the liver as liver fat. Accumulation of fat in the liver leads to fatty liver disease and impaired liver function.

Choline can be of help

To synthesise VLDLs in the liver, choline is an essential compound. VLDLs contain phosphatidylcholine (PC) and choline has a function both as a building block and as a methyl donor in the formation of PC. The methyl group metabolism in the liver, where choline functions as a methyl donor, is not only an important process for the formation of PC, but also for synthesis of other compounds such as carnitine.

Because choline is so important in the synthesis of VLDLs and the methylation of other compounds, a good choline supply is required for exporting fats from the liver and for the optimal functioning of the liver in general.

Choline is not considered an essential nutrient in the diet of cows, as they can produce choline by themselves. However, if the metabolism of cows is very fast, which is typical for high-producing cows in the beginning of lactation, choline production might be inadequate. In this case, administering bioavailable choline can optimise the metabolism and, in the end, maximise milk production.

Only bioavailable when protected

To be bioavailable, choline has to be taken up in the small intestine. However, when choline is added to the feed (in the form of choline chloride), it first enters the rumen. The microbiota present in the rumen degrades almost all the choline chloride.

Studies in sheep showed that C14-labeled choline was converted into trimethylamine in the rumen, and 76% was emitted as methane. This means unprotected choline will not be

Figure 1: Lipid metabolism in the dairy cow.

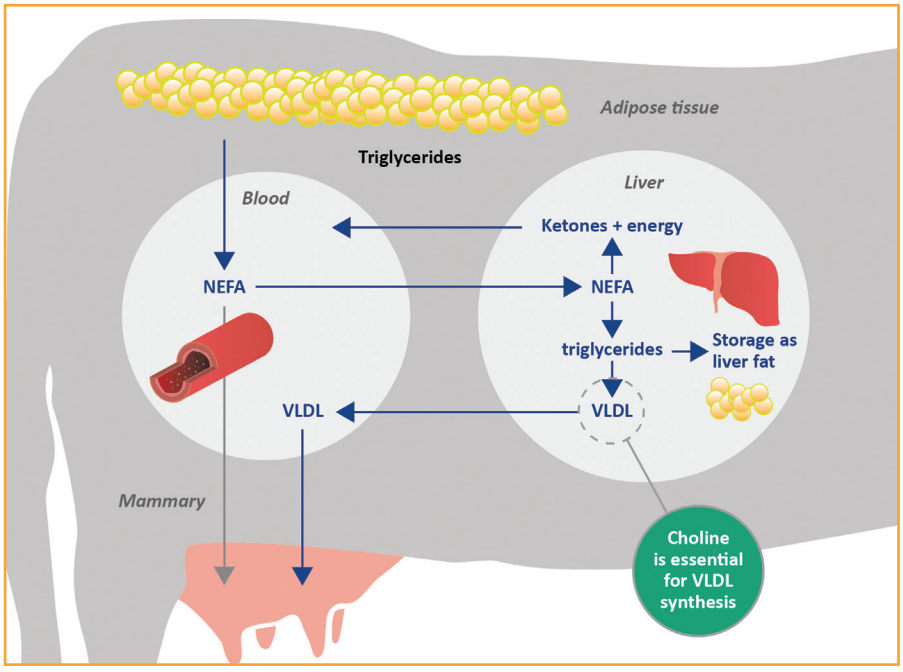
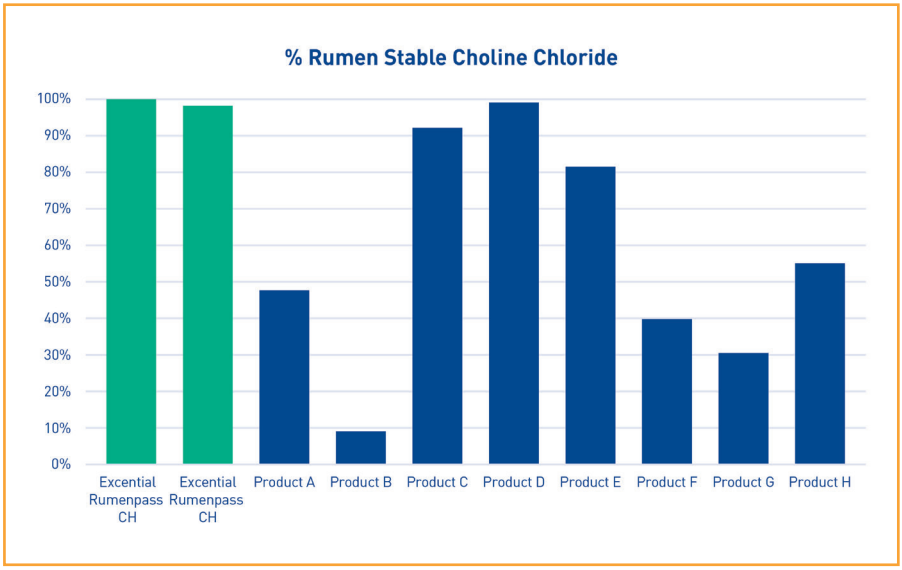


Figure 2: Rumen stability of protected choline chloride products after eight hours' incubation in rumen fistulated cows.



bioavailable for the ruminating cow and is useless to support its metabolism. In fistulated cows, when unprotected choline chloride is administered directly into the abomasum or the small intestine, positive influences could be observed.

To bypass the rumen in practice, choline chloride can be protected by a layer of fatty acids. Rumen microbes are incapable of digesting this fatty acid layer, and only in the small intestine do the digestive lipase enzymes break down the protection and release choline that is available for absorption.

By adding a good rumen bypass choline source to the diet, the positive effects of bioavailable choline can be obtained. Attention should be paid to the quality of the coating, as research in rumen fistulated cows shows there is a great difference among products in terms of protecting the choline chloride against rumen degradation (*Figure 2*).

Positive effects in dairy cows

Using protected choline chloride is an excellent way to support liver function in the transition dairy cow. During early lactation, choline appears to be a limiting nutrient for high milk production and supplementing rumen bypass choline chloride helps maximise milk production in dairy. Several studies show milk yield improvements, with an approximate 7% increase in milk production.

As explained by the important role of choline in the formation of VLDLs, it is also shown that protected choline chloride helps to avoid fatty liver syndrome. Especially in 'at risk' cows (fat cows prepartum), additional choline is beneficial in terms of supporting the fat metabolism and to encourage the transport of triglycerides out of the liver.

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Another typical metabolic disorder in transition dairy cows is ketosis. As mentioned, incomplete oxidation of NEFAs in the liver leads to the formation of ketones (e.g. BHBA), which will appear in the blood, urine and milk.

High ketone levels in the blood (> 1,2mmol/ℓ) can result in clinical disease (clinical ketosis) with symptoms of decreased feed intake, a drop in milk production, weight loss and nervous symptoms. Also, subclinical ketosis, when ketone levels in the blood are elevated but clinical symptoms are less obvious, leads to economically important production losses.

The incidence of subclinical ketosis in dairy herds can be high (20 to 30%), which results in reduced milk yield and also in direct costs associated with the higher susceptibility to diseases. The prevalence of both fatty liver disease and (subclinical) ketosis can be reduced with the preventive use of protected choline chloride, which reduces the costs incurred by these metabolic diseases.

Thanks to these beneficial effects that lead, depending on the situation, to a decrease in direct and indirect costs and an increase in milk yield and reproductive performances, protected choline chloride will result in an economic benefit for the cow herd.

Dosage recommendations

Choline requirements for dairy are not established (NRC, 2001), but high-producing cows excrete 3 to 5g/day of choline in the milk. It appears that a minimal daily supplementation of 10g of bioavailable choline chloride is needed to see significant results. In several studies, dosages of 15g are used and these amounts of choline chloride should therefore be recommended.

As for good rumen stability of choline chloride, the fat coating should be protective enough. Typically, products contain around 25% of the active ingredient. Consequently, recommended supplementation of rumen protected choline chloride is 60g/cow/day.

It is especially advised to supplement choline chloride during the transition phase. It is advised to start from approximately three weeks prior to the expected calving date and to supplement cows until three to six weeks post-calving. If herds are experiencing problems later during lactation, a longer supply should be considered (e.g. the first 90 days of lactation).

In conclusion

Although dairy cows can endogenously produce choline, the availability of this nutrient will be inadequate for maximal performance. Supplementary choline chloride has proved to have beneficial effects, but only if it is protected against degradation in the rumen. Supplementation leads to higher milk yields and prevents metabolic disorders such as ketosis and fatty liver. In nutritional strategies to lower problems in transition cows, good rumen protected choline chloride certainly deserves its place.

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