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Stearic, palmitic acids

Research has shown that long-chain fatty acids are not just a source of energy but are bioactive compounds and have metabolically different functions in the cow.

By J.R. LOFTEN, J.G. LINN, J.K. DRACKLEY, T.C. JENKINS, C.G. SODERHOLM and A.F. KERTZ

Inclusion of fat in lactating dairy cow diets is a common practice today to meet energy requirements for milk production, reproduction and body condition restoration.

Dry rumen inert fat supplements have increased in usage because of their versatility on farms in that they can be added to grain/mineral mixes, added directly to total mixed rations or top-dressed.

The fatty acid composition of ruminant fats will vary, but the long-chain fatty acids (LCFAs) - palmitic (C16:0), stearic (C18:0), oleic (C18:1) and linoleic (C18:2) acids — are the most common.

Research over the last several years has shown that these LCFAs are not just a source of energy but are bioactive compounds and have metabolically different functions in the cow.

The two saturated fatty acids C16:0 and C18:0 differ greatly in metabolic function and in how they support milk production. Until recently, there was limited information to differentiate the role of these two fatty acids in dairy cow nutrition (Loften et al., 2014).

Digestion, absorption

While C16:0 and C18:0 are similar in chemical formula — only differing by two carbon atoms — their presence and role in dairy cow metabolism are quite different.

Palmitic acid is the most common saturated fatty acid found in plants, animals and microorganisms. Common sources of C16:0 include palm oil, palmkernel oil, coconut oil and milk fat. Stearic acid is prevalent in nature, found in animal and vegetable fats, but generally is higher in animal than in vegetable fats. Melting points (145°F for C16:0 and 157°F for C18:0) and pH (4.78 for C16:0 and 4.5 for C18:0) of the two fatty acids are similar.

The composition of dietary fatty acids and those fatty acids entering the small intestine are quite different. Wu et al. (1997) was one of the first to show that C16:0 was the only fatty acid to increase in the amount flowing from the rumen above the amount fed with or without fat supplemented in the diet (Table 1). Later studies have shown that the amount of C18:0 leaving the rumen can be as much as 25 times greater than intake amounts and accounts for 40-70% of total fatty acid flow into the duodenum. The amount of C16:0 flowing into the duodenum from the rumen is generally similar to the dietary intake and represents 10-20% of the total fatty acid flow.

Early digestibility studies underestimated the digestibility of C18:0 because these studies were based on whole-tract disappearance and did not account for increased C16:0 leaving the rumen as a result of the rumen biohydrogenation of oleic, linoleic and linolenic fatty acids.

More recent studies (Doreau and Ferlay, 1994; Doreau and Chillard, 1997; Enjalbert et al., 1997; Lock et al., 2006) compared digestibility between the duodenum and ileum or the duodenum, ileum and feces and concluded that digestibility of C16:0 and C18:0 essentially the same (Table 2). Thus, digestibility of C16:0 and C18:0 is essentially equal, as shown.

Metabolism

Stearic acid is the predominant fatty acid flowing out of the rumen and absorbed by the dairy cow, yet C18:0 and C18:1 fatty acids are essentially equal, as shown.

Reprint heifer fertility

Although well-conditioned heifers took longer to achieve estrus after energy restriction, a disadvantage occurred after adjusting the diets to reinitiate estrous cycles again. Well-conditioned heifers were required to be in greater condition after calving. Therefore, these heifers were perceived to have a “normal” condition at a greater BCS than those heifers maintained at a BCS of five.

Other disadvantages of feeding heifers to have excess fat are that they have a decrease in subsequent milk production, a potential for increased calving difficulty and pregnancy rates that tend to decline.

The Bottom Line

The primary objective of a beef cattle producer is for every cow to produce one live calf once a year. Many factors account for the failure of heifers and cows to maintain that yearly calving interval.

The nutrition/reproduction interaction is a complex system involving many interactions between nutritional components and physiological signals, but the greatest opportunity for a heifer to become a productive cow is to ensure that she becomes pregnant each in her first breeding season, and sound nutritional management of replacement heifers is a key component to ensure successful lifetime productivity of those heifers in the herd.

References


1. Fatty acid intake and rumen outflow in cows fed a 40% concentrate diet without fat (control) or with rumen inert fat or animal/vegetable (AV) blend

<table>
<thead>
<tr>
<th>Fatty acid</th>
<th>g/day</th>
<th>Control</th>
<th>Rumen inert</th>
<th>AV blend</th>
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<tbody>
<tr>
<td>C16:0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intake</td>
<td>71</td>
<td>400</td>
<td>165</td>
<td></td>
</tr>
<tr>
<td>Outflow</td>
<td>83</td>
<td>313</td>
<td>152</td>
<td></td>
</tr>
<tr>
<td>C18:0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intake</td>
<td>12</td>
<td>75</td>
<td>104</td>
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</tr>
<tr>
<td>Outflow</td>
<td>169</td>
<td>254</td>
<td>412</td>
<td></td>
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<tr>
<td>C18:1 (total)</td>
<td></td>
<td>79</td>
<td>309</td>
<td>297</td>
</tr>
<tr>
<td>Intake</td>
<td></td>
<td>79</td>
<td>309</td>
<td>297</td>
</tr>
<tr>
<td>Outflow</td>
<td>90</td>
<td>158</td>
<td>126</td>
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</tr>
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<td>Total fatty acids</td>
<td></td>
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<td>1,052</td>
<td>934</td>
</tr>
<tr>
<td>Intake</td>
<td>402</td>
<td>837</td>
<td>810</td>
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</tbody>
</table>

2. Average digestibility values of LCFAs in dairy cows

The fatty acid composition of the AV blend was 17.0% C16:0, 17.2% C18:0 and 34.5% C18:1.

References

Enjalbert et al., 1997; Lock et al., 2006; Loften et al., 2014; Storlie et al., 2006; Wu et al. (1997).