Meeting the energy needs of dairy cows in transition and early lactation can be a balancing act. Increasing the energy density in diets with more grain or fatty acid supply can alleviate negative energy balance, however, this solution comes with a potential downside of lowering performance and health status and increasing damage from oxidative stress.

Recently, researchers in China, in conjunction with Novus International, conducted three studies to evaluate and explain how energy density affects cows at different stages of lactation and how adding a dietary antioxidant affects performance. In general, they found that feeding AGRADO® Plus feed ingredient, with its proprietary blend of antioxidants, counter-balances several of the negative effects of feeding fatty acids resulting in improved antioxidative status, dry matter intake, indicators of peri-partum health and subsequent lactation performance.

Study 1: How Different Rumen-Inert Fatty Acids Supplemented with a Dietary Antioxidant Affect Performance and Antioxidative Status of Early-Lactation Cows

Sixty Holstein cows (average 100 DIM) in 15 blocks of four cows each were fed four diets varying in fatty acid type (LS: lower saturation with calcium salts of long-chain fatty acids; or HS: higher saturation with a product high in palmitic fatty acid), with or without AGRADO Plus in a 2 x 2 factorial design. The experiment lasted nine weeks, with the first week for adaptation. Cows were housed in tie-stall barns and milked three times a day.

Measurements included: DMI based on weighing diets offered and refused on two consecutive days weekly; dietary samples collected weekly were analyzed for chemical composition; health status was recorded by a veterinarian; and milk production was recorded one day per week throughout the experiment. Blood samples were taken on days 16, 36 and 56 with plasma analyzed for metabolite and antioxidant status.

Results

Neither level of saturation nor AGRADO Plus supplementation showed a significant effect on DMI during the study. Milk yield was lower in the LS-fed cows compared with the cows fed HS. The addition of AGRADO Plus improved milk yield to the level obtained in HS-fed cows (Figure 1). Feeding AGRADO Plus improved antioxidant status – decreasing the potent pro-oxidant H2O2 and increased total antioxidant capacity – across the saturation levels. Supplementing with AGRADO Plus also reduced the concentration of non-esterified fatty acids across both saturation levels. Trans-10, cis-12, conjugated cinoelic acid (CLA) was also decreased across both saturation levels.

Key Findings

Inclusion of AGRADO Plus resulted in:

- Increased milk yield.
- Increased total antioxidant capacity in early-lactation cows.
- Decreased plasma nonesterified fatty acids and hydrogen peroxide contents in the early-lactation cows.
- Increased dry matter intake and milk yield during early-lactation.
- Decreased malondialdehyde values – a sign of oxidative damage – at calving.
**Study 2: Antioxidant in Pre-Partum Diet Helps Protect Peri-Partum Health and Post-Partum Performance**

The transition period is a critical time for dairy cows and can be a time of high oxidative stress. The objective of this study was to determine how changes in dietary energy density pre-partum and the addition of AGRADO Plus to the diet pre- and post-partum affected the performance and antioxidative status during the transition period.

Forty Holstein multiparous cows were allocated to 10 blocks of four cows and fed one of four diets of high- and low-energy density, each with or without AGRADO Plus as an antioxidant in a 2 × 2 factorial design. AGRADO Plus was fed 5 g/cow per day. These diets were first offered 21 days before anticipated calving.

Pre-partum dietary treatments were high energy, low energy, with and without antioxidants. During the post-partum period, all cows were fed the same lactation diets (no difference in diet energy levels among groups), and the AGRADO Plus treatment was the same as for the pre-partum period during the first three weeks after calving. Cows were housed, milked and sampled as in the first study; milk production was recorded on days five, 12 and 19 after calving; and blood samples were taken weekly pre- and post-partum.

**Results**

Researchers found that feeding a high-energy lactation diet pre-partum depressed the DMI, milk yield and four percent fat-corrected milk of cows. AGRADO Plus improved the milk in HE, LE diets. Four percent FCM yields were improved in HE diets. The high-energy diet also increased plasma glucose and β-hydroxybutyric acid (BHBA), but AGRADO Plus decreased the plasma BHBA value during the transition period and also significantly decreased malondialdehyde values, an indicator of oxidative damage, at calving.

The researchers concluded that the diet containing high energy density pre-partum may negatively affect the antioxidative status, DMI and subsequent performance of the cows. The addition of AGRADO Plus may improve the antioxidative status and reduce plasma BHBA, eventually resulting in improved lactation performance. They noted that the response to the AGRADO Plus addition was more pronounced for cows fed the high-energy diet pre-partum (Table 1).

**Study 3: Mitigating Effects of Fatty Acids on Rumen Microflora**

In a third study, the researchers used an in vitro gas test to evaluate the effect of fatty acids of different degrees of saturation on rumen fermentation in the absence or presence of AGRADO Plus as a dietary antioxidant. The source of unsaturated fatty acids was a calcium salt of long-chain fatty acids (50% UFA), and palm acid was the source of the saturated fatty acid in a substrate of 100 milligrams corn powder and 100 milligrams Chinese wild ryegrass hay.

**Results**

Supplementation of unsaturated fat significantly increased the populations of protozoa relative to total bacterial 16S rDNA, while showing a negative effect on fibrobacter succinogenes.

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatment</th>
<th>SEM</th>
<th>Ex</th>
<th>Ex</th>
<th>Ex</th>
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<td>LE</td>
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<td></td>
<td>LEA</td>
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<td>DMI, post-partum</td>
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<td>LEA</td>
<td>16.2a</td>
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<td>Yield (kg/d)</td>
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<td>0.72</td>
<td>0.05</td>
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<td>4% fat-concentrated milk</td>
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<td>Milk protein</td>
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<td>Milk fat (%)</td>
<td>0.70</td>
<td>0.04</td>
<td>0.10</td>
<td>0.26</td>
<td>0.39</td>
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</table>

*LS* = lower saturation fatty acid; *HS* = higher saturation fatty acid. Bars indicate the standard error of the mean (SEM).

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**Table 1.** Effect of Dietary Antioxidant and Energy Density Pre-Partum on Milk Yield and Milk Composition in Dairy Cows Post-Partum

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*Means within a row with different superscripts differ (P < 0.05)

1HE = High Energy; HEA = High Energy with Antioxidant; LE = Low Energy; LEA = Low Energy with Antioxidant

2E = Energy Density Effect; AOX = Antioxidant Effect; ExAOX = Interaction of Energy Density and Antioxidant
AGRADO Plus significantly increased gas production and organic matter digestibility after 24 hours of incubation and tended to decrease malondialdehyde value and increase superoxide dismutase activity. AGRADO Plus increased ruminococcus flavefaciens and ruminococcus albus in the unsaturated fat group.

In conclusion, supplementation of unsaturated fat results in reductions in cellulytic bacteria concentration that addition of AGRADO Plus can alleviate (Figure 2). The addition of AGRADO Plus improved the antioxidative status and organic material digestibility regardless of fatty acid type.

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