Below you'll find short summaries highlighting publications impacting ruminant and other species nutrition in the US. Please feel free to reach out with any questions or if seeking specific follow-up information.

Current Research

The essential oil blend Agolin Ruminant L reduces methane production in vitro and in vivo when included in the drinking water of cattle (Batley et al., 2024): This study explored the effectiveness of delivering Agolin to beef cattle via drinking water to decrease methane production over two experiments. In the first experiment, varying concentrations of Agolin L (a liquid version) were tested with a medium-quality forage substrate in 48 h incubations with rumen fluid. Data indicated that the Agolin L decreased methane production in vitro by 15.8% over the 48 h period. The second experiment, conducted over 56 days with Droughtmaster steers, found that including Agolin L in drinking water decreased methane emissions by 16.4%. However, feed and water intake, live weight gain, and rumen fermentation parameters were not significantly affected and thus, methane intensity was non-affected. This study demonstrates that a liquid (water) delivery option does not decrease the efficacy of the Agolin EO blend, offering a promising approach to mitigating greenhouse gas emissions in beef cattle without negatively impacting animal performance. However, further research is needed to explore the long-term effects and optimal delivery rates of Agolin L in different cattle diets.

Dynamic interplay of immune response, metabolome, and microbiota in cows during high-grain feeding: insights from multi-omics analysis (Castillo-Lopez et al., 2024): This study examined how adapting cattle onto a high-grain diet impacts the immune response, ruminal metabolome, and gut microbiota of non-lactating Holstein cows. Over a period of 4 weeks, the cows transitioned from a forage diet to a high-grain diet, allowing researchers to track changes in inflammation-related gene expression, bacterial diversity, and metabolic activity. The immune response was primarily assessed through the nuclear factor-kappaB pathway in ruminal papillae, with increased expression of pro-inflammatory genes such as IL1R, CD14, and TNFR over

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time. Despite stabilization of microbial diversity after three weeks on high grain, bacterial relative abundance continued to shift, particularly favoring propionate-producing taxa like Succinivibrionaceae. Metabolite analysis revealed enrichment in intermediates of carbohydrate metabolism pathways, with significant increases in compounds like succinic acid and ribose as well as biogenic amines, suggesting elevated microbial activity and amino acid decarboxylation. The study highlights that while microbial **diversity** stabilizes within a few weeks on new diets, the immune response and microbial composition continue to adjust beyond the four-week mark, indicating that cows may require more time to fully adapt to high-grain diets. These findings suggest important considerations for feeding regimens, particularly when transitioning cattle to energy-dense rations. These data highlight a continuing story from Feedworks on the value of incorporating Calmin (a longer-term rumen stabilizing additive) in any diet (calves, transition cows, incoming feedlot cattle) where ruminants will be challenged to adapt to a new diet.

Mammary gland responses to altering the supply of de novo fatty acid substrates and preformed fatty acids on the yields of milk components and milk fatty acids (Benoit et al., 2024): This study out of the Lock Lipid Lab sought to describe the potential interaction between acetate (for de novo fatty acids) and cottonseed with or without palmitic acid supplementation for ECM and milk FA profiles. Holstein, mid-lactation cows (n = 32; avg. milk = 106 lbs/d) were assigned to diets either low or high in palmitic acid content, and then supplemented sodium acetate, cottonseed or both. As reported previously, palmitic supplementation increased NDF digestibility by 4 percentage units, and acetate also increased NDFd slightly (1.1 units, a bit more unexpected). As previously demonstrated, acetate increased the yields of milk fat, ECM, and various fatty acids, particularly de novo FAs, while cottonseed increased milk production and the yield of preformed fatty acids but decreased the yield of de novo and mixed fatty acids. In diets high in palmitic acid, the combination of acetate and cottonseed significantly enhanced milk fat yield compared to other treatments, indicating that balancing de novo FA substrates and preformed FA sources is essential for optimal milk fat production. These findings suggest that the boost of milk fat from feeding palmitic FA sources does not exclude the benefit of additional

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acetate in the rumen. However, the effect size (noted in figure 1) may suggest a diminished effect of palmitic supplementation when rumen acetate supply (high functioning fiber digestion) is already maximized. Strategies to maximize milk fat yield such as those outlined recently by Dr. Kevin Harvatine at the Penn State workshop (balancing effective fiber, managing fermentability load, high quality forages to increase acetate, balancing diet with oilseeds or fat supplements) should be weighed with the current costs versus milk component values.

Tea Polyphenols Inhibit Methanogenesis and Improve Rumen Epithelial Transport in Dairy Cows (Teng et al., 2024): This study employed both in vitro and in vivo experiments; the in vitro experiments demonstrated that tea polyphenols significantly decreased methane production while lowering acetate:propionate. This effect was linked to alterations in the microbial community including unclassified archaea (methanogens) while microbial groups associated with more efficient fermentation, such as "Rikenellaceae RC9 Gut Group" and "Butyrivibrio 2", were enriched in the tea polyphenol group. The in vivo experiments report that tea polyphenols increased blood antioxidant levels, including total antioxidant capacity and glutathione peroxidase, indicating enhanced health status. The study also highlighted the potential for tea polyphenols to increase the efficiency of VFA transport across the rumen epithelium which is would presumably increase energy metabolism of dairy cows. These benefits, especially the enhanced antioxidant capacity, are consistent with the advantages provided by other polyphenol-based products aimed at promoting overall animal health. However, more targeted research is necessary to fully understand the specific impact of polyphenol-based products on the rumen microbiome and fermentation processes. Polyphenols may be partially metabolized by rumen microbes into other antioxidant intermediates, or even fully degraded, depending on their molecular structure and solubility.

Live Presenations

Cornell Nutrition Conference Spotlight: Dr. Stephanie Hansen's talk: "Optimal vs Adequate: Trace Minerals in Transition Cows" emphasized the critical role of trace minerals in the health and productivity of transition cows,

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especially during late gestation and early lactation. Dr. Hansen highlighted the low absorption rates of key trace minerals like Zn, Cu, and Mn, which presents challenges in ensuring adequate intake. The interaction of mineral type with rumen microbes make supplementation strategies even more challenging. *Hansen reminded the audience that late gestation is when fetal development is at its maximum and thus trace mineral supplementation during this time significantly impacts the calf's future health and productivity.* Despite cows' milk being naturally low in trace minerals, providing various forms of minerals (i.e., inorganic, organic, hydroxy, and injectable supplements) can support optimal cow and calf health.

Dr. Hansen also discussed the specific functions of various trace minerals (Zn is required for a wide variety of functions) and she stressed the importance of balancing mineral supplementation carefully, as over-supplementation can inadvertently antagonize other minerals, and over supplementation of Cu specifically can cause oxidative damage in the liver. Chromium, though not required, shows potential benefits, such as reducing cortisol levels and improving glucose metabolism postpartum. Studies highlighted in this talk indicate that chromium supplementation might improve milk yield and reduce lipolysis in early lactation, contributing to better overall health during the transition period. In summary, while the transition period demands heightened trace mineral supplementation for both cow and calf health, *Hansen cautioned against the common "more is better" approach, advocating instead for precise and balanced supplementation to avoid the risks of over-supplementation*, particularly with copper. Mineral supplementation approaches should also blend types of minerals to maximize delivery to the small intestine without compromising rumen function.

Penn State Dairy Nutrition Workshop Spotlight: Dr. Adrian Barragan (Redefining the Transition Period: Inflammatory Patterns and Anti-Inflammatory Interventions for High-Priority Cow Groups) focused on managing systemic inflammation during the transition period to enhance cow and calf welfare. He emphasized that while some level of systemic inflammation is necessary for normal physiological processes like parturition and placenta expulsion, excessive inflammation can negatively impact cow performance and health. The extent of inflammation varies by factors such as parity, BCS, and calving complications (e.g., stillbirths or twins). High-priority groups, including cows with high SCC, lameness, or a history of disease, likely require targeted management strategies. Barragan discussed anti-inflammatory treatments, including steroidal (e.g., dexamethasone) and non-steroidal drugs (e.g., flunixin meglumine and aspirin), and highlighted the importance of carefully timing these interventions to maximize benefits. While postpartum treatments can improve milk production and reduce inflammation in multiparous and dystocia-affected cows, prepartum strategies may be more effective for primiparous and over-conditioned cows. Further research is needed to identify additional high-priority groups and optimize anti-inflammatory protocols to support cow and calf health during this critical period. Barragan previously discussed similar content on the Dairy Podcast Show and with the FDA directly warning against aspirin use in a recent letter, other approaches to manage inflammation must be prioritized.

From the archives:

Linking road transportation with oxidative stress in cattle and other species (Deters and Hansen, 2020): This invited review explores the relationship between transportation and oxidative stress in cattle. Transportation is a fact of life in the livestock industry but it introduces significant physical and psychological stressors that stimulate reactive oxygen species and lead to oxidative stress in cattle. Prolonged oxidative stress depletes antioxidants and can damage cellular components, impair immune function, and exacerbate conditions like bovine respiratory disease. The review highlights what biomarkers are used to assess oxidative stress (i.e., malondialdehyde and glutathione peroxidase), though inconsistencies in study methodologies make it challenging to define a standard oxidative stress response. Nutritional strategies, including supplementation with antioxidative vitamins (E and C) and trace minerals, are discussed as potential mitigators of transit-induced oxidative stress. Additionally, yeast fermentation products and synthetic antioxidants can also be used to enhance antioxidant capacity of the ruminant. Understanding these mechanisms and potential interventions can improve welfare, production efficiency, and meat quality.

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Other notes:

1. Dr. Phil Cardoso discussed AA balancing related to dairy cattle health at the Cornell Nutrition Conference. This proceedings paper includes nice summaries of what we know related to AA-balancing and milk production. However, a key reminder that often is forgotten is what Cardoso includes about methionine supplementation and embryonic survival. Methionine may provide the energy necessary for blastocyst growth post-insemination and secure pregnancy for the dairy cow. During later stages of pregnancy, methionine may again be upregulating nutrient delivery to the fetus and ensuring better calf viability. Another recent paper illustrates how methionine (raising %MP from 2.2 to 2.6%) can help calves during heat stress.
2. Dr. Brown spoke at the Cornell Nutrition Conference on cow nutritional strategies that can impact the calf downstream. Many producers (and nutritionists) chase milk components or feed costs with rations but a more consistent approach will ensure higher value calves in the current marketplace. As an example to this, Dr. Brown illustrated rumen-protected choline effects during gestation on calf insulin sensitivity, fat deposition, and marbling. Other conversation points included the value of driving %CP in starter pellets and the suggestion that byproducts high in CP may be an avenue to keep starter pellets affordable without shorting the calf's potential.
3. A survey of mycotoxins in corn targeting the SE U.S. (Pokoo-Aikins et al., 2024) highlights the occurrence and co-occurrence of mycotoxins in feedstuffs. A consensus is that 2024 is likely to yield many hits in diets with fumonisin and deoxynivalenol being the highest in this sample pool. Knoblock covered similar content at the Penn State Dairy Workshop, especially that combinations of mycotoxins raise unknown risk and up to 90% of samples report combinations of toxins. In a previous update, we shared how rumen microbes may help degrade mycotoxins. However, testing your feedstuffs to have a targeted approach to specific toxin risks is a good practice this coming year.
4. A study evaluating chitosan supplementation (300 or 600 mg/d) in lactating dairy goats (El-Zaiat et al., 2024) reported that 600 mg/d feeding rate increased many markers for goat efficiency and shifted microbial populations towards propionate-producing pathways.

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However, buried in this data is a decrease in total VFA *concentration*, raising questions about what the long-term energy effect may be of this treatment.

5. Loh et al. (2024) ran in-vitro fermentations to evaluate inoculum source approaches (1:2 buffer dilution improved fermentation over 1:4), and then test effect of a blend of sulfate minerals (**SULF**) (Cu, 10 ppm; Mn, 40 ppm; Zn, 60 ppm) versus hydroxychloride (**HYD**) sources. While HYD diets had much better VFA production than SULF in vitro, a buried conversation point is that cultures from SULF-fed donors had the best NDFd when fed SULF diet in vitro but had poorer VFA production. This raises questions about the interaction of rumen fluid donor diet with treatment for future studies, and a potential discrepancy between diet digestibility versus VFA production when evaluating future data.
6. Ahmed and Nishida (2024) reported that the red seaweed, *Asparagopsis* spp., was more effective when fed as complete biomass than when only the bromoform was provided to in vitro cultures. This highlights that there is either a) more bioactives in the seaweed that contribute to efficacy, or, b) that the bromoform contained within the biomass is slower to release and has more sustained efficacy. There is clearly much left to learn about the impact of these seaweeds on methanogenesis when applied to feeding ruminants.
7. Hoffman et al. (2024) looked at pre-calving blood markers to see which were most correlated with post-partum metabolic issues. They report that pre-partum NEFAs are negatively correlated with post-partum calcium levels, emphasizing that the cow's energy state affects her mineral mobilization.
8. Martinez-Fernandez et al. (2024) fed 3-NOP (marketed as Bovaer in the US) to pregnant heifers and then a sub-plot of half of their calves versus a set of control animals. Typical treatment effects of microbial shifts are described including more propionate, succinate, and formate; decreased methanogens and H_2-utilizing bacteria. After removing the 3-NOP from the calf diets, one set of calves produced equal CH_4 to the control calves. However, the second batch of calves responded different and produced 10% less CH_4 for up to 28 weeks after coming off 3-NOP. More data is needed to describe a potential lasting effect when 3-NOP is introduced in a developing rumen.

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